THURSDAY, SEPTEMBER 29, 1910.

HISTORY OF BOTANY.

A History of Botany, 1860–1900, being a Continuation of Sachs' "History of Botany, 1530–1860." By Prof. J. Reynolds Green, F.R.S. (Oxford: Clarendon Press, 1909.) Price 9*s.* 6*d.* net.

BOTANICAL science has been fortunate in having had as historian a botanist of such wide knowledge and mature judgment as the late professor of botany in the University of Würzburg. Sachs' "History of Botany," which covers the period from the sixteenth century up to 1860, will always rank, not only as a standard history of botany, but also as the model of a critical study of the growth and progress of scientific thought. Botanists will be grateful to the delegates of the Clarendon Press for their decision to arrange for the continuation of the history of botany up to the close of the nineteenth century, the latter half of which has witnessed such a surprising development of the biological sciences under the stimulus of Darwin's "Origin of Species," published a year before the date at which Sachs' "History of Botany" stops. Sachs himself lays the greatest stress upon the change in outlook in morphological and systematic botany produced by Darwin's epoch-making work; but though he frequently refers to the new conception of evolution, he does not deal in detail with the Darwinian theory of evolution, owing, no doubt, to his conviction that it marked the beginning of a new era, rather than the close of the period under his consideration.

Dr. Green, who has undertaken the honourable task of continuing Sachs' history, has therefore had, as he recognises in his introduction, a very clear starting point for his survey of botanical progress during the latter half of the nineteenth century. Yet he does not commence his history, as might have been expected, with an account of the Darwinian theory of evolution. The fact that the publication of the "Origin of Species" took place a year prior to 1860, the date at which Dr. Green takes up the history, should not have been allowed to stand in the way of his dealing fully with the subject, since it received no detailed treatment in the earlier history. Even if this omission is technically justifiable, one would at least have expected a chapter dealing with such botanical work as has confirmed, elaborated, or modified the Darwinian theory of evolution. Yet Darwin's own amplifications of his theory as detailed in his "Variation of Animals and Plants under Domestication," published in 1868, are not recorded, nor is the theory of pangenesis, put forward by Darwin in 1868, and elaborated by De Vries, either mentioned or criticised. One cannot help feeling that the omission of all discussion of the theory of evolution is a serious blemish to this history of botany. It would indeed have been legitimate to have included a consideration of the work of Weismann and other zoologists who have contributed to the establishment of the theory of evolution. Some discussion, it is true, bearing on evolutionary principles is to be found in the chapters dealing with the morphology of plants, but the importance of the subject warrants a more special treatment.

In general, Dr. Green has adhered to the lines on which Sachs founded the original work, and commences with a consideration of the advances in our knowledge of the morphology of plants. In the first chapter, dealing with the nature of the alternation of generations, he discusses the classic work of Hofmeister, who first clearly established the homologies in the various groups of the Archegoniatæ, and formulated the theory of the alternation of generations obtaining in these plants. Then follows a careful and critical account of the later and divergent views as to the antithetic or homologous nature of these alternating generations, a divergence of opinion which continues to the present time. Dr. Green gives us also an excellent and impartial summary of the opposing views on morphology, on one hand the school of organographers led by Goebel, which considers that physiological requirement is the main factor affecting changes of structure, while the rival school of Naegeli and Celakovsky attributes differentiation to some inherent tendency of the protoplasm to develop in the direction of increasing complexity. In this field of thought, too, the close of the century found active difference of opinion. The difficulties, on the other hand, which had arisen with regard to the proper interpretation of the flower were, as is shown in the chapter on the morphology of the flower, largely overcome by the general acceptance of Goebel's view of the independent morphological value of the sporangium.

To the chapter on taxonomy is added a brief account of the various Floras published during the latter half of the nineteenth century, but this somewhat cursory treatment of the subject of geographical distribution of plants as an annex to systematic botany does not do justice either to the general importance from an evolutionary point of view of the distribution of plants, nor does it allow of an adequate consideration of the physiological and ecological bearing of the more recent work on plant geography. The publication of the "Origin of Species," it has been said, "placed botanical geography on an entirely new basis," yet no one would gather this from the meagre treatment accorded it in this new history of botany. Sir Joseph Hooker's great memoir on the "Distribution of Arctic Plants" is dismissed in two lines, and yet, in conjunction with his "Introductory Essay to the Flora of Tasmania," it probably did more than any other publication to win the support of botanists for the Darwinian theory of evolution. The total omission of any mention of Warming's "Ecology of Plants" and of Schimper's "Plant Geography on Physiological Basis," which represent the trend of modern studies in plant distribution, seems most unfortunate. It is equally regrettable that the series of monographs which have appeared in Engler's "Jahrbücher" and the important work of Drude on plant geography have been left out of consideration.

An interesting feature of the history is the inclusion

of a special chapter on palæobotany, a branch of study conspicuously absent from Sachs' history, for before 1860 our knowledge of fossil plants, based mainly on plant impressions, was too inexact and too uncertain to be of much value in the discussion of the relationship of plants.

But with the publication of the classic memoirs of Renault and of Williamson a precise knowledge of the extinct vegetation of at least one geological period led to striking advances in our knowledge of the extinct vascular cryptogams, and the discovery, at the beginning of the present century, of the seed-bearing nature of many of the fern-like plants of the Carboniferous period, led to a remarkable advance in our conception of the course of evolution of plants and an unexpectedly complete vindication of Hofmeister's views. There is no more striking testimony of the stimulus given to the study of palæobotany by Renault and Williamson than the band of still active workers in France and England, the work of which is passed in review in chapter v.

It is perhaps in consonance with the general trend of advance in botanical science that physiology should receive a fairly lengthy treatment, but a perusal of book iii. certainly gives the reader the impression that the author has given a somewhat more detailed account of the problems of this branch of botany, and that subjects of equal importance connected with the anatomy of plants have been less generously treated.

One must take into consideration that none of the chapters on physiology deal with the physiology of the reproductive processes. These are dealt with partly in connection with the alternation of generations, and partly in connection with the morphology of the flower. But the physiology of reproduction really merits a chapter to itself, in which the modern views of the nature of fertilisation might have been more fully set forth, and the splendid work of Darwin and Müller on self- and cross-fertilisation might then have received ampler treatment.

Grateful as we feel to Dr. Green for the summaries of work done in the various fields of botany, and recognising fully their usefulness, we close the book with a feeling that it lacks the breadth of treatment and the perspective of Sachs' history. But in making this somewhat invidious comparison, we do not wish to detract from the careful and painstaking work of the author, which is shown by the very large number of books and papers which he passes under review. His task has been doubly difficult, partly owing to the fact that he has had to deal with innumerable memoirs rather than with a smaller number of great works, and partly owing to the fact that he has been called upon to write the history of a comparatively short period of scientific advance, a period, moreover, so recent as to make it difficult to get a proper perspective. These difficulties might have daunted the most courageous, and we feel duly indebted to Dr. Green for undertaking the onerous task and providing us with so useful a summary of the work done during the latter half of the nineteenth century in so many fields of botanical research.

FUELS AND FURNACES.

Fuel and Refractory Materials. By Prof. A. H. Sexton. Second edition. Pp. x+364. (London: Blackie and Son, Ltd., 1909.) Price 5*s.* net.

THIS work deals generally with natural and prepared fuels, with coal-washing, recovery of by-products, the types of furnaces for metallurgical purposes, with the working of these furnaces in regard to the economical use of fuel, with the measurement of the high temperatures produced, and the commercial testing and calorimetry of fuels, as well as with the natural refractory materials and the apparatus made from these.

The book is packed with information on this very extensive subject, although it is a little loose in places, sometimes in expression, at others with regard to information given.

On p. 39 calorific power is defined as the heat evolved, which is ambiguous. On p. 59 coal is stated to be the only important fuel except natural gas and oil, but for much special Government work and for the higher class Sheffield steels, the irons made with charcoal fuel in Sweden and elsewhere are of the greatest importance; also, later, it is stated that charcoal *has* been used in blast-furnaces, whereas at least quite recently there was charcoal pig-iron being made in one blast-furnace in Cumberland, and it is also extensively made in such countries as Sweden.

The time-honoured diagrams of charcoal burning in piles remind one how they shocked the commercial sensibilities of a former student, who was also a Swedish ironmaster, as all the beautifully arranged trunks shown would, according to him, have been cut up into planks for sale, and visits to several charcoal-burning districts confirmed the statement.

Coalite, the product of the coking of coal at a barely visible red-heat, is just mentioned, and as this new departure in coking is creating such an amount of interest in the hope that it may help in the future to reduce the smoke produced in those worst of offenders, domestic fire-grates, one would have liked a little more said about coalite.

A good account is given of fuels generally, but the cost of illuminating gas is stated as varying from 2*s.* 6*d.* to 8*s.* per 1000, whereas in Sheffield it varies from 1*s.* 4*d.* to 1*s.* per 1000 cubic feet.

The description of the use of steam in producers is very well done, but the statement that no producer is satisfactory that allows any sensible amount of CO_2 to pass into the gas is too severe, as in ordinary works practice it is not feasible to reduce the CO_2 below 4 to 6 per cent. by volume, and there is no advice given on the important matter of the thickness of the bed of fuel that should be kept for normal working.

Silicon, manganese, &c., important fuels in metallurgical operations, are not mentioned.

In dealing with standards of temperature it is not clearly enough stated that the present accepted standard is the gas thermometer, and in the description of the Wanner pyrometer, the statement that

"W" is a Nicols prism will be apt to confuse the student. The resistance pyrometer is said to give the correct temperature to a tenth of a degree at 1000° C., but owing to the coating required to protect the platinum wire for most work, nothing like this accuracy will be obtained in practice. In speaking of the useful Féry spiral pyrometer, it is indicated that one of its objections is that it will only give "black body" temperatures, but surely this limitation applies to the other radiation pyrometers also.

The account of the manufacture of Sheffield steel-melting crucibles is not correct, nor is the statement (p. 346) that the crucible is "put to dry, after which it is used without firing," as these crucibles are subjected to a very careful firing, or annealing, on a very ingeniously designed annealing grate. Also, amongst the addition of non-plastic material added to enable the crucible to be made without cracking, are mentioned burnt clay, silica, and graphite; but in Sheffield work the material used is the best ground coke-dust, which not only has this effect, but by forming a solid skeleton to the material of the crucible at temperatures at which the fireclay material is quite soft, enables the crucible to stand the necessarily rough usage to which it is subjected during the making of crucible steel, without losing its shape. If from any little accident in the annealing of the crucible air has been allowed to impinge on any part of it so as to burn out the coke-dust, the crucible loses its shape at these portions, and is exceedingly difficult to manipulate.

The whole subject-matter of the book covers a very wide field, and these critical observations are not intended to indicate that the work will not be a useful one for students, but are only intended to set them on their guard in cases where it will be necessary for them to know the exact state of practical work, or to compare with other authorities where their own experience seems to differ from the statements made in the book. A. McWILLIAM.

MEDICAL PARASITOLOGY.

A Handbook of Practical Parasitology. By Prof. Max Braun and Dr. M. Lühe. Translated by Linda Forster. Pp. viii+208. (London: J. Bale, Sons and Danielsson, Ltd., 1910.) Price 10*s.* 6*d.* net.

THIS is a handy and very useful work by two extremely competent authorities, and well worth translating into English for the benefit of medical men and others to whom the German language may present difficulties. The book is divided into three parts—(i.) Protozoa, (ii.) Helminthes, and (iii.) Arthropoda. Each of these sections begins with an introductory portion, in which, after a general account of the group, very full directions are given for its practical study, with an excellent summary of the most important and useful methods of technique. The group is then dealt with systematically, those forms most important for the purposes of the book being described in their place in the classification, and for each main subdivision a common and easily obtained type is described in detail with directions for procuring and studying it. The information given is in general accurate and up-to-date—the date, that is to say, of the German edition—and the figures are clear and well executed.

In the Protozoa the step is taken of abolishing the class Sporozoa and elevating its two principal subdivisions, Neosporidia and Telosporidia, to the rank of independent classes. The Neosporidia are placed immediately after the Rhizopoda, while the Telosporidia follow the Flagellata, but with subtraction of the Hæmosporidia, which are classified with the Trypanosomidæ amongst the Flagellata as the third order, Binucleata, of that class. In their treatment of these organisms the authors take up an advanced neo-Schaudinnian standpoint with regard to certain highly controversial questions.

The term Helminthes has no zoological significance, but is used in a sense convenient for medical requirements to comprise the Trematodes, Cestodes, Nematodes, and Acanthocephala; not, however, the leeches. In the section Arthropoda, which is a brief one, an account is given of the mites, Linguatulids, lice, fleas, and parasitic Diptera. The Arthropods which transmit parasites, such as ticks and "stinging-flies" (*sic*), are dealt with under the Protozoa.

The translation is, in general, clear, but some curious results arise from the translator's desire to anglicise scientific terms. It appears to be a rule with her to convert the termination "-idium," plural "-idia," into "-ide," plural "-ides," and the consequences are in many cases very puzzling. "Coccide," for instance, suggests a cochineal insect, but means in this book a coccidian parasite. No zoologist would ever guess the meaning of "Myxides," used to denote individuals of the common parasite of the bladder of the pike, *Myxidium lieberkühni*. Most zoologists, and many people who are not zoologists, are familiar with chromidia, disguised here as "chromides." In these and many other cases the meaning of the term used can only be inferred from the context or deduced from analogy. It is also very misleading to use the term "carnivori" to denote birds of prey (p. 60); "small-pox" on p. 32 should be carp-pox; and *Trypanosoma*, in the description of Fig. 14, should be *Trypanoplasma*. It is to be regretted that the eminent zoologists and others, to whom the translator expresses her indebtedness for assistance, did not correct these vagaries. E. A. M.

POPULAR ASTRONOMY.

(1) *Astronomy, a Handy Manual for Students and Others.* By Prof. F. W. Dyson, F.R.S. Pp. vii+247. (London: J. M. Dent and Sons, Ltd., 1910.) Price 2*s.* 6*d.* net.

(2) *Chats about Astronomy.* By H. P. Hollis. Pp. vi+226. (London: T. Werner Laurie, n.d.) Price 3*s.* 6*d.* net.

MANY signs point to the fact that the popular interest in astronomy grows from day to day. Perhaps in revolt against the merely utilitarian the world will not willingly let die the least obviously practical of the sciences. The production of books,

urged by this increased interest, and rendered necessary by the extraordinary modern progress of the science, is not behind the demand. That diverse tastes and capacities have to be catered for is clearly seen in the characters of the above books. The first, condensed, but logical and lucid, will appeal essentially to the lover of astronomy having a mind comparatively trained to precise thinking, while the second frankly provides for the reader who needs spoon-feeding, and likes printed talk.

(1) A simple account of the methods and results in astronomy, without unnecessary detail, and clearly stated for the student and general reader, is the aim and in great part the achievement of this handy little manual. Such faults as the book possesses spring mostly from a too great conciseness. In such subjects as the finding of the solar parallax and the estimation of the distance of the Milky Way, it is better to keep in mind the weaker brethren than the resolute student. Too great economy of words ceases to be a virtue. Jumps, however, requiring undue intellectual effort on the part of the reader are not of frequent occurrence, while the general precision and clarity are ample compensations.

The work is comprehensive in scope, embracing the ancient astronomy and its development through the Copernican system to the most modern outlook on the universe. Recent work on astrophysics, the more intimate study of suns, near and far, is effectively presented. Very few mistakes have been noticed, though what seems an erroneous inference from diagram lxxxiv. leads to the inversion of the relative masses of Sirius and its companion, while it might be inferred from a statement on p. 116 that a magnetic field is a property of all sun-spots. This certainly is not proven.

The reproductions are effective and well chosen, and the diagrams, while efficient, have a home-made look about them which is quite pleasant, though the practice of using Roman numerals to indicate them seems wholly without virtue. An efficient and tasteful binding and handy format are further recommendations for a remarkably cheap book.

(2) Though dealing somewhat discursively with such parts of astronomy as are of most popular appeal, the common sense and individuality of the writer prevent the treatment from becoming banal. To the man in the street interested in the phenomena of the skies, the book may be recommended, and he will no doubt read it with interest and profit. In great part the author restricts himself to the realm of naked-eye astronomy. Both the manner and matter and the definiteness with which the subject is treated suggest and encourage a practical acquaintance with the phenomena on the part of the reader. The earth and its movements, stars and planets, sun-spots and comets, and the changes of the moon are among the subjects informingly and chattily dealt with. A brightly and amusingly written chapter on astronomers and their work gives an excellent account of a much misunderstood profession. The inset reproductions are sufficiently good, but the general appearance of the book might certainly be improved.

MARINE BIOLOGICAL RESEARCH IN BRITISH SEAS.

(1) *Bulletin Trimestrie: Conseil Permanent International pour l'Exploration de la Mer. Résumé des Observations sur le Plankton des Mers explorées par le Conseil pendant les Années*, 1902–1908. Edited by H. M. Kyle. Part i. Pp. xxxiv+79, and 10 plates. (Copenhague: And. Fred Høst et Fils, 1910.)

(2) *The Decapod Natantia of the Coasts of Ireland.* By Stanley M. Kemp. Scientific Investigations, 1908, Department of Agriculture and Technical Instruction for Ireland, Fisheries Branch. Pp. 190+23 plates. (Dublin: 1910.) Price 3*s.* 6*d.*

(3) *Report of a Survey of the Trawling Grounds on the Coasts of Counties Down, Louth, Meath, and Dublin.* By E. W. L. Holt. Part I., Record of Fishing Operations. Scientific Investigations, 1909, No. 1, Department of Agriculture and Technical Instruction for Ireland. Pp. 538+2 plates. (Dublin: 1910.) Price 3*s.*

(1) IN 1908 the International Council resolved to prepare a report on the plankton work carried out by the countries participating in the international fisheries investigations, and the present bulletin contains the first instalment of this report. The bulletin begins with lists of the stations and times of investigation, and of the kinds of nets employed and the occasions on which they were worked. Special reports are then given, in which various specialists deal with the annual and seasonal abundance of the main groups of animal and plant organisms represented in the catches. The groups so far summarised are the Tintinnoidea, Halosphæra and Flagellates, Cladocera, Pteropoda, and Copepoda. Following these special reports are synoptical charts representing the abundance and seasonal distribution of the commoner species contained in the groups studied. The material thus summarised is very considerable; 332 stations in all were worked, some 14,000 hauls were made, and altogether about 800 species of planktonic organisms were identified. It is evident, however, that the deduction of general results from this mass of material has been a difficult task. The coordination of the observations has been imperfect from the first; many changes have been made, and there has been confusion in the choice of methods of investigation. Nevertheless the results obtained are of very great value, and general facts of distribution in relation to the physical changes taking place in the sea emerge clearly from the study of the data. The report provides a concise and valuable summary of this extensive investigation.

(2) This is a minute and careful account of forty-seven species of decapod natant Crustacea (fifty-four in all are recorded from the entire British sea-area) collected by the Irish Fishery cruiser *Helga* off the coasts of Ireland, the main localities investigated being Rathlin Deep, the Irish Sea between Dublin and the Isle of Man, the deep water of Counties Cork and Kerry, and the region near the Porcupine Bank. The report, which is a valuable addition to our knowledge of the British marine fauna, includes full details of

the localities fished, as well as the physical conditions of the sea during the operations. The economic aspect of the research is not neglected.

(3) This is the first instalment of the results of an extensive survey of the Irish fishing-grounds, which is now being carried on by Mr. Holt and his colleagues. It is well known to those engaged in actual fishery administration that mere statistics of the quantities of fish landed at the ports afford, in themselves, information of very little value for a rational regulation of the industry. Fishery authorities competent to their work must obviously obtain at first hand a knowledge of the natural conditions of the sea areas under their control, and this has been the object of the Irish survey. The observations recorded are those of fishing operations carried on by the cruiser *Helga* at such times as her attention was not being directed to the detection of predatory trawlers; they include lists of the fishes present on the fishing-grounds visited, with the numbers taken per haul, and the individual measurements of those caught. It is quite impossible to summarise the results here stated, but one may say with confidence that the report is a contribution of essential value for a real understanding of the natural conditions of the British fisheries. J. J.

OUR BOOK SHELF.

Science in Modern Life. Prepared under the editorship of J. R. Ainsworth Davis. Vol vi., Engineering. By J. W. French. Pp. vi+225. (London: The Gresham Publishing Co., 1910.) Price 6*s.* net.

THE first half of this book is devoted to the various systems of power production, and the other half to the application of such power to the manifold needs of mankind; there is also a short account of the properties of, and the modern methods of manufacturing on a large scale, the chief materials used in constructional work.

In a book of this nature, which is evidently intended to give non-technical readers an intelligent idea of the remarkable work done by the engineer in providing for the varied daily needs of communities living under the complex conditions of civilised life, it is a pity that space should have been given to descriptions of machines and methods which are obsolete, and are only interesting from the historical point of view. In dealing with high-speed engines, there are two illustrations and some amount of letterpress devoted to the Willans and Robinson central valve engine, which is no longer made, though, of course, such engines are still to be found in generating stations and factories where they were installed some years ago, and where they will remain until unfit for further service; it is, however, an obsolete type. In discussing water-tube boilers Mr. French states that "of these types the most extensively adopted in the navies of the world is the Belleville water-tube boiler." This is incorrect; no recent British warship has been fitted with this steam generator, which did not prove altogether satisfactory.

That the section which deals with the applications of power is well up to date is shown by the chapter dealing with aërial navigation and hydroplanes. The latest types of machines are described and discussed. The cable-way illustrated on p. 127 was used in connection with the building of the new low-level lighthouse at Beachy Head, and not, as stated, for the Eddystone Lighthouse.

There are a dozen excellent plates, and about 600 other illustrations, which will greatly increase the utility of the book to those readers who are not familiar with such technical matters. T. H. B.

Vegetationsbilder. Edited by Prof. Dr. G. Karsten and Prof. Dr. H. Schenck. Eighth series. Part 1. Trockensteppen der Kalahari. F. Seiner. Part 2. Von den Juan Fernandez Inseln. Carl Skottberg. Part 3. Die schwäbische Alp. Otto Feucht. Part 4. Aus Bosnien und der Herzegovina. L. Adamovič. Parts 5-6. Die Flora von Irland. Prof. T. Johnson. With six plates in each part. (Jena: Gustav Fischer, 1910.) Price 4 marks each part.

THE eighth series has progressed rapidly, as six parts have been published within the year. For the first time the British Islands is represented, namely, in the double part dealing with the flora of Ireland, arranged by Prof. Johnson. It would be difficult to improve on the subjects chosen, which include *Arbutus unedo*, one of the original forest trees, *Erica mackaii*, *Erica mediterranea*, *Daboecia polifolia*, *Euphorbia hibernica*, *Eriocaulon articulatum*, and *Eryngium maritimum*. All the photographs are excellent, and the number takes rank among the best. European countries are also represented in the pictures of the plant associations of Bosnia and Herzegovina, contributed by Prof. L. Adamovič, and those illustrating the Swabian Alps, provided by Mr. O. Feucht. Naturally the magnificent spruce, *Picea omorika*, endemic to Bosnia, is selected by Prof. Adamovič for illustration, and another subject is *Pinus leucodermis*; other photographs portray associations on the chalk, serpentine, and screes. The slopes and cliffs of the Swabian Jura are rich in calcicolous plants, of which *Saxifraga aizoon* and *Saxifraga decipiens* are two of the most prominent; the illustrations of *Laserpitium Siler* and of Juniper trees about eight feet high also attract attention. The part devoted to the Kalahari desert contains photographs of the well-known trees *Copaifera mopane*, *Copaifera coleosperma*, *Kigelia pinnata*, and *Acacia haematoxylon*, in their natural habitats; a remarkable large shrub, *Sesothamnus Seineri*, discovered by the author, presents striking xerophytic characters. Dr. C. Skottsberg illustrates a number of endemic plants. *Boehmeria excelsa*, a tree growing to a height of eighteen feet, *Juania australis*, a pinnate-leaved palm, *Gunnera palmata*, and a strong root-climbing fern, *Arthropteris altescendens*, are confined to the island of Masatierra; scenes from the island of Masafuera show forest of *Myrceugenia Schultzei* and the tree fern, *Dicksonia berteroana*.

Light Visible and Invisible. By Silvanus P. Thompson, F.R.S. Second edition, enlarged. Pp. xiii+382. (London: Macmillan and Co., Ltd., 1910.) Price 6*s.* net.

THE first edition of Prof. Thompson's popular book was reviewed at length in NATURE of March 31, 1898 (vol. lvii., p. 506). To the new edition have been added chapters on radium and the manufacture of light, the latter being the lecture given to a popular audience at the meeting of the British Association at York in 1906. We have little doubt that with these additions the volume will continue to be read widely.

A Home-work Atlas of Maps in Black and White. Edited by Prof. L. W. Lyde. Pp. 15. (London: A. and C. Black, 1910.) Price 1*s.*

THESE simple maps, showing in a striking way the essential facts of the geography of each of the continents, should prove of real use in schools to give pupils guidance as to how, when answering questions, long verbal descriptions may be saved by judicious diagrams.

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.]*

British Marine Zoology.

PROF. MACBRIDE'S letter in NATURE of September 15 does not require a detailed answer, as some of his statements are merely matters of opinion; but there are a few points on which I should like to comment..

(1) Prof. MacBride says we are unable to support properly one biological station, and that he does not see how we "could be expected to support two"—the second being evidently that proposed by Mr. Pace. But why does he try to ignore the three or four other existing stations? They are all supported; some of them, so far as regards students and researchers, are very well supported indeed.

(2) When he refers to some biological station as an "expensive toy," which in his experience its local friends "soon tire of supporting," one would like to ask of what station he is writing? The statement does not seem to apply to any of those mentioned.

(3) It is difficult for one who has followed the work of the U.S. Bureau of Fisheries Laboratory at Wood's Hole to understand Prof. MacBride's words in regard to it. He says it is "devoted entirely to economic work." A moment's thought of the scientific researches issued from that laboratory by Sumner and others shows the inadequacy of such a description.

(4) As to the Canadian stations, again I think Prof. MacBride does but scant justice to praiseworthy efforts. The western station at Nanaimo was visited last September by a party of biologists from the British Association, who were, to say the least, more appreciative than Prof. MacBride.

But the main thing I want to say is that Prof. MacBride, both in his original article and in his reply to my criticism, has, it seems to me, a false ideal. Expensive equipment, large funds, increased support—these are his keynote; and not a word is said as to a rich and varied fauna, physical features affording natural facilities for research and sympathetic personal service—the factors in the case that give character and tradition to a biological station.

W. A. HERDMAN.

IT would be interesting to know what biological stations Prof. MacBride had in mind when writing the letter which appeared in NATURE of September 15.

Prof. MacBride states that it would be better to concentrate scientific support on one station than to have it spread over a number of stations poorly provided with funds and with staff, and, *ipso facto*, incapable of really first-class work. Surely there is more than one station in Great Britain which is capable of affording opportunities of first-class work, and I venture to think that the number of workers attending some of the smaller stations is ample proof of their usefulness.

The case cited by Prof. MacBride, of Chicago students travelling 1000 miles to Wood's Hole, will, I am afraid, not help many of our Liverpool students to attend vacation courses other than those held now at Port Erin, and Chicago students would have to travel nearly 1000 miles in any case to reach the sea.

There is, to my mind, a great advantage in having biological stations near to our universities, so that it is possible to reach them quickly and frequently. Such stations would serve the departments of zoology, botany, physiology, and biochemistry, and the staff of these departments would feel more at home there than at some station which was only visited at odd times, and in the control of which they would not be so immediately concerned. As a result there would be more encouragement for students to work at these laboratories, and little time lost in preparation.

With regard to the economic side of the controversy, one might quote from a paper by the director of the Fisheries Laboratory at Wood's Hole:—"But the life of the sea is an interrelated whole. Hence the futility of endeavouring, even on economic grounds, to restrict our investigations to food fishes or other animals of obvious commercial importance." WM. J. DAKIN.

Port Erin Biological Station, September 19.

THERE are one or two matters alluded to in Prof. Herdman's and Mr. Dakin's letters on which I should like to say a word or two.

(1) I had no desire to ignore existing biological stations other than Plymouth, but, until Mr. Pace's circular appeared, I think I am correct in saying that the Marine Biological Association was alone in making its appeal for support to all the zoologists in the United Kingdom. The other stations depend on local support.

(2) The curiosity of Mr. Dakin and Prof. Herdman as to the particular station which "local friends tired of supporting" is, I think, uncalled for. Prof. Herdman's unrivalled acquaintance with biological institutions in this country surely includes acquaintance with a station which has been closed.

(3) I held up the station at Wood's Hole as an example of a laboratory devoted to purely scientific ends, and supported solely by professional biologists. That valuable scientific work of general interest occasionally issues from the laboratory of the U.S. Bureau of Fisheries, which was founded and is maintained for research on economic lines, is totally irrelevant.

(4) As to my want of appreciation of "praiseworthy efforts" in Canada, is Prof. Herdman aware that every cent of expense in connection with all three stations in Canada is borne by the Federal Government, which also pays the travelling expenses of workers?

Finally, in regard to "ideals," I would in all modesty oppose my experience to that of Prof. Herdman. For the last twenty years I have been engaged in zoological research. On a good many occasions I have visited small biological stations, but the only stations where I have been able to bring research to a successful issue are those of Naples and Plymouth, which in the matter of boats and apparatus are thoroughly equipped, and which in the matter of "sympathetic personal service" are very near perfection. A biological station where senior students can handle living animals is one thing, and one where advanced research can be done is another. In Plymouth we possess a station of the second kind, certainly, to say the least, better equipped than any other in the kingdom. It will be a thousand pities if it has to curtail its usefulness for lack of support. It was this strong feeling of the absolute necessity of a well-equipped laboratory which led me in 1906, after several summers of futile attempts to utilise the small movable laboratory, to make the motion at the meeting of the Biological Board in Ottawa which resulted in the building of the permanent station at St. Andrews, New Brunswick. E. W. MACBRIDE.

The Spotted Kudu.

IN the *Times* of September 23 and the *Field* of September 24 (vol. cxvi., p. 607) I have given preliminary notices of the skull and skin of a hitherto unknown kudu shot by Mr. Ivor Buxton to the west of the Arusi plateau of Gallaland, in the Sahatu Mountains, and south-east of Lake Zwei, at an estimated height of 9000 feet above sea-level. As the owner has promised to present the specimen to the British Museum, I take this opportunity of making it the type of a new species.

The specimen is an adult bull, its full age being indicated by the worn condition of the cheek-teeth. The head, neck, and body are covered with coarse dark-brown hair, much more like that of a Kashmir stag or a mule-deer than that of either of the striped kudus, and the fronts of the legs are dark greyish-brown, and the remainder grey. The throat and chest lack the abundant fringe of long hair characteristic of the typical kudu, but are marked by two broad patches of white, one above the other, while the body-skin shows large white spots on the flanks and hindquarters, but no kudu-like stripes. The face has the usual tragelaphine white markings. The horns are of the kudu-type, but with a much more outward direction, and are greatly inferior in length to those of the typical species, their tips being worn to a

yellow straw-colour, as in the nyala and situtunga. They have also a more distinct back ridge than in other kudu horns, and thereby again approximate to those of the two last-named species; while the bony cores have no ridge corresponding to that on the sheaths. The skull has a transverse diameter of 4½ inches across the orbits, and a contour length of 15⅛ inches, the corresponding dimensions in a skull of the typical species with horns of the same length being 5½ inches and 14⅝ inches.

The spotted kudu, as I have called the new species, is in great degree intermediate between other kudus and the situtunga and nyala. It agrees approximately in size with the typical kudu, but in horn-characters is to a certain extent intermediate between that species and the situtunga or nyala. In the presence of a white patch on the throat and a second on the chest it resembles the lesser kudu and situtunga, as it also does in the absence of a neck frill; but in its long, coarse, dark, and white-spotted coat it comes much nearer male situtungas and nyalas than to either of the striped kudus. The ears are rather narrower and more pointed than in the typical kudu.

I propose to name the species *Strepsiceros buxtoni*, reserving for future consideration the question whether this species does not render it advisable to merge the genus Strepsiceros in Tragelaphus. If that course were adopted, the typical kudu would become *Tragelaphus strepsiceros*, the lesser kudu *T. imberbis*, and the spotted kudu *T. buxtoni*. R. LYDEKKER.

The Habits of Worms.

So little is known about the habits of worms that it seems desirable to place on record any new observation calculated to throw light on the subject. On September 17 I received from Mr. Edwards, curator of the Worcester Museum, a small tube containing about half a score of living worms. The letter which accompanied the tube informed me that the worms were found in a lavatory basin. It was assumed that they had found their way up through the waste-pipe, as none had been found when the plug was fixed in the bottom of the basin. The worms were taken in the morning when the plug was not inserted, and when the water had been very slowly dripping all night. They were found singly, but when placed in a tube coiled themselves into a ball, and were difficult to separate. Each worm was about three-quarters of an inch in length, possessed of red blood, and having five to eight setæ in each bundle. These features, together with the shape of the brain and spermathecæ, show the species to be *Pachydrilus subterraneus*, Vejdovsky. It was first described in 1889, and on April 8, 1892, I received it from the late Dr. Plowright, of King's Lynn. This was the first British record; but it has since been found by Mr. Southern and myself in various parts of the British Isles. It was obtained by Prof. Vejdovsky from the underground waters of Lille and Prague, and has more than once been sent to me by irate persons who complained that it had been found in their drinking water.

Pachydrilus (Lumbricillus) belongs to the large and important order of enchytræids, some of the species of which are parasitic upon plants, while others feed on decaying leaves and vegetable matter, and yet others live in the water. As I am preparing a monograph of British annelids for the Ray Society, I am exceedingly anxious to obtain information and materials for making the work complete, and shall be grateful if observers will submit specimens of annelids of all kinds for identification, together with observations of their habits.

HILDERIC FRIEND.

Swadlincote, Burton-on-Trent.

Erasmus Darwin on Flying Machines.

PROF. MELDOLA'S reference to Erasmus Darwin's prophecy of flying machines (p. 370) omits the most remarkable proof, as it seems to me, of his insight into the future. The verses which he quotes are from Canto I., lines 289–96, of the "Botanic Garden"; on line 254 there is a note in which occurs the following passage (the italics are mine):—

"As the specific levity of air is too great for the support of great burthens by balloons, there seems no probable method of flying conveniently but by the power of steam, *or some other explosive material*, which another half-century may probably discover."

University College, London. ARTHUR PLATT.

CAUSAL GEOLOGY.[1]

IN science there can be no orthodoxy, and consequently there are no heresies. Prof. Schwarz's book will be read and circulated, instead of being burnt as a danger to established modes of thought. It will bring, in consequence, a freshness to those who have repeated, year after year, the same explanations of phenomena in their courses of instruction. They will feel much like the humdrum banker, who thinks that he really understands his business, until his son takes him one evening to the theatre, and he meets for the first time with the ideal villains of finance. The planetesimal hypothesis of Chamberlin is held by the present author to enable "one to build up a system of geology without an appeal to the unknown and the unknowable" (p. v). "Unknowable" is a rash word; but there is a good deal more of the unknown than of the known in the explanations of earth-structure put forward by Prof. Schwarz. We remember a paper of his, in which the former boundaries of continents and oceans were ingeniously deduced from a rock-fragment discovered in a southern isle. The present work includes speculations of a similar order of magnitude, but the underlying facts are marshalled more strategically, and far bigger battalions are brought into the field.

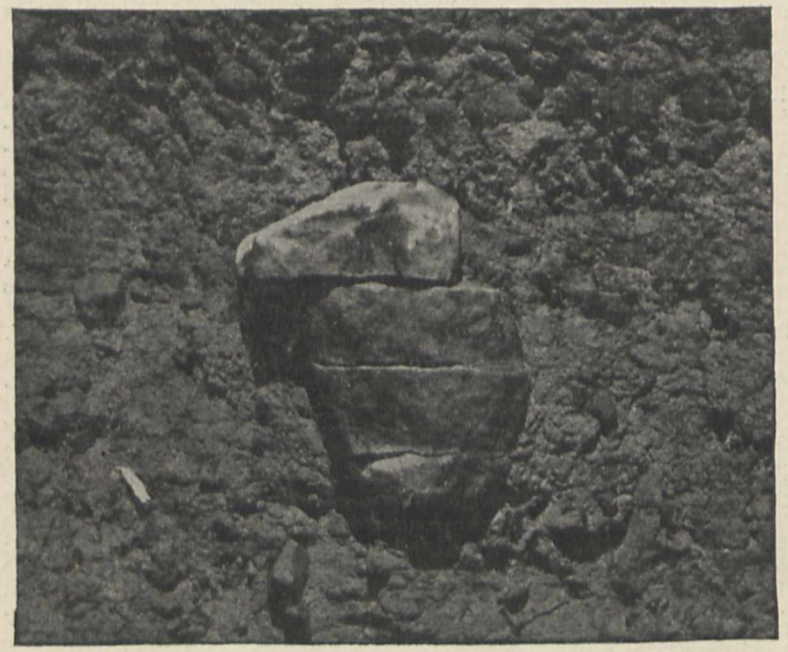
The planetesimal hypothesis, as developed by Prof. Schwarz, leads him to the conception of a cold earth, steadily growing in bulk by the accretion of meteoritic, or, as he prefers to write it, meteoric matter. The phenomena of the surface cannot, then, be caused by shrinkage of the interior, nor can volcanic action be ascribed to general internal heat. Earth-movements (p. 189) are said to develop sufficient heat to vaporise water in the crustal layers affected by them; all this water has crept down by capillary action from the surface, and may form outbursts of steam, shattering the sedimentary rocks around the orifice. If the heat generated is sufficient to melt the sediments, the product, with the water in it, appears as an ordinary upwelling of lava.

From the author's point of view, all gneisses and granites are derived from sediments by metamorphism in dissolving waters, or by actual melting (pp. 40, 221, &c.). The ultrabasic vents of Kimberley and Pretoria, so well known as the diamond-pipes, contain "meteoric matter of the centrosphere" (p. 198), since here faulting was sufficiently profound to melt up the ferriferous masses that underlie the ordinary crust. The faulting is accounted for by the transference of sedimentary matter from one part of the surface to another, the overladen rocks flowing away under the pressure; and we are given to understand that melting, with production of granite domes, or of lava ready to arise in fissures, takes place where water is present, and where the pressure is most intense, instead of where pressure is relieved. A fine instance of revivalism in geology appears on p. 227, where Prof. Schwarz, rejecting Darwin's observations in South Africa, and *lit par lit* injection generally, urges that "thin laminæ of granite substance bedded in between metamorphosed sediments" may result

[1] "Causal Geology." By Prof. E. H. L. Schwarz. Pp. viii+248. (London: Blackie and Son, Ltd., 1910.) Price 7*s*. 6*d*. net.

from the sediments "changing into granite in the ultimate expression of metamorphism."

It would be unfair, however, to judge the author's powers of observation from this or by his more startling propositions, such as that of the reconstitution of sand-grains on p. 140. The fact that he has seen so much throughout South Africa, in a country laid bare by nature for the geologist, entitles him to a serious hearing. The emphasis that he lays on the descent of ore-material from the surface (p. 11), and on the ascent of calcium carbonate from below, recalls at once the tropical rains, and the "pans" upon the desiccating surface. But surely, as Mr. Mennell has lately pointed out in his "Petrology," there is abundant evidence of the accumulation of iron-ores under African conditions at the surface. The whole siliceous crust, however, according to Prof. Schwarz, is a residue from the leaching-out and down-sinking of iron and magnesium from the primitive meteoritic matter. The silica was first set free from this matter in a colloidal form which consolidated as



Boulder in Dwyka Conglomerate, Prieska, illustrating lateral flow in rocks under pressure. From "Causal Geology."

chert. Quartz arose only by metamorphic action in the depths (p. 39). When we are told that chert is not crystalline, and when we reflect on the quartz deposited in cavities from solution, as is the case in limestones which retain all their fossils, we cannot help thinking that our author's earlier studies have been temporarily overcast by a cloud of planetesimals. The careless writing of some sentences suggests that the work has been pushed forward with something of the heat of a new gospel. The word "meteorite" is thus missing in the middle of p. 10; cubes of salt are said to be present (p. 57) in the "bubbles in granitic quartz"; to most field-workers the Archæan masses (p. 69) cannot seem "characterised by the enormous development of limestone"; when carbon dioxide is included in an analysis of the air, the omission of argon and its allies can hardly be excused (p. 93) by their "minute proportions"; Fig. A, a lunar area, opposite p. 22, should surely be inverted to agree with its description; and, to come to smaller matters, grammar is imperfect on pp. 3, 131, 145, and 200.

Yet we again and again respect Prof. Schwarz's grasp of geological literature, writing as he does in a small South African town, and his preface shows that he is still to be ranked among the inquirers, and not as the apostle of a dogma. Probably we also have been the gainers, if, after reading his well-printed and well-illustrated book, we feel that we know less than before concerning the constitution of the globe.

GRENVILLE A. J. COLE.

THE BRITISH SECTION OF THE BRUSSELS EXHIBITION.

THE importance of a Government department to deal with exhibitions could not have been better exemplified than when the King of the Belgians opened the new British section of the Brussels Exhibition on September 19. Exactly five weeks previously the section which had cost so much in thought, time, and money was reduced to a smoking mass of ruins. For a moment everyone was stunned by the extent of the loss, but within a few hours it had been determined to rebuild the section provided the reply received from previous exhibitors was satisfactory. The replies were not only satisfactory, but almost overwhelming; in fact, more space was applied for than the Commission had at its disposal.

But the rebuilding of the section was only rendered possible by the Belgian Commission placing at the disposal of the British organisers the *Salle des Fêtes*. This building was originally used for holding large congresses and meetings, and had a platform and a sloping auditorium, the side alleys being divided up into reception and cloak rooms. All the internal fittings of this building have been removed, and it has been divided up into courts in a most artistic fashion, the various courts radiating out from a central transept.

The space of the original building was 150,600 square feet; the present space is only 35,500 feet; but this fact made it difficult rather than easy to design and fit up the new section, owing to the large number of exhibitors who desired space. How rare is it for an exhibition to be ready for the opening day, even after months have been spent in collecting the exhibits! But although the work was enormous, the new section arose from the ashes in the space of five weeks, and the whole exhibit, with the exception of one or two cases, was absolutely finished when the King of the Belgians opened it. Not only was the exhibit finished, but the new catalogue, "Catalogue Officiel de la nouvelle Section Britannique," was ready on the same day for distribution. Without the machinery of the committees organised by the Royal Commission of the Board of Trade it would, however, hardly have been possible to have accomplished this feat.

In declaring the new section open, and replying to Sir Arthur Harding, the King said: "Your Excellency has associated the British and Belgian people in the eulogy which you have made in such happy terms of the work of repairing the disaster caused by the fire. Certainly the Belgians have displayed in that work their fine qualities of courage and perseverance which no misfortune can daunt, and I congratulate them upon it highly. But what shall I say

of the English—of the Government as of the exhibitors—who, in reconstructing in the space of a few weeks a section as beautiful and interesting as anyone could possibly wish for, have once more shown of what that unconquerable tenacity, the characteristic of the British Empire, is capable. I find no words to express to Your Excellency my admiration and my gratitude."

One of the most interesting exhibits is that of the Thermal Syndicate. The articles are manufactured at the high temperature of the electric arc, and it is of particular interest to notice that even the intense heat of the conflagration had no effect upon the silica ware. In the new section, tubes and pipes which had been through the fire are exhibited alongside of articles freshly manufactured. These tubes have glass fused to them, but, except for slight discoloration, are absolutely uninjured by the ordeal through which they have passed.

Although Messrs. Johnson and Matthey have not been able to exhibit again, it should be mentioned that the transparent silica shown by them in the original section was also in no wise injured by the heat, although much of it was broken by the falling *débris*. The writer found pieces of platinum exhibited by the same firm absolutely embedded in fused glass, which gives a good idea of the intense heat to which everything in the burning building was subjected.

As showing the resource of energy of some of the exhibitors, mention should be made of the pottery exhibit of Mr. Bernard Moore. A large vase is shown which has been designed and manufactured since the fire and bears a commemorative design—a phœnix rising from the flames with the motto *Quod ignis debit incendium abstulit.* The Pilkington Tile and Pottery Co. also shows a commemorative vase. This is of particular interest, because it shows a new lustre which has not been discovered more than three months.

The International Salt Co., Ltd., shows salt purified by a new process. The salt is fused and air blown through it, the impurities separate out, and the pure salt is run off. Whether this process will be able to compete against the older process remains to be seen, but at least it is interesting.

Owing to the exigencies of time and of space, it has not been found possible to instal again completely the very fine display of scientific instruments and of chemical products which was shown in the original section, but the chemical court makes quite a good display. The section, as a whole, is a splendid example of what can be done by organisation and the courage which knows no defeat.

It should be mentioned in closing that the advances due to recent science have been found to be of the utmost value in the cutting and removal of the tangled mass of iron-work which is all that remains of the burnt-out parts of the exhibition. The cutting of even thick girders is done entirely by burning with the oxyhydrogen flame, and it is extremely interesting to notice how rapidly it is possible to work by means of this method.

F. MOLLWO PERKIN.

MATHEMATICS IN AUSTRIA.

AS the result of an educational conference, convened at Vienna in 1908, changes of considerable importance have been made in the curriculum of the secondary schools of Austria. At the instance of the Board of Education, the mathematical syllabus issued in 1909 for the Austrian Gymnasien has been translated into English, and it deserves the thoughtful consideration of all those who are interested in the efficiency of our own educational system. It comes at an opportune moment and forms a useful contribution to all the discussions and experimental investigations of the last few years, which should provide a sound foundation for the work of the International Commission on Mathematical Teaching, which will report to the congress at Cambridge in 1912. We do not propose to examine this pamphlet in detail, but it may be useful to note some of its salient features.

Although in recent years the theoretical has been replaced by the practical in our secondary schools to a degree which many have considered dangerous, it is clear that far more drastic measures have been adopted by the Austrian authorities. The course of arithmetic is limited to multiplication and division of decimals, contracted methods, proportion and interest. There are few who will not admit that the time spent on mixtures, discount, stocks, and the various other specialised arithmetical problems, which occupy so large a space in our text-books, might be employed to far greater advantage. At present only a small proportion of boys ever obtain a working knowledge of the elements of trigonometry and the calculus. Reform in this direction is badly needed, but it is almost impossible for changes to be made in the school curriculum so long as the various examining bodies, and in particular the Oxford and Cambridge joint board and the Civil Service Commissioners, continue to require a standard in arithmetic, which can only be attained by a large expenditure of time. There is much to be said for omitting altogether the arithmetic paper from these examinations, but, if this should be regarded as too extreme a measure, we are profoundly convinced of the desirability of restricting it to simple questions on the laws of the subject; the time thus saved would be devoted to numerical trigonometry, and consequently it would be reasonable to expect from candidates for such examinations as the leaving certificate or army qualifying an elementary practical knowledge of trigonometry. It would be difficult to exaggerate the benefits which would result from such a change as this, and we do not doubt that it will come, although not in the near future.

The next feature of interest is the importance which is attached to the idea of functionality.

"The notion of Function is recognised as the idea which differentiates higher from elementary mathematics, and a full grasp of it is held to be the proper aim of school teaching . . . the habit of looking at variable quantities as varying *continuously* and in obedience to *law* is to be fostered from the beginning."

Experience shows how slow is the growth of appreciation of this conception, but the sphere of its operation is so extensive and its application so stimulating that it well repays the effort required. If the graphical work in algebra is not designed to illustrate this principle, it is reduced to a valueless mechanical operation.

The last noteworthy variation is the combination of plane and solid geometry throughout. The cultivation of the power of thinking in three dimensions receives far more attention on the Continent than in England. Many even of those who win mathematical scholarships at our universities have no knowledge of the rudiments of practical solid geometry. There are signs, however, of change in this direction, and the value of an elementary course on plan and elevation of simple solids is being gradually realised.

Enough has been said to show that the guiding principles of this syllabus are progressive and eminently practical, and the Board of Education have done well to render it accessible.

NOTES.

THE Thomas Young lecture of the Optical Society will be delivered in the lecture hall of the Chemical Society this evening by Prof. R. W. Wood, of the Johns Hopkins University, Baltimore, U.S.A. The subjects will be "The Echelette Grating" and "The Mercury Telescope."

LIEUT. FILCHNER, the German explorer, in an address at the meeting of German naturalists and physicians at Königsberg, announced, says Reuter, that the start of his Antarctic expedition could with a certainty be fixed for the spring of 1911. He has agreed with Captain Scott, who starts from the Ross Sea for the Pole, while Lieut. Filchner's base will be the Weddell Sea, that, if the expeditions meet in the centre of the Antarctic, some of Captain Scott's party shall join his and accompany him to the Ross Sea, and that some of his party shall go with Captain Scott to the Weddell Sea.

WE learn from the *British Medical Journal* that the fifth International Dairy Congress, which will be held in Stockholm in 1911, offers a prize of 20*l*. for the best essay on the nutritive value of raw milk as compared with that of pasteurised, sterilised, or evaporated milk, determined, at least in part, by experiments made upon infants. In case the raw milk is found to give the better results, it is requested that the *rôle* played by the enzymes of the milk be determined if possible. The papers, which may be written in German, French, or English, and typewritten, should be sent before April 1, 1911, to the Secrétariat-général de la Fédération internationale de Laiterie, 23 rue David Desvachez, Bruxelles, Belgium.

THE observatory of the Hampstead Scientific Society is now in full working order. It is equipped with an 8-inch equatorially mounted reflector telescope, which may be used by members of the society on any evening by arrangement with the secretaries, and by the public on Saturday evenings. A special meeting of the astronomical section of the society will be held on October 5, at 8.30 p.m., at Stansfeld House, Prince Arthur Road, Hampstead, when a paper on Saturn will be read. For several successive evenings following the observatory will be devoted to demonstrations on Saturn. Inquiries may be addressed to Mr. P. H. Hepburn, one of the honorary secretaries of the astronomical section, 49 Downshire Hill, Hampstead.

THE Marconi Wireless Telegraph Company announces that it has received a Marconigram from the Italian Lloyd steamship *Principessa Mafalda* stating that Mr. Marconi, who was on board, has been successful in obtaining wireless messages from Clifden, Ireland, and Glace Bay, Canada, stations up to a distance of 3500 miles, in broad daylight. A kite was used for the support of the aërial wire on the vessel, and, except for encountering high wind, which stopped kite-flying, Mr. Marconi is confident that a greater distance would have been achieved. The distance easily excels all accomplishments in the reception of wireless messages on shipboard in the daytime, the greatest previous distance at sea being 1750 miles.

THE Berlin correspondent of the *Times* announces the death, in his sixty-fourth year, of Prof. Theobald Fischer, professor of geography in the University of Marburg. Prof. Fischer made valuable contributions to the knowledge of the structure of the plateau of the Atlas; and the results of most of his researches are to be found in *Petermann's Mitteilungen* and in the Proceedings of the Hamburg Geographical Society. He was the author of a work on the peninsulas of southern Europe in Kirchhof's "Länderkunde Europas," and of books on the date palm (1881) and the olive (1904).

M. G. CHAVEZ was successful on Friday, September 23, in making a flight with a Blériot monoplane across the Alps from Brigue to Domo d'Ossola, but he had the misfortune to meet with a severe accident when landing, from the effects of which he died on Tuesday, September 27. To traverse by aëroplane a distance of about thirty miles of snow-covered mountain, including the Simplon, which reaches a height of 6600 feet, is a notable achievement, even though it has a sensational aspect. M. Chavez started at 1.30 p.m., and reached Domo d'Ossola at 2.19; over the Simplon Pass he encountered a very high wind, which caused him to take the route over the Gorge of Gondo instead of going by the shorter route over the Mousoera Pass. When quite near the landing place at Domo d'Ossola the wings of the monoplane appear to have broken, and the machine fell to the ground with M. Chavez beneath. Everyone will regret that the remarkable feat of crossing the Alps by aëroplane should have had such a melancholy termination. M. Chavez is the fifteenth airman who has been killed by flying accidents this year.

WE record with regret the death, on September 16, of Mr. Hormuzd Rassam, at the age of eighty-four years. Mr. Rassam in 1845 joined Mr. (afterwards Sir) A. H. Layard to assist him in his Assyrian researches. He was sent out again by the trustees of the British Museum in 1849 to take part in Layard's second undertaking, and carried on work for the British Museum until 1854. In 1864 he was selected by the British Government to proceed to Abyssinia to try to persuade King Theodore to release Consul Cameron and other prisoners. Though at first he met with success with King Theodore, he was, after a few months, thrown into prison with the original prisoners, who had been retaken, and he was kept in chains for nearly two years. The occurrences led to the war with Abyssinia in 1868. Mr. Rassam conducted further Assyrian explorations from 1876 to 1882, and during the Turko-Russian war he was sent to Asia Minor, Armenia, and Kurdistan by the British Foreign Office. Among his published works may be mentioned "British Mission to Theodore, King of Abyssinia, with Notices of the Country Traversed from Massowah through the Soudan, the Amhara, and back to Annesly Bay from Magdala," two vols., and "Asshur and the Land of Nimrod."

THE second International Congress of Alimentary Hygiene will be held in Brussels on October 4–8. In addition to the usual meetings of sections, the following lectures are included in the provisional programme:—Tuesday, October 4: Prof. Dastre, "The Ultra-violet Rays and their Application to Alimentary Hygiene"; October 5: Prof. Paterno, "The Chemical Sciences"; October 6: M. Bordet, "Hygiene and Bacteriology." Various social functions and visits to the exhibition, to the Colonial Museum, and to the Institut au Parc Leopold have also been arranged. Members and associates (subscription, 20 francs and 10 francs respectively) are admitted free to the Universal Exhibition during the time of the congress. Further information may be obtained of the honorary secretary, Mr. Cecil H. Cribb, 136 Shaftesbury Avenue, London, W.

THE annual foray of the mycological section of the Yorkshire Naturalists' Union was held at Sandsend, near Whitby, on September 17–22. The magnificent old woods

at Mulgrave, with their deep, well-watered ravines invariably produce a rich fungus flora independent of season, which to a very great extent determines the presence or absence of fungi in less favoured districts. Notwithstanding four previous visits, six agarics new to the British flora were met with, in addition to a species only previously recorded from Jersey. *Mycena flavipes*, a beautiful fungus with a pink cap and a bright yellow stem, was met with in some quantity. This fungus was first recorded as a British species from specimens collected in Mulgrave Woods about twenty-five years ago, and has not been met with elsewhere in this country. A considerable number of rare and interesting British species were also collected. Several parasitic fungi were also noted. The total number of species collected amounted to between four and five hundred. During the evenings, discourses on mycological subjects were given by Mr. Harold Wager, F.R.S., Mr. A. Clarke, Mr. T. Gibbs, and Mr. Geo. Massee. Mr. Cheesman exhibited a collection of Myxogastres collected in the Rocky Mountains, and Mr. A. Clarke exhibited an extensive series of coloured drawings of fungi. Much of the success of the meeting was due to the facilities kindly afforded by the Rev. the Marquis of Normanby.

PROF. FLINDERS PETRIE in *Man* for September records the discovery in the neighbourhood of the Pyramid of Sneferu (B.C. 4600) of a stone tomb dating from a time before the construction of the pyramid, the earliest private tomb in Egypt to which a date can be assigned. This burial is of the highest interest, as it shows that the body was completely unfleshed before it was wrapped in linen. It lies in a sarcophagus of red granite, the oldest stone sarcophagus known. It has long been known that in prehistoric burials the corpse was stripped of the flesh, the bones even being broken to extract the marrow. In the present case each bone was separately wrapped in linen; and the present discovery proves that the disseverıng of the skeleton was the custom among the higher classes at the beginning of the Pyramid period.

IN the last progress report of work at Knossos Dr. A. J. Evans records a remarkable discovery of what he calls the "Tomb of the Double Axes," which has produced more definite evidence regarding the sepulchral cult and the conception of the after-world than any grave yet opened in Crete or prehistoric Greece. Here the double axes were socketed in sacral horns of plaster, and it would seem that the tomb, besides being a place of sepulture, was also a chapel, where the protection of the Great Mother of the prehistoric Cretan cult was sought for the shade of the departed warrior, the stone benches round the shrine being probably arranged for some memorial function in which the family took part. Inside the tomb was found a bronze axe, not of the thin ritual type, but a real prehistoric implement, probably used by the workmen at some early reopening of the sepulchral chamber to admit of the presentation of offerings to the dead.

AN interesting recent addition to the Maidstone Museum is a model of the fine dolmen situated at Coldrum, some 2¼ miles north of West Malling. The dolmen itself stands on the edge of a well-marked prehistoric cultivation terrace at the foot of the chalk escarpment and faces east, towards Kits Coty House, which is some six miles distant. It was in this dolmen that Mr. F. J. Bennett recently found some remains of prehistoric man, and it is to Mr. Bennett, assisted by Mr. Filkins, of Maidstone, that the model is due. It is built to scale, the model of each stone having been made and fixed at the site of Coldrum itself, thus ensuring an accurate representation. Mr. Bennett has also had prepared plans of the Coldrum and Addington megaliths, together with a photographic survey of the former and a tracing of the 25-inch map showing additional sarsens, so that visitors to the museum may more clearly understand the relations of the various parts and their surroundings. With so many of our megalithic remains being neglected or wilfully despoiled, it is an urgent necessity that similar models, plans, &c., should be made of the few which still remain intact.

A MEMOIR on "Factors in the Transmission and Prevention of Malaria in the Panama Canal Zone," by Dr. S. T. Darling, in the *Annals of Tropical Medicine and Parasitology*, vol. iv., No. 2, describes a number of very interesting observations and experiments on the development of the parasites of simple and malignant tertian malaria in mosquitoes, and on the infectivity of different species of anopheline mosquitoes in the region in question. *Cellia albimana*, the common white-hind-footed mosquito, a very hardy species, was found to be the most efficient transmitter of malaria, *C. tarsimaculata* scarcely less so; on the other hand, *Arribalzagia malefactor* belies its name, since it was not found possible to infect it. Incidentally, the author comes to a conclusion which will perhaps be a surprise to many—that the characteristic musical note of the mosquito is caused by the vibration of the proboscis, not by the wings in flight.

A RECENT number of the *Philippine Journal of Science* (vol. v., No. 1, Section B) contains seven papers by different investigators on the subject of the etiology of beriberi, together with a report of the discussion which followed the reading of these papers at the first biennial meeting of the Far-Eastern Association of Tropical Medicine, held at Manila in March. It was generally agreed, and a resolution was passed by the meeting to the effect, that "beriberi is associated with the continuous consumption of white (polished) rice as the staple article of diet." Evidence, experimental and otherwise, was brought forward to prove that in the process of polishing the rice the grains are deprived of certain outer layers, the pericarp and sub-pericarpal tissue, which appear to contain some substance or substances essential for the maintenance of the normal metabolism of nerve-tissues. On this view, beriberi is a disorder of metabolism, due to deficiencies of diet. The chief obstacle to the acceptance of this theory, it is pointed out, is that it does not explain the occurrence of beriberi in some tropical countries and its absence in others, such as Ceylon, where white rice is equally the staple diet of the natives. Some experts consider, therefore, that the diet is only the predisposing condition, and that the true cause of the disease has yet to be found.

A SYNOPSIS of the Silurian fossils of the South Yarra district forms the subject of a paper by Mr. F. Chapman, palæontologist to the Melbourne Museum, in the August number of the *Victorian Naturalist*. The presence of an eurypterid of the genus Pterygotus, of the peculiar brittle-star described by the author as a new genus, Gregoriara, and of the bivalve *Cardiola cornucopiae*, is stated to link the fauna with that of the British and Bohemian Silurian.

THE September issue of the *Irish Naturalist* is devoted to a report of the sixth triennial conference and excursion of the Irish Field Club, held at Rosapenna, County Donegal, on July 8–13. Notes on the natural history and

archæology of the district are contributed by a number of members of the club, among which reference may be made to Mr. Ussher's announcement of the discovery of five specimens of the humerus of the great auk.

DR. A. C. GÜNTHER, with the assistance of Mr. Tate Regan, has (in the *Journal des Museum Godeffroy*, Heft xvii., Hamburg, 1910) completed the description of the collection of fishes made in the Indian Ocean and South Pacific by Andrew Garrett. Four new species, *Trygon ponapensis*, *Tetrodon regani*, *Opichthys macrops*, and *O. garretti*, are described. The report is very beautifully illustrated by twenty coloured plates.

ATTENTION has previously been directed in NATURE to the need for uniform orthography of geographical names in Government departments; this need is exemplified by the "Return" of the British Museum for 1910. In 1909 Mrs. J. A. Brooke presented to the museum a series of specimens sent from China by her son, the late Mr. J. W. Brooke, some of which went to Bloomsbury and others to Cromwell Road. Those at Bloomsbury are entered (p. 77) as having been obtained in Szechuan, while those at Cromwell Road are recorded (p. 123) as coming from Sze-chuen.

WE have received copies of several papers on human skulls and skeletons and supposed evidence of human work, read by Dr. F. Ameghino before the Congreso Científico Internacional Americano, held at Buenos Aires in July last. In one he describes a skull from a cave in Cuba as a new species, under the name of *Homo cubensis*. Skeletons from the Moro district, on the Atlantic coast of Argentina, are described in a second paper under the name of *H. sinemento*, and stated to be of a more primitive type than the Neanderthal *H. primigenius*. These remains are stated to be of Lower Pampean age; in a third paper the author describes another skeleton, from the Upper Pampean, which is regarded as representing a third species, *H. caputinclinatus*. The other four papers relate to supposed evidence of man's presence in various formations, the oldest of which is classed as Upper Eocene.

To vol. xxviii., pp. 127–239, of the Bulletin of the American Museum of Natural History Dr. R. Broom contributes an important article on the relationship of the Permian reptiles of North America to those of South. After reviewing the leading types of each, he concludes that in the Upper Carboniferous northern South America was the home of a primitive vertebrate fauna from which originated both the North American Pelycosauria and the African Anomodontia (in the wider sense of the term). In the Permian this fauna invaded North America, where it soon became isolated. Early in the same epoch the Brazilian Mesosaurus reached Africa by a land-bridge, and later on appeared other types, which probably developed in the area now occupied by the South Atlantic. When sundered, the North American and African faunas underwent great development in divergent directions, the former undergoing many strange specialisations—notably in vertebral spines—while the latter showed a tendency to a great increase in the size of the limbs. This limb-lengthening, accompanied by the alteration of the phalangeal formula of the toes from 2.3.4.5.4 to 2.3.3.3.3, started the mammalian line of evolution, for directly the more specialised anomodonts raised their bodies above the ground they were well on the way to become mammals. Birds, in fact, "are reptiles that became active on their hind limbs; mammals are reptiles that acquired activity through the development of all four."

AN article entitled "Hunting Birds with the Camera," contributed by Mr. W. Bickerton to the October number of the *Royal Magazine*, gives a good idea of the great patience required by anyone who desires to photograph birds. The article is accompanied by several striking illustrations, including two of a reed-warbler feeding a young cuckoo. Mr. Bickerton says that, of all our summer visiting birds, the reed-warbler has its nest used most frequently by the cuckoo to deposit her eggs. He remarks, "In the area I am describing no fewer than seven different eggs of the cuckoo lay each in a different reed-warbler's nest, left there for the latter bird to hatch out."

THE second number of the botanical section of the current volume of the Philippine Journal of Science contains the latter portion of the critical enumeration of Philippine Leguminosæ prepared by Mr. E. D. Merrill, a third set of bryological determinations by Dr. V. F. Brotherus, and a short list of indigenous fungi compiled by Messrs. H. and P. Sydow.

AN investigation into the causes underlying a serious loss of gooseberry bushes in Cambridgeshire is recorded by Mr. T. F. Brooke and Mr. A. W. Bartlett in *Annales Mycologici* (vol. vii., No. 2). Two fungi fell under suspicion, but definite proof in the shape of infection experiments was only obtained for *Botrytis cinerea*, although good reason is adduced for finding a second cause of disease in *Cystoporina ribis*. The diseases are not in any way connected and distinct macroscopic and microscopic characters are defined for each fungus; further, it is noted that in no case were both fungi discovered on the same plant.

A NEW and peculiar type of resin collector that has been tried in the pine forests of Florida, U.S.A., is described by Mr. J. S. Woolsey, jun., in the *Indian Forester* (August). The tree is tapped by two small tunnels, about an inch in diameter and five inches long, bored from a common opening or mouth tangentially through the sap wood. The collector consists of two metal caps set at right angles, and connected by a hollow angle piece. One metal cap is fitted over the mouth, while a glass jar, into which the resin flows, is fitted to the other horizontal cap. It is claimed that the method gives an increased yield and a clean gum, and that evaporation is avoided.

SYSTEMATIC articles are prominent in the latest issue of the *Kew Bulletin* (No. 7), as, in addition to a long series of new species of Protea and other African diagnoses, Mr. J. S. Gamble contributes a second list of new Lauraceæ from the Malayan region, principally additions to the genera Cinnamomum, Alseodaphne, and Notophœbe, and Dr. O. Stapf presents a revision of the Australian plant *Epacris heteronema*. Also Mr. G. Massee describes several new exotic fungi, including a Sphærulina and a Phoma, both discovered on *Welwitschia mirabilis* in Damaraland. More important from an economic aspect is *Eutypa caulivora* (Sphæriaceæ), a parasite collected on rubber trees in Singapore, that kills its host by blocking up the water channels with mycelium.

THE Australian Commonwealth Bureau of Meteorology has commenced the issue of a monthly report from January last. It is intended to embody, *inter alia*, discussions on current weather, daily observations at each of the capital cities, and extracts, or brief articles, on matters of general scientific interest, and, judging from the first number, it gives promise of taking a prominent place among the leading weather bulletins. The principal article in the

January number deals with the disastrous flood during that month in the Upper Darling tributaries, owing to abnormally heavy rains, attributed by Mr. H. A. Hunt to the joint action of an anticyclonic area over the southern half, and a monsoonal depression operating in the northern half, of the continent. In the Namoi basin several places recorded more than 12 inches of rain between January 11 and 15, and at Bingara, in the area of the river Gwydir, 19·44 inches were registered, the normal for the whole month being 3¼ inches. The report states that, generally speaking, the amount of damage was inestimable, but the deposit left by the subsidence of the water has rendered the soil fertile over a vast area.

We have received copies of several papers which have been published recently by members of the staff of the Reichsanstalt at Charlottenburg, amongst them one on the thermal expansion of metals, by Dr. E. Grüneisen, which appeared in the *Annalen der Physik* for August 5. The first part of the paper deals with the observations of expansion of platinum, palladium, copper, silver, aluminium, iron, nickel, and iridium made previously at the Reichsanstalt by Holborn, Day, Scheel and others, and the second part with observations made by the author on magnesium, zinc, cadmium, antimony, iridium, gold, lead, and bismuth by comparison of the expansion of a bar of each metal with that of a platinum standard bar by a method analogous to the double-mirror method of determining the bending of a beam. With the exception of zinc, cadmium, and possibly tin, the whole of the metals which have regular expansions confirm Thiesen's law that the rate of expansion is proportional to a power of the absolute temperature. The author finds that the power lies between 0·06 and 0·5, and is a periodic function of the atomic weight of the metal.

Engineering for September 23 contains a photograph of submarine "D 1," which is the largest vessel of its class belonging to the British Navy. An interesting development in this vessel consists in the application of wireless telegraphy to submarine work. Successful experiments have been carried out recently with this vessel in Torbay, the crusier *Bonaventure* establishing and maintaining communication with the "D 1" when submerged. The "D 1" replied from below the surface. The installation was tested when the submarine was submerged to a depth just sufficient to keep the periscope above water, *i.e.* about one-half of the telegraphy mast was below water. The possibilities of such a development are considerable, as not only could the actions of submarines be directed by these means from larger vessels, but a flotilla of submarines will be able to use the system for the purpose of communicating among themselves when submerged, their value in naval warfare being thus considerably improved.

The progress of the great Barren Jack dam in Australia is described in the *Engineer* for September 23. This dam will be one of the largest in the world when finished. The design in plan gives a length of 784 feet, curved to a radius of 1200 feet, and a maximum height of 240 feet. The structure is of cyclopean concrete; the base is 163 feet wide and 20 feet high, with vertical sides, and this level has now been reached. The catchment area embraces 5000 square miles, mostly of hard shale formation, and much of it mountainous, which is snow-fed in winter. The maximum depth of water behind the dam will be 224 feet, and the capacity will be 33,380 millions of cubic feet. Nature has furnished a gorge in hills of granite, providing the best site and best materials for a dam, behind which is an unfailing supply of rainfall; a natural 220-mile channel, and, at the proper place, a foundation for a distributing weir. That advantage is now being taken of this almost ready-made but long neglected irrigation opportunity is a matter for congratulation. It is not intended to wait for the completion of the work before putting it to use. The building contract provides for the wall reaching a height of 110 feet in August, 1911, when storage will be started, so as to ensure irrigation in the summer of 1911–12. The remainder of the dam is to be finished in August, 1913.

We have received from Ozonair, Ltd., of 96 Victoria Street, a catalogue of apparatus suitable for laboratory and research work. Four arrangements are described ranging in cost from 15*l.* to 100*l.* for alternating, and from 25*l.* to 110*l.* for direct current, for a complete installation operated from the street mains. It is claimed that the yield of ozone is greater than that of any other generator, and that the purity of the effluent is unapproached.

A report on recent progress in the chemistry of the sugars, by Mr. J. S. Hepburn, appears in the Journal of the Franklin Institute for August. This paper reviews the work of Emil Fischer upon sugars and ferments, describes the synthesis of monoses, disaccharides, and glucosides, and discusses the fermentation of the sugars, the action of the various inverting enzymes, and the lock-and-key theory of enzyme action. The splitting of racemic sugar derivatives into their active components and asymmetric syntheses within the sugar are also considered. References are given to original papers, of which no fewer than seventy-four are by Prof. Emil Fischer and his colleagues or pupils.

A supplement of eighty-four pages to the *Columbia University Quarterly* gives an account of the Charles Frederick Chandler testimonial, presented on the occasion of his retirement from the positions of head of the department of chemistry and dean of the School of Mines of Columbia University. Prof. Chandler has been a college teacher during fifty-four years, and his retirement marked the close of his forty-sixth year of service at Columbia. A bibliography of fifty publications testifies to the fact that his keen interest in pure science was allied with much work of a public and philanthropic kind. His work on behalf of public health in New York was of the utmost value, and the story of his midnight raid upon the cattle stalls of Washington Market, as set forth in the *Columbia Quarterly*, will form a fascinating feature in some future history of municipal cleansing; the ingenious methods by which in the following years he overcame the prejudice of the poorer people against the isolation of small-pox cases is an eloquent testimony to his versatile ability.

Two important crystallographic papers, by Prof. Armstrong and Messrs. Colgate and Rodd, have recently appeared in the Journal of the Chemical Society. The investigation has been in progress since 1892. The work now described includes the crystallographic examination of no fewer than twenty-nine derivatives of the *p*-dihalogenbenzenesulphonic acids; but considerable progress has already been made in the study of the five similar series of isomeric acids in which the two halogens occupy the *ortho* and *meta* positions relatively to one another. The series now described is comparatively simple in its crystallographic properties; almost all the compounds belong to one of the two types of close-packed arrangement which Barlow and Pope have indicated for the benzene molecule, namely, the rhombohedral arrangement,

in which (*a*) one parameter has a value slightly below 2·780, or (*b*) two of the parameters are nearly equal. Amongst the sulphonic chlorides and bromides two isomorphous series are seen, the second series being restricted to compounds in which an iodine atom is present; it is noteworthy that the two chloriodobenzenesulphonic chlorides are found in different series, and that one of them was on one occasion obtained in a labile form, the crystals becoming cloudy and opaque when removed from the solvent from which they had separated. This behaviour indicates clearly that certain members of the series are actually dimorphous, and the whole series may therefore be regarded as isodimorphous. Isodimorphism was also detected amongst the anilides and toluides. It is remarkable that two other series, containing the halogen atoms in the *meta* position, which were examined by Dr. E. C. Jee in 1900, proved to be isotrimorphous and isotetramorphous respectively. The completion of the work on these series will be awaited with interest.

A SECOND edition of "A Text-book of Zoology," by Profs. T. Jeffrey Parker and W. A. Haswell, is announced as nearly ready by Messrs. Macmillan and Co., Ltd. The work has been subjected to careful revision throughout; some parts have been to a great extent rewritten, and a considerable number of new illustrations have been added.

OUR ASTRONOMICAL COLUMN.

VELOCITIES AND ACCELERATIONS OF THE EJECTA FROM HALLEY'S COMET.—Profs. Barnard and Lowell and Senor J. Comas Sola all deal with the velocities and accelerations of the matter ejected from the body of Halley's comet, during May and June, in No. 4441 of the *Astronomische Nachrichten* (pp. 11–16).

From measures of photographs taken at the Yerkes Observatory (Y), Honolulu (H), and Beirut (B) on June 6, Prof. Barnard found the velocities of recession, of a well-marked feature in the tail, given in the following table :—

Stations	Interval between photographs Hours	Hourly motion ′	Recession per second: From comet Miles	From comet km.	From sun Miles	From sun km.
Y–H	4·25	3·60	23·1	37·2	39·7	63·9
Y–B	15·15	5·17	33·1	53·3	49·7	80·0
H–B	10·90	5·78	37·3	59·7	53·9	86·4

These results show a strong acceleration in the mass measured, which was about 1·5° from the head; from the last two photographs this acceleration was about 14 miles (22 km.) per second.

Similar results are obtained by Prof. Lowell from the measures of two photographs taken, with rather less than an hour's interval, on May 23. On these photographs are shown four knots in the tail, at distances varying from 1° 28′ to 6° 15′ from the head, and the measures give for the velocities of the particles composing the knots 13·6, 17·2, 19·7, and 29·7 miles per second respectively, thus showing an acceleration of the velocities as the particles receded further from the head.

Senor Sola, dealing with the velocities of the gaseous globes ejected from the nucleus on June 4, shown on photographs taken on June 4, 6, and 7, finds that between June 4 and 6 the acceleration of these ejecta was 0·148 metre per second, and between June 6 and 7 was 0·248 metre per second.

OBSERVATIONS OF COMETS.—New observations of three comets are published in No. 4441 of the *Astronomische Nachrichten*. A number of observers give positions, determined during August, of Metcalf's comet, 1910*b*, and generally describe it as a faint object, magnitude about 11·0, having a central condensation and a suspicion of a tail.

D'Arrest's comet was observed at the Algiers Observatory on August 26 and 29 and September 1 by M. Gonnessiat. The correction to Leveau's ephemeris was an increasing quantity, and on September 1 had the value −1m. 19·39s., +6′ 16·2″; the comet is described as a diffuse nebulosity of 2′ or 3′ diameter, with a feeble, central condensation of about magnitude 14·5.

With a 9-inch refractor Mr. Innes found that, on August 11 and 12, Halley's comet was a most difficult object, and was, therefore, much fainter than the magnitude (7·4) given in No. 4423 of the *Astronomische Nachrichten*. Observations made between July 26 and August 11 indicate a correction of about −11s. to the ephemeris given in the same place; the ephemeris is nearly correct in δ. When last seen the comet was a nebulous object, of 1′ diameter, showing a slight condensation.

THE SOLAR PHYSICS OBSERVATORY, SOUTH KENSINGTON.—From the report published by the Board of Education, dealing with the work done at the Solar Physics Observatory, South Kensington, during 1909, we learn that spectroheliograms of the solar disc were obtained on 147 days during the year; of the 286 negatives secured, 231 have been selected for the measurement of flocculic areas in pursuance of the scheme for establishing a cooperative daily record of such areas. Fifty-seven photographs showing the calcium prominences at the limb were also secured with the spectroheliograph. Visual observations of the sun were possible on 232 days, and "no spots" was recorded on five occasions. The spectra of 138 spots were observed visually, and show that the lines chiefly affected, in the region F–D, are due to V, Ti, Sc, and Mg, associated with H. A powerful instrument for the photographic recording of sun-spot spectra cannot be used owing to the vibration occasioned by traffic in the vicinity. Work with the 36-inch reflector on Halley's comet and other objects was also restricted by the poor observing conditions. A large number of photographs of stellar spectra were secured with various prismatic cameras, those obtained with a calcite-quartz optical system being employed for the temperature-comparisons of various stars.

THE DETERMINATION OF LONGITUDE.—In an interesting brochure of sixty-two pages, now published as an extract from the journal *L'Horloger*, Dr. Jean Mascart recounts the history of the determination of longitudes, with a special chapter on the invention and development of marine chronometers, and an account of the voyage of the *Flore*, which had for its purpose the actual testing of the different methods of determination, in 1771–2. The brochure is well illustrated with portraits and cuts of historical instruments and their parts, and contains numerous references to the literature of the subject with which it deals.

THE ROYAL COMMISSION ON WELSH MONUMENTS.

THE first report of the commission contains a general account of work already done, and an outline of the work proposed to be done. The first volume of classified information the commission hopes to publish in the course of the present year, in the form of an inventory of monuments in the county of Montgomery.

The task undertaken is truly immense. No type of monument nor available source of information seems to have been overlooked in the outline given. There are, of course, inevitable limitations to be considered, but it is not likely that the work in value and extent will ever be a subject for serious adverse criticism. As, however, the commission's plan of campaign has been published at a time when that plan may be reconsidered in some details before the information collected has been cast into a final form, one may venture to direct attention to a class of facts which is not even mentioned in the report, but which may be shown to be by far the most important within the scope of the inquiry.

The most important documents are the monuments themselves. Whatever facts may be directly elicited from them take precedence of all facts elicited from "finds," folklore, and documentary information. They may be

called structural facts, and they are to be regarded as facts irrespective of any theory. So long as such facts may be gathered, as a rule, at every ancient site, there seems to be no valid reason why they should not be treated as of first importance in any examination of ancient monuments. Opinions may differ greatly as to the value of deductions from the facts, but no difference of opinion can possibly justify a policy of turning a deaf ear to the positive testimony of the monuments themselves.

The sharpest distinction should be made between the testimony of a structure and that of any "finds," and the commission's chief object is to make an inventory of structures. Judging a structure by the finds alone, the popular epithet "sepulchral" is often tolerable, but the epithet does not explain the structure even of a hermetically closed cist, which everybody would regard as sepulchral. Now, "grave goods" have been given a place in the commission's schedule, and for that reason alone one would claim recognition of the structural facts. The relation of a burial to the surface soil is particularised, and such details show that the structural facts, in a way, are included in the schedule. The facts I have chiefly in mind are measures, both angular and linear. Some measures of the sort, of course, are given in ordinary reports and plans of monuments, but measures made on the lines of a working theory, based on the sum of knowledge already gained by measurements, must be much more to the point than any measures made with absolutely no theory in view. Even when a working theory is adopted, some technical knowledge is indispensable for making the required measures.

The subject, I understand, has been considered by the commission. Some information bearing on the astronomical inquiry, which I had the honour of submitting at the Cardiff meeting, was accepted. I understand, further, that some arrangements have been, or are being, made for making measures. The report, however, gives us no light on the matter. There is not even a recommendation of the inquiry. We are told what features of ancient churches are to be observed, but not a word about the one feature which usually gives character to the whole, orientation.

If measures of monuments have any meaning—and if they were and likely to remain meaningless, to ignore them would be a reckless accommodation to our ignorance—that meaning must be the vertebral column of any body of information about them. In most, if not all, branches of scientific inquiry measurements take precedence of any other data. If such a commission were appointed to gather anthropological data, is it likely that anthropometry would be given a second place in the inquiry? A similar method for archæological research has been devised in which measurement forms the first and best basis for a classification of monuments, all apart from any theory as to the significance of the measures. To those who are in the habit of regarding measures as constituting the very soul of a monument, the preservation of measures is the best possible preservation of a monument.

One can easily understand why a representative body of archæologists should hesitate a little before giving its endorsement to a line of inquiry which has to make its own way into favour. Probably at a mixed gathering of archæologists a majority might be found in favour of keeping it in abeyance. The commission might justify its silence, if not inaction, in such a matter, to such an audience, by referring to the element of prejudice which unfortunately is not confined to non-scientific bodies. There is, however, no evidence, so far as the commission is concerned, of such a slavish subjection of what should be a free, open, and thorough inquiry to the idiosyncrasies of the human equation. Just as the commission seeks the sympathetic cooperation of the Welsh public in its work, it is to be hoped that a representation of this kind will receive an equally sympathetic treatment by the commission itself.

The task of sifting and sorting the contents of the vast drag-net which the commission has cast over Wales is not an enviable one, but a better master of method in handling such materials could hardly be found than the secretary, Mr. Edward Owen.

JOHN GRIFFITH.

ANNUAL REPORT OF THE GOVERNMENT LABORATORY.

THE report of the principal chemist of the Government Laboratory, London, upon the work of the department during the last fiscal year, contains, as usual, a mass of information respecting the chemical examinations and inquiries made for the various branches of the executive. On former occasions we have described the general work of the laboratory in some detail, and will therefore, in the present instance, merely note a few of the many miscellaneous points of interest mentioned in the report.

Conformably to the provisions of the White Phosphorus Matches Prohibition Act, 1908, which came into operation on January 1 this year, a number of samples of imported matches were examined in order to ascertain whether they were free from the white or poisonous form of phosphorus. In only seven instances, however, out of 647, was white phosphorus found to be present. The importation of the matches in these consignments was prohibited. They were but an insignificant proportion of the total matches imported. Only doubtful cases are dealt with in the laboratory, as the absence of white phosphorus is shown in the great majority of cases by simple tests which have been devised for application by the local customs officials. The effect of the Act already has been to stamp out the use of white phosphorus in imported matches; and as regards matches made in the United Kingdom, samples of the paste used for "tipping" have been taken from the factories, but in no case has the use of white phosphorus been detected.

A number of samples of beer and brewing materials were found to contain arsenic in excess of the limits laid down by the Royal Commission on Arsenical Poisoning. One sample of malt contained as much as one-eighth of a grain of arsenic per lb., and the beer brewed from it showed a considerable excess of the poison. The brewers were immediately warned of the danger of allowing such beer to go into consumption. On investigation, the presence of the arsenic was traced to the fuel used for kiln-drying the malt.

Articles of food taken from the canteens on board naval vessels were not in all cases free from objection. Thus, of four samples of "lard," one consisted of cocoa-nut oil, one was considerably adulterated with cotton-seed oil and beef stearine, and the remaining two gave evidence of slight contamination with cotton-seed oil; and out of four samples of condensed milk, one was found to be a "skimmed" product and another was deficient in fat. The general Admiralty supplies, however, were found to be usually satisfactory.

The tendency of makers of foodstuffs to work down to a "standard," when one has been fixed, is exemplified by a remark which the principal chemist makes in regard to the proportion of water in imported colonial butter. Since the fixing of the limit of water at 16 per cent., "the quantity of water in colonial butter, formerly exceptionally low, is now nearer the limit, and occasionally exceeds it." Two samples of imported "pastry margarine" were found to contain solid paraffin, in one case as much as 10 per cent. Amongst miscellaneous samples analysed may be mentioned certain feeding-meals which were examined in connection with alleged poisoning of cattle; in some instances the meal was found to contain Java or Rangoon beans, which, on digestion with water, produce prussic acid through the influence of an enzyme. In another case of cattle poisoning, the food was found to have been contaminated with an arsenic-paste sheep dip.

In connection with lead poisoning in the pottery industry, a large number of samples were examined. From works in which cases of plumbism had occurred, thirty-six specimens of glaze were taken. The proportion of lead oxide in these glazes varied from 12·6 to 47·5 per cent., and it is noteworthy that, with one exception, the lead was almost wholly present as a soluble compound.

Samples of air from certain mines in Scotland were found to be very impure, proportions of carbon dioxide as high as 3½ per cent. being shown, and as much as 16 per cent of methane; whilst the oxygen in one sample had been reduced to 15½ per cent.

Arising out of suspected frauds in connection with claims

for old age pensions, the Government chemists were asked if possible to ascertain the date of entries made in family Bibles, old letters, and certificates. In some cases they were able to show, from the nature of the ink employed, that the writing was comparatively recent, and that the entries had been made for the purpose of manufacturing evidence in support of the claim.

The total number of analyses and examinations made during the year at the two main laboratories (Clement's Inn and Custom House) was 170,033, the greater number being in connection with dutiable articles. Legal proceedings were taken in 223 cases for contraventions of revenue laws, and the total amount of fines paid was 2877*l*.

THE ARCHÆOLOGICAL SURVEY OF NUBIA.

THE last Bulletin of the Archæological Survey of Nubia describes excavations in the cemeteries and buildings of the ancient district of Pselchis, which will become submerged when the new Nile barrage is completed. The results are to some degree unsatisfactory, owing to the prevalence, even from ancient times, of the practice of *sebakh*-digging by agriculturists in order to obtain fresh supplies of rich soil to re-fertilise the land, which is periodically covered by a layer of fine sand drifted by the prevailing wind. This results in the destruction of many interesting remains; and treasure hunters have also done much damage, but the operations of the latter can be easily distinguished from the ruder methods adopted by the farmers.

The anatomical reports by Prof. G. Elliot Smith and Dr. D. E. Derry are, as usual, exhaustive, and present much valuable information. They disclose the advance in the Byzantine-Pagan period, between the second and fourth centuries A.D., of a group of negroes from the south with distinctive physical characteristics, customs, and arts. Their occupation of these new settlements was certainly not altogether peaceful, many skeletons showing evidence of death by wounds, and one, in particular, with such extensive cranial injuries that it is difficult to understand how the victim could even for a short time have survived. One of the negresses whose remains were discovered in this cemetery displays an extremely abnormal type of prognathism. While the alveolar index of adult Europeans is 96·2, and that of African negroes 104·4, this specimen gives an index of 123·3, which is little below that of the chimpanzee, 128·8. It would be interesting to identify this abnormal type with that of some modern race; and a clue may be found in the fact that the negroes whose remains were found here practised the custom of filing the teeth, which, with removal of some of the incisors, still prevails among the Masai and some of the Kavirondo Bantus.

It seems to be generally believed that the latter races derived this custom from the Dinka and other allied Nilotic peoples, some of whom may have supplied the individuals whose remains have now, in such strange circumstances, been subjected to scientific examination. The question of the ancient prevalence of tuberculosis is also advanced by the fact that many of these people suffered from spinal disease due to this malady. It must have been common among them, because the high average of cases found in these cemeteries cannot be accounted for by the supposition that this site was used as a sanatorium for this class of disease.

MANGANESE-ORE DEPOSITS.

THE paper referred to below gives an elaborate and interesting account of the occurrence of manganese ore in Sandur, one of the States of the Presidency of Madras; its value lies mainly in the abundance of detail given respecting this one particular occurrence, and it thus lacks the broader economic interest that attaches to that recent admirable memoir dealing with the manganese deposits of the whole of India, "The Manganese-ore Deposits of India," by Dr. L. L. Fermor, Mem. Geol. Surv. India, xxxvii., which appeared at the commencement of the present year, and which has given so much valuable information regarding the occurrence and distribution of this ore. Mr. Ghose gives no figures at all to show the output of manganese from the State of Sandur, and thus avoids directing attention to its relative unimportance; it may therefore be as well to make up here for his shortcomings in this respect:—

Production of manganese ore during 1908 in the State of Sandur, 23,413 tons.

Production of manganese ore during 1908 in the Presidency of Madras, 513,845 tons.

Production of manganese ore during 1908 in the whole of India, 2,584,525 tons.

The production of ore, of which the paper treats, is therefore less than 1 per cent. of the output of India, and may be looked upon as economically negligible; it would accordingly be difficult to justify the concluding sentence of Mr. Ghose's paper, in which he characterises these Sandur deposits as "among the largest and most remarkable manganese-ore deposits of the world." Such exaggeration of language is out of place in a scientific paper, especially seeing that, as a matter of fact, the Sandur deposits are considerably smaller than those of Nagpur or Balaghat, whilst the ore is also apparently of inferior quality. In the same way, the estimates of the probable ore reserves may be dismissed as resting on very slight foundation.

The interest of the paper centres essentially in the geological description of the occurrences, and in the author's views as to their formation, which differ entirely from those put forward by the India Geological Survey authorities. Dr. Fermor looks upon these manganese deposits as having "been formed by the replacement at the surface of Dharwar schists, phyllites, and quartzites" in such a manner as to form a capping approaching to laterite in its character, and he accordingly designates these ores as "*lateroid* replacement masses"; this view appears, moreover, to be endorsed by Sir Thomas Holland. Mr. Ghose, on the other hand, considers that these "deposits primarily owe their origin to sedimentary deposition from magmatic solution. Their economic value has been enhanced by secondary enrichment." It should be noted that he does not use the term "magmatic solution" in the sense in which it has generally been employed by writers on ore deposits, but means in this case hot solutions containing iron and manganese, flowing in horizontal currents over the floor of an ocean.

Apart from all other considerations, it is obvious that these two theories would assign widely different economic values to the ore deposits in question. If the former is correct, the extension of the ore bodies in depth is strictly limited, whereas the latter theory, according to which the deposits are syngenetic, would impose no such limits upon their extension, and the suspicion cannot be avoided that the author's promulgation of his theory may have been unconsciously influenced by his desire to magnify the economic value of ore deposits, in the opening up of which he has taken a leading part. Seeing that the result of future mining operations will demonstrate without doubt which of these two conflicting theories is the correct one, whilst at present decisive evidence is lacking, it is hardly worth while to examine critically the bases upon which they rest, and the question may well be left for the future to settle, it being sufficient to record here that, whether his theories are right or wrong, the author has produced a full and interesting description of this system of deposits, and has thus contributed to our knowledge of the occurrences of ores of manganese. H. L.

1 "Manganese-ore Deposits of the Sandur State." By A. Ghose. Excerpt from the Transactions of the Mining and Geological Institute of India, vol. iv., pp. 155–204+21 plates. Part 3, February, 1910.

ZOOLOGICAL WORK IN INDIA.

IN vol. ii., No. 8, of the entomological series of the Memoirs of the Department of Agriculture, the Government entomologist, Mr. H. Maxwell-Lefroy, commences a lavishly illustrated account of the life-history of Indian insects, dealing in this instance with beetles. Hitherto, it is stated, little definite information has been recorded with regard to the life-histories of the beetles of India, and entomologists will therefore welcome the particulars given by the author in the case of eight of the commoner species. In seven out of the eight, the egg, larva, pupa, and imago are illustrated by coloured plates, executed in first-class style by the Calcutta Phototype Company.

Three out of five numbers of the Records of the Indian Museum, recently to hand, contain articles on biting flies and gnats. In the first of these, vol. iv., No. 1, Mr. F. V. Theobald describes certain new genera and species of Culicidæ, typified by specimens in the Indian Museum. It is stated, however, that in the case of the Culices with banded proboscis, some at least of the determinations must be regarded as provisional, since certainty cannot be attained until both sexes have been bred in captivity and the generative organs of the males and the larvæ carefully examined. In No. 3 of the same volume Mr. E. Brunetti records a protest against what he considers unnecessary subdivision and splitting in the Culicidæ, remarking that specialists in the Diptera must regard the present state of affairs as absurd, and that Prof. Williston appears to be the only systematic dipterologist who has attempted to stem the tide. The plea of the unwieldiness of big genera cannot be upheld, it is added, since the systematist is quite accustomed to such genera: a similar protest, it may be mentioned, seems called for in the case of the excessive generic splitting now in vogue in the squirrel and mice family. Mr. Brunetti concludes by stating that the subject will be more fully discussed in the supplement to the catalogue on which he is now engaged.

An article forming part ii. of the fourth volume, by Dr. Annandale, on Indian sand-flies (Phlebotomus), will be read with interest, since not only are these minute insects some of the greatest torments to Europeans in India, but, as may be inferred from the investigations made on their south European representatives, it is practically certain that they are also carriers of certain types of fever.

Finally, in the fourth and last part of vol. iv., Mr. Brunetti publishes a systematic revision of the Oriental blood-sucking flies of the family Muscidæ, with the description of a new genus.

From among a dozen articles in the first and second parts of the fifth volume of the Records, it must suffice to direct attention to one by Dr. R. E. Lloyd, on variation in Indian rats. In a previous paper the author has adduced evidence in favour of discontinuous variation having played a prominent part in the production of races. Individual rats from any particular towns, for instance, sometimes show more or less marked differences from their fellows, and the evidence they afford for discontinuous evolution lies in the manner in which these are distributed among the multitude of whole-coloured specimens. In the present paper it is stated that, among the thousands of normally coloured rats infesting Poona, there is found a colony of about one hundred individuals characterised by the presence of a white breast-patch, these having apparently originated in the city itself. Again, it was found that the rats of Naini Tal differ from the normal type of plains-rat by their shorter tails, longer and greyer fur, and a more or less well-defined white breast-patch. Some rats in the district differ, however, from this type by the under side of the tail being white. Accordingly, we find that in a single limited area there live, under apparently similar conditions, two phases of a widely distributed species, differing from one another solely in one obvious feature, these two phases living apart from each other. Obviously, any explanation as to the origin of the white-tailed phase will apply equally to the case of the white-breasted Poona rats, and the author concludes by endeavouring to explain each instance by the light of the theory of gametic factors. R. L.

THE BRITISH ASSOCIATION AT SHEFFIELD.

SECTION G.

ENGINEERING.

OPENING ADDRESS BY PROF. W. E. DALBY, M.A., M.INST.C.E., PRESIDENT OF THE SECTION.

British Railways: Some Facts and a Few Problems.

IT is remarkable how few among us really realise the large part that railways play in our national life. How many of us realise that the capital invested in the railway companies of the United Kingdom is nearly twice the amount of the national debt; that the gross income of the railway companies is within measurable distance of the national income; that to produce this income every inhabitant of the British Islands would have to pay annually 3*l.* per head; that they employ more than six hundred thousand people; and that about eight million tons of coal are burnt annually in the fire-boxes of their locomotives? I hope to place before you in the short time which can be devoted to a presidential address a few facts concerning this great asset of our national life and some problems connected with the recent developments of railway working—problems brought into existence by the steady progress of scientific discovery and the endeavour to apply the new discoveries to improve the service and to increase the comfort of the travelling public.

A great deal of interesting information is to be found in the Railway Returns issued by the Board of Trade. I have plotted some of the figures given, in order to show generally the progress which has been made through the years, and at the same time to exhibit the rates of change of various quantities in comparison with one another.

Consider, in the first place, what the railways have cost the nation. This is represented financially at any instant by the paid-up capital of the companies. The total paid-up capital in 1850 was 240 millions sterling. In 1908 this amount had increased to 1310 millions. The curve marked "Total" in Fig. 1 shows the total paid-up capital plotted against the year. It will be noticed that

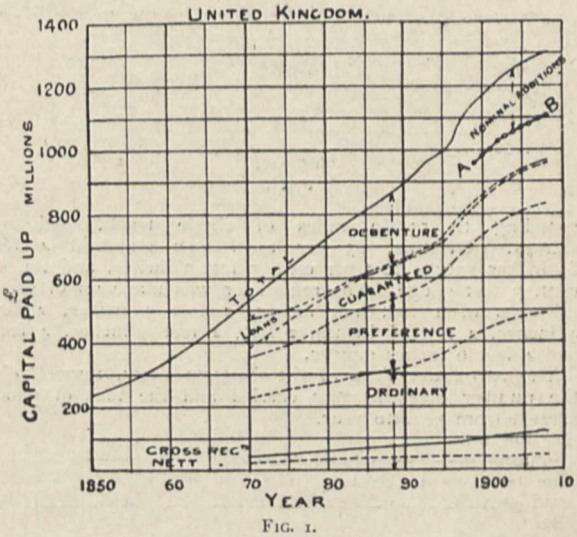


FIG. 1.

the increase per annum is remarkably regular up to about 1896, and is at the rate of not quite 100 millions per annum. After this date the capital increases at a somewhat greater rate, but in 1900 the rate drops with a tendency to a gradually decreasing value. Part of the increase immediately after 1896 is, however, due to nominal additions to the capital. The extent to which this process of watering the stock has been carried is indicated over the period 1898 to 1908 by the curve AB. In the year 1908 the nominal additions to capital amounted to 196 millions of pounds.

Curves are also plotted showing the amounts of the different kinds of stock making up the total. It will be noticed that the ordinary stock is a little more than one-third of the total paid-up capital in 1908, viz. 38 per cent. In 1870 it was about 43 per cent.

The lower curve on the diagram shows the gross receipts, which amounted to 120 millions of pounds in 1908. The dotted line indicates the net revenue after deducting from the total receipts the working expenditure. This, for 1908, was 43½ millions, corresponding to 3·32 per cent. of the total paid-up capital. If the net receipts are reckoned as a percentage of the paid-up capital after deducting the nominal additions, the return is increased to 3·9 per cent. These figures practically represent the average dividend reckoned in the two ways for the year 1908.

Fig. 2 shows by the upper curve the number of miles open for traffic plotted against the year. This curve indicates great activity of construction during the period 1850 to 1870, with a regular but gradually decreasing addition of mileage from year to year afterwards.

At the end of 1908 there were 23,205 miles open, corresponding to 53,669 miles of single track, including sidings. Of this, 85 per cent. was standard 4 feet 8½ inches gauge, 12·3 per cent. 5 feet 3 inches, and 2·2 per cent. 3 feet gauge. The remainder was made up of small mileages of 1 foot 11½ inches, 2 feet 3 inches, 2 feet 4 inches, 2 feet 4½ inches, 2 feet, 2 feet 9 inches, 4 feet, and 4 feet 6 inches gauges.

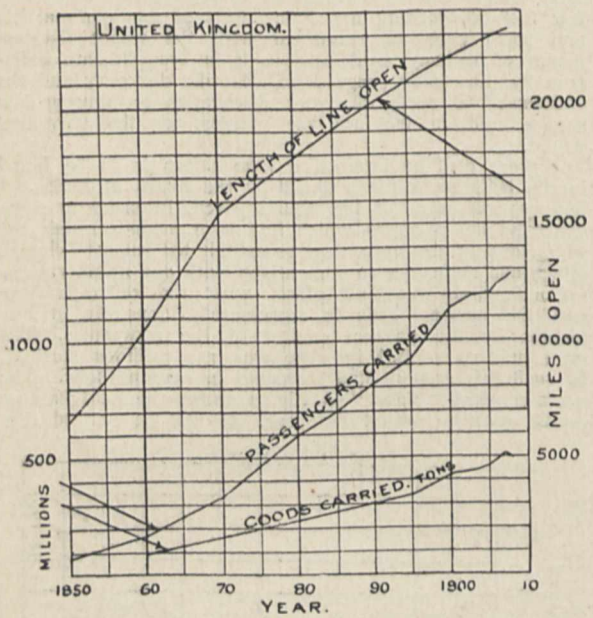


Fig. 2.

The two lower lines of the diagram show, respectively, the number of passengers carried and the tons of goods carried from year to year.

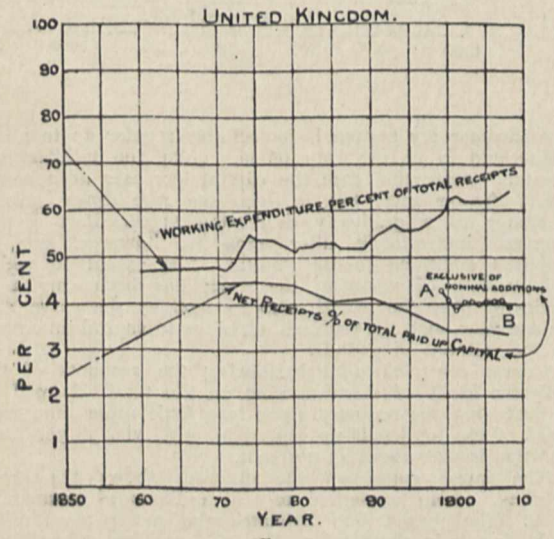


Fig. 3.

The curves of mileage, passengers carried, and goods carried increase regularly with the increase of capital, indicating that up to the present time the possibility of remunerative return on capital invested in railway enterprise in this country is not exhausted. It is true that there is a maximum of goods carried in the year 1907; but the sudden drop in the curve between the years 1907 and 1908 suggests that the drop is only of a temporary character, and there is every reason to believe that the curve will resume its upward tendency with time. In 1908 the railways of the United Kingdom carried 1278 millions of passengers, exclusive of season-ticket holders, and 491 million tons of goods; the quantity of goods carried in 1907 was nearly 515 millions of tons. It is curious that, very approximately, the companies carry per annum one passenger and about 0·4 ton of goods for every pound sterling of paid-up capital.

The proportion of the gross receipts absorbed in carrying out this service is shown by the upper curve of Fig. 3. The proportion has increased, on the whole regularly, from 47 per cent. in 1860 to 64 per cent. in 1908.

The lower curve shows the net receipts as a percentage of the paid-up capital. From 1899 onwards the curve AB shows the net receipts reckoned on the paid-up capital exclusive of the nominal additions. It will be observed that the net receipts have not declined more than half a per cent. since 1870, notwithstanding the increase in working expenditure.

Fig. 4 indicates the cost of working the traffic calculated in terms of the train-mile, no data being available regarding the actual work done as represented by the ton-mile or the passenger-mile. In some respects the train-mile is the fairest way of comparing costs, because when a train is running, whether it is full or empty, the same service must be performed by the majority of the departments.

Cost of Working per Train-mile of Railways in England and Wales.

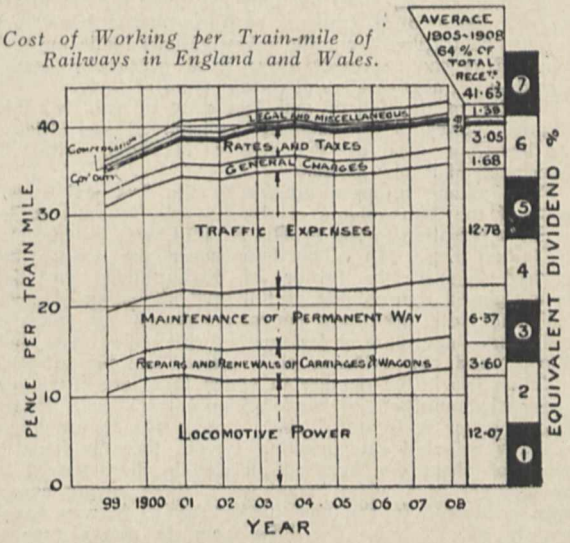


Fig. 4.

The curves bring out clearly that the proportion of the total expenditure per train-mile absorbed by these several services remains fairly constant over a series of years. To the right is exhibited the average for the four years 1905 to 1908. The figures are also reproduced in the following table:—

TABLE I.

Average Working Costs per Train-mile of the Railways in England and Wales taken over the Years 1905 *to* 1908.

	Pence per train-mile.
Locomotive power	12·07
Repairs and renewals of carriages and waggons	3·60
Maintenance of permanent-way	6·37
Traffic expenses	12·78
General charges	1·68
Rates and taxes	3·05
Government duty	0·22
Compensation	0·47
Legal and miscellaneous	1·39
Total	41·63

Locomotive power absorbs an amount about equal to the traffic expenses; and companies actually pay in rates and taxes a sum nearly equal to the whole amount required to maintain the rolling-stock in an efficient state.

To the right is shown a scale, the divisions of which represent an amount estimated in pence per train-mile corresponding to 1 per cent. of the average dividend. This shows that if the whole of the locomotive power could be obtained for nothing, the average dividend would only be increased by 1¾ per cent. Reckoned on the ordinary stock alone, however, the increase would be about three times this amount.

It may be of interest at this stage to compare the financial position and the cost of the working of railways in their earlier days with the state of things now. For this purpose the position of the old London and Birmingham Railway is compared with the position of the London and North-Western Railway, the system into which it has grown. The years selected are 1840 and 1908.

I have taken out the cost per mile of working the traffic of the London and Birmingham Railway from some accounts given in Winshaw's "Railways." The details are grouped somewhat differently in the list just given, but in the main the various items may be compared.

The number of train-miles on the London and Birmingham Railway recorded for the year January to December, 1839, is 714,998. The accounts given are for the year June, 1839, to June, 1840. The mileage record is thus not strictly comparable with the expense account, but it may be regarded as covering the same period with sufficient accuracy for our purpose.

The costs work out as follows:—

TABLE II.

Cost per Train-mile for the Year ending June, 1840, London and Birmingham Railway.

	Pence per mile.
Locomotive power	23·2
Maintenance of way	27·2
Traffic expenses, including repairs to waggons	25·9
General charges, including legal charges ...	4·5
Rates and taxes...	4·5
Government duty	7·65
Accident account	0·35
Total	93·30

The receipts amounted to 231*d.* per train-mile. Hence the working expenditure was 40 per cent. of the gross receipts.

The gross receipts for the year ending June 30, 1840, were 687,104*l.*, which, after deducting charges for loans, rents, and depreciation of locomotives, carriages, and waggons, enabled a dividend of 9¼ per cent. to be paid on the ordinary stock.

There are two noteworthy facts in these old accounts. First, the allowance for depreciation on the rolling-stock of nearly 4 per cent. of the receipts. Secondly, the fact that the cost of working the traffic is given per ton-mile. This method of estimating the cost of working has gradually fallen into desuetude on British railways. One company only at the present time records ton-mile statistics. Quite recently (in 1909) the committee appointed by the Board of Trade to make inquiries with reference to the form and scope of the accounts and statistical returns rendered by the railway companies under the Railway Regulation Acts have had the question of ton-mile and passenger-mile statistics under consideration. There was considerable difference of opinion concerning the matter, and in the end the committee did not recommend that the return of ton-mile and passenger-mile statistics should be made compulsory on the railway companies.

Returning to the London and Birmingham Railway accounts, the actual figures given by Mr. Bury, the locomotive engineer, were, for the year ending December, 1839:—

Passenger Trains.—Ton-miles, 21,159,796, giving an average of 542,533 ton-miles per engine at 0·86 lb. of coke per ton-mile costing 0·17*d.*

Goods Trains.—17,527,439 ton-miles, giving an average of 584,247 per engine at 0·57 lb. of coke per ton-mile costing 0·11*d.* per ton-mile.

Table III. shows various amounts and quantities in comparison with one another. Beneath the actual figures are placed proportional figures, the London and Birmingham item being in every case denoted by unity.

TABLE III.

Comparison of Capital, Receipts, Miles Open, Train-miles, and Cost of Working between the London and Birmingham Railway for the Year ending June, 1840, and the London and North-Western Railway for the Year ending December, 1908.

	Stock and Share Capital.		Loans and Debentures.		Total.	Gross Receipts.
	£	Interest per cent.	£	Interest per cent.	£	£
L. & B. Ry., 1840 . . .	3,125,000	9¾	2,125,900	4½	5,250,000	687,000
L. & N. W. Ry., 1908 .	85,861,760	5 app. average on all types of stock.	39,175,374	3 average.	125,037,134	35,515,334
L. & B. Ry., 1840 . . .	1		1		1	1
L. & N. W. Ry., 1908 .	27·5		18·4		24	22·6

	Miles Open in Equivalent Single Track.	Train-miles Run.	Receipts per Train-mile.	Cost of Working per Train-mile.	Expenditure to Gross Receipts per cent.
L. & B. Ry., 1840 . . .	250	714,998	231 pence	93 pence	40
L. & N. W. Ry., 1908.	5,406	48,732,644	76½ ,,	50 ,,	65
L. & B. Ry., 1840 . . .	1	1	1	1	1
L. & N. W. Ry., 1908.	21·6	68·3	0·33	0·54	1·62

The comparison brings out some curious facts. For instance, it will be noticed that the gross receipts of the London and North-Western Railway in 1908 were twenty-two and a half times as much as those of the London and Birmingham Railway in 1840, and that the track mileage open was about twenty-two times as great. The money earned per mile of track open is thus practically the same after a lapse of seventy years. To earn the same amount per mile of track open, however, the trains of the London and North-Western Railway had in 1908 to run 68·3 times the number of train-miles that the trains of the London and Birmingham Railway ran in 1840. That is to say, in order to earn a sovereign a London and North-Western train has now to run three times the distance which it was necessary for a London and Birmingham train to run to earn the same amount.

Another point to notice is that although the mileage and the receipts per mile of track open have each increased in the same proportion, yet the capital has increased at a greater rate, being on the total amount twenty-four times as much as in 1840, and the stock and share capital has increased twenty-eight times. So that with the necessity of running three times the train-mileage to obtain the same return per mile of track open, there runs the obligation to pay interest on an ordinary stock which has been increased in a greater proportion than the mileage and in a greater proportion than the earning power of the line. Lower dividends are therefore inevitable. The cost of working per train-mile has decreased gradually to about half its value in 1840, but, at the same time, the receipts per train-mile have dwindled to one-third of the amount in 1840.

These figures show that a more conservative system of financing the railways might have been adopted in the earlier days with advantage. If, when the receipts per

train-mile were larger, a proportion of the revenue had been used annually for the construction of new works and for the provision of new rolling-stock, instead of raising fresh capital for everything in the nature of an addition to the railway, the companies would to-day have been in a position to regard with equanimity the increasing cost of working.

It is too late in the day to recover such a strong financial position, but even now on many lines a larger proportion of the revenue could be sunk in the line with great ultimate advantage to the financial position.

The Problem of the Locomotive Department.

During the last twenty years the demand on the locomotive has steadily increased. The demand has been met, though with increasing difficulty, owing to the constructive limitations imposed by the gauge. The transference of a train from one place to another requires that work should be done continuously by the locomotive against the tractive resistance. The size of the locomotive is determined by the rate at which this work is to be done. If T represents the tractive resistance at any instant, and V the speed of the train, then the rate at which work is done is expressed by the product TV. The pull exerted by the locomotive must never be less than the resistance of the whole train considered as a dead load on the worst gradient and curve combination on the road, and it can never be greater than about one-quarter of the total weight on the coupled wheels of the engine.

Again, the tractive pull of the engine may be analysed into two parts—one the pull exerted to increase the speed of the train, the other the pull required to maintain the speed when once it has been reached. For an express train the number of seconds required to attain the journey speed is so small a fraction of the total time interval between the stops that the question of acceleration is not one of much importance. But for a local service where stops are frequent the time required to attain the journey speed from rest is so large a fraction of the time between stops that this consideration dominates the design of the locomotive, and, in fact, makes it desirable to substitute the electric motor for the locomotive in many cases.

An accurate estimate of the rate at which work must be done to run a stated service can only be made if there are given the weight of the vehicles in the train, the weight of the engine, the kind of stock composing the train, the speed and acceleration required at each point of the journey and a section of the road; and, in addition to this, allowance must be made for weather conditions.

A general idea of the problem can, however, be obtained by omitting the consideration of acceleration, gradients, and the unknown factor of weather conditions, considering only the rate at which work must be done to draw a given load at a given speed on the level. Even thus simplified the problem can be solved only approximately, because, although the tractive resistance of a train as a whole is a function of the speed, the tractive resistance per ton of load of the vehicles and per ton of load of the engine differ both in absolute value and in their rates of change for a stated speed, and, further, the ratio between the weight of the vehicles and the weight of the engine is a very variable quantity.

For our purpose, however, it will be sufficiently accurate to assume that the resistance of the whole train, expressed in pounds per ton, is given by the formula

$$T = 5\tfrac{1}{3} + \frac{V^2}{256}.$$

It follows that the horse-power which must be developed at the driving-wheels to maintain a speed of V miles per hour on the level with a train weighing W tons is

$$HP = W\left\{\frac{V}{70} + \frac{V^3}{96{,}000}\right\}.$$

Fig. 5 shows curves of horse-power plotted from this equation for various weights of train. From this diagram a glimpse of the problem confronting locomotive engineers at the present day can readily be obtained.

To illustrate the point, consider the case of the Scotch express on the West Coast route.[1] This is an historic service, and goes away back to 1844, in which year the first train left Euston for Carlisle, travelling by way of Rugby, Leicester, York, and Newcastle, and occupying 15¼ hours. It was not until 1847, however, that there was a through service to Edinburgh *via* Berwick.

In September, 1848, the West Coast service for Edinburgh was established by way of Birmingham and Carlisle, the timing being 8 hours 55 minutes to Carlisle, and 12 hours to Edinburgh.

In September, 1863, the starting time from Euston was fixed at 10 a.m., and in 1875 the train ran *via* the Trent Valley between Rugby and Stafford, thus cutting out Birmingham and shortening the journey to Carlisle from 309 miles to 299 miles, the timing being 7 hours 42 minutes to Carlisle, and 10 hours and 25 minutes to Edinburgh. The speed has gradually been increased, and in 1905 the timing was 5 hours 54 minutes to Carlisle, and 8¼ hours to Edinburgh. Now the timing is 5 hours 48 minutes to Carlisle, but is still 8¼ hours to Edinburgh.

Three specific examples are plotted on the diagram, showing the power requirements in 1864, 1885, and 1903 for this train. Typical trains in 1864, 1885, and 1903 weighed, including engine and tender, 100 tons, 250 tons, and 450 tons respectively. The average speeds were thirty-

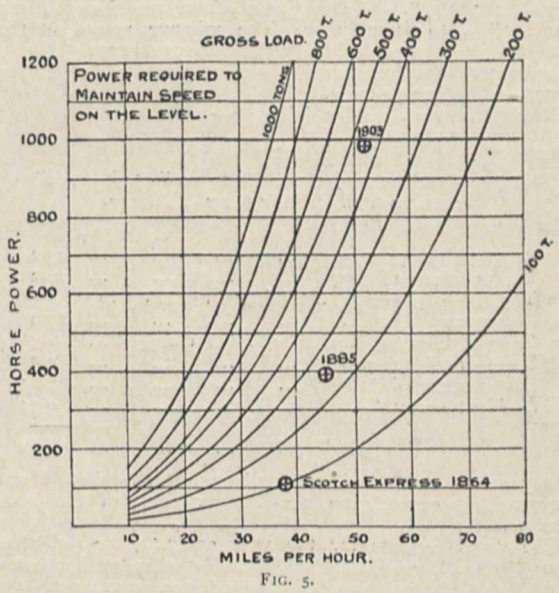


FIG. 5.

eight, forty-five, and fifty-two miles per hour respectively. A glance at the diagram will show that the power required to work this train was about 100 horse-power in 1864, 400 horse-power in 1885, and 1000 horse-power in 1903.

It must not be supposed that the increase in the weight of the train means a proportionate increase in the paying load. Far from it. On a particular day in 1903, when the total weight of the Scotch express was 450 tons approximately, the weight of the vehicles was about 346 tons. There were two dining-cars on the train, and the seating accommodation, exclusive of the seats in the dining-cars, was for 247 passengers, giving an average of 1·4 tons of dead load to be hauled by the engine per passenger, assuming the train to be full. In the days before corridor stock and dining-cars were invented the dead load to be hauled was about a quarter of a ton per passenger for a full train.

In a particular boat special, consisting of two first-class saloons, one second- and third-class vehicles, one first-class dining-car, one second and third-class dining-car, one kitchen-car, and two brake-vans, seating accommodation was provided, exclusive of the dining-cars, for 104 passengers, and the dead load to be hauled averaged 2·72

[1] I am indebted to Mr. Bowen Cooke for particulars of the Scotch Express Service.

tons per passenger. Notwithstanding this increase in the dead load of luxurious accommodation, the fares are now less than in former days on corresponding services. Similar developments have taken place in almost every important service, and new express services are all characterised by heavy trains and high speeds.

Characteristic Energy-curves of Steam Locomotives.

This steadily increasing demand for power necessarily directs attention to the problem, What is the maximum power which can be obtained from a locomotive within the limits of the construction-gauge obtaining on British railways? The answer to this can be found without much ambiguity from a diagram which I have devised, consisting of a set of typical characteristic energy-curves to represent the transference and transformation of energy in a steam locomotive, an example of which is given in Fig. 6. While examining the records of a large number of locomotive trials, I discovered that if the indicated horse-power be plotted against the rate at which heat energy is transferred across the boiler-heating surface the points fall within a straight-line region, providing that the regulator is always full open and that the power is

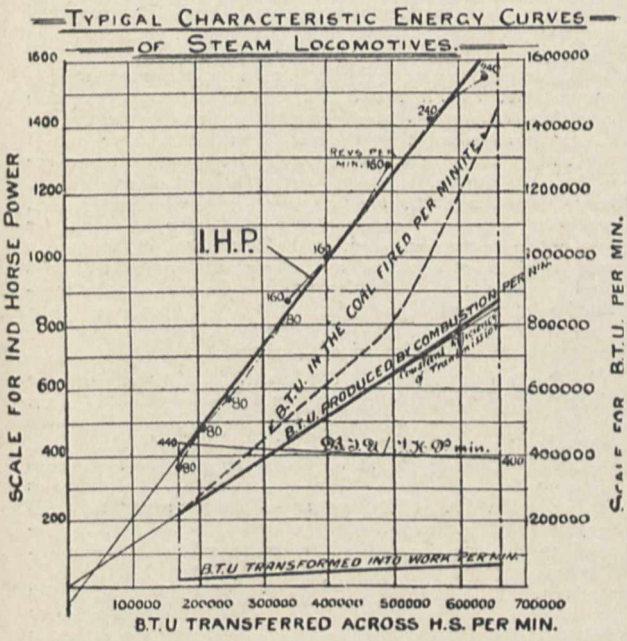


FIG. 6.

regulated by means of the reversing lever—that is to say, by varying the cut-off in the cylinders. It is assumed at the same time, of course, that the boiler-pressure is maintained constant. I have recently drawn a series of characteristic energy-curves for particular engines, and these are published in *Engineering*, August 19 and 26, 1910. A typical set is shown in Fig. 6.

The horizontal scale represents the number of British thermal units transferred across the boiler-heating surface per minute. This quantity is used as an independent variable. Plotted vertically are corresponding horse-powers, each experiment being shown by a black dot on the diagram. The small figures against the dots denote the speed in revolutions of the crank-axle per minute. Experiments at the same speed are linked by a faint chain-dotted line. A glance at the diagram will show at once how nearly all the experiments fall on a straight line, notwithstanding the wide range of speed and power.

The ordinates of the dotted curve just below the I.H.P. curve represent the heat energy in the coal shovelled per minute into the fire-box—that is, the rate at which energy is supplied to the locomotive. The thick line immediately beneath it represents the energy produced by combustion. The vertical distance between these two curves represents energy unproduced, but energy which might have been produced under more favourable conditions of combustion. Some of the unproduced energy passes out of the chimney-top in carbon monoxide gas, but the greater proportion is found in the partially consumed particles of fuel thrown out at the chimney-top in consequence of the fierce draught which must be used to burn the coal in sufficient quantity to produce energy at the rate required. The rate of combustion is measured by the number of pounds of fuel burnt per square foot of grate per hour. In land practice, with natural draft, 20 lb. of coal per square foot of grate per hour is a maximum rate. In a locomotive the rate sometimes reaches 150 lb. per square foot per hour. In the diagram shown the maximum rate is about 120 lb. per square foot, and the dotted curve begins to turn upwards at about 70 lb. per square foot per hour. The vertical distance between the curves shows what has to be paid for high rates of combustion.

I found that in almost every case the curve representing the energy actually produced by combustion differed very little from a straight line, passing through the origin, showing that at all rates of working the efficiency of transmission is approximately constant. That is to say, the proportion of the heat energy actually produced by combustion in the fire-box which passes across the boiler-heating surface per minute is nearly constant, and is therefore independent of the rate of working.

The lowest curve on the diagram represents the rate at which heat energy is transformed into mechanical energy in the cylinders of the locomotive. It seems a small rate in proportion to the rate at which heat energy is supplied to the fire-box, but it is not really so bad as it looks, because the engine actually transformed 60 per cent. of the energy which would have been transformed by a perfect engine working on the Rankine cycle between the same limits of pressure. The engine efficiency is represented in a familiar way by a curve labelled "B.T.H. per I.H.P. minute." It will be seen that the change of efficiency is small, notwithstanding large changes in the indicated horse-power.

The diagram indicates that the indicated horse-power is practically proportional to the rate at which heat is transferred across the boiler-heating surface, and as this is again proportional to the extent of the heating surface, the limit of economical power is reached when the dimensions of the boiler have reached the limits of the construction-gauge, the boiler being provided with a fire-grate of such size that, at maximum rate of working, the rate of combustion falls between 70 and 100 lb. of coal per square foot of grate per hour. A boiler of large heating surface may be made with a small grate, necessitating a high rate of combustion to obtain the required rate of heat-production. Then, although a large power may be obtained, it will not be obtained economically.

Returning now to the consideration of the type of locomotive required for a local service with frequent stops, the problem is to provide an engine which will get into its stride in the least time consistent with the comfort of the passengers. The average speed of a locomotive on local service is low. The greater part of the time is occupied in reaching the journey speed, and the brake must then often be applied for a stop a few moments after the speed has been attained. In some cases the stations are so close together that there is no period between acceleration and retardation. Without going into the details of the calculation, I may say that to start from rest a train weighing, including the engine, 300 tons, and to attain a speed of thirty miles per hour in thirty seconds requires about 1350 indicated horse-power. During the period of acceleration the engine must exert an average tractive pull of nearly fifteen tons.

Mr. James Holden, until recently locomotive engineer of the Great Eastern Railway, built an engine to produce an acceleration of thirty miles per hour in thirty seconds with a gross load of 300 tons. The engine weighed 78 tons, and was supported on ten coupled wheels, each 4 feet 6 inches diameter. There were three high-pressure cylinders, each 18½ inches diameter and 24 inches stroke. A boiler was provided with 3000 square feet of heating surface and a grate of 42 square feet area. Boiler

pressure, 200 lb. per square inch. This engine practically reached the limit of the construction-gauge.

An acceleration of thirty miles per hour in thirty seconds is considerably below what may be applied to a passenger without fear of complaint. But it is clear that it is just about as much as a locomotive can do with a train of reasonable weight. Even with a gross load of 300 tons nearly one-third of it is concentrated in the locomotive, leaving only 200 tons to carry paying load. The problem of quick acceleration cannot therefore be properly solved by means of a steam locomotive. But with electric traction the limitations imposed on the locomotive by the construction-gauge and by the strength of the permanent way are swept away.

The equivalent of the boiler-power of a dozen locomotives can be instantaneously applied to the wheels of the electric train, and every axle in the train may become a driving axle. Thus the whole weight of the stock, including the paying load, may be utilised for tractive purposes. If, for instance, the train weighed 200 tons, then a tractive force equal to one-fifth of this, namely, 40 tons, could be exerted on the train, but uniformly distributed between the several wheels, before slipping took place. The problem of quick acceleration is therefore completely solved by the electric motor.

Electric Railways.

December 18, 1890, is memorable in the history of railway enterprise in this country, for on that date the City and South London Railway was opened for traffic, and the trains were worked entirely by electricity, although the original intention was to use the endless cable system of haulage. This line inaugurated a wonderful system of traction on railways, in which independent trains, moving at different speeds at different parts of the line, are all connected by a subtle electric link to the furnaces of one central station.

Since that epoch-marking year electric traction on the railways of this country has made a gradual if somewhat slower extension than anticipated. But electrically operated trains have in one branch of railway working beaten the steam locomotive out of the field, and now reign supreme—that is, in cases, as indicated above, where a quick, frequent service is required over a somewhat short length of road. The superiority of the motor over the steam locomotive, apart from questions of cleanliness, convenience, and comfort, lies in the fact that more power can be conveyed to the train and can be utilised by the motors for the purpose of acceleration than could possibly be supplied by the largest locomotive which could be constructed within the limits of the construction-gauge. There are many other considerations, but this one is fundamental, and determines the issue in many cases.

A few facts relating to the present state of electric railways in the United Kingdom may prove of interest. At the end of 1908 there were in the United Kingdom 204 miles of equivalent single track worked solely by electricity and 200 miles worked mainly by electricity, corresponding to 138 miles of line open for traffic. Of this, 102 miles belong to the tube railways of London and 201 miles to the older system formed by the District and the Metropolitan Railways and their extensions.

It is not an easy matter to ascertain exactly how much capital is invested in these undertakings for the purpose of electric working alone, since some of the lines originally constructed for a steam locomotive service have been converted to electric working. On the converted lines there is the dead weight of capital corresponding to the locomotive power provided before electrification took place. The capital invested in the 102 miles of tube railways in London is a little more than 25,000,000*l.*

The total number of passengers carried (exclusive of season tickets) on the 138 miles of electrical track during the year 1908 was nearly 342 millions, being roughly one-third of the total number of passengers carried on all the railways of England and Wales during the same period.

The average cost of working this traffic is 22·3*d.* per train-mile. This figure includes the service of the lifts, which is presumably returned with the traffic expenses. The charges work out in this way:—

TABLE IV.

Average Working Cost per Train-mile of the Electric Railways worked wholly or mainly by Electricity in England and Wales for the Year 1908.

	Pence per train-mile.
Locomotive power	8·40
Repairs and renewals of carriages and waggons	1·50
Maintenance of permanent way	2·40
Traffic expenses	5·22
General charges	1·52
Rates and taxes	2·36
Government duty	0·088
Compensation	0·116
Legal and miscellaneous	0·75
Total	22·35

The corresponding total receipts were 38·65*d.* per train-mile. The working expenses are thus 58 per cent. of the total receipts. Comparing this with the figures given above for the whole of the lines in England and Wales, it will be seen that the cost for locomotive power on the electric railways appears to be about two-thirds of the cost on steam lines per mile run, the cost for repairs and renewals of carriages and waggons about one-half, and the cost for traffic expenses about one-half.

The two kinds of working are not, however, strictly comparable, as all the conditions of traffic in the two cases are different, and the length of the electric lines is relatively so small that the problems which arise out of the transmission of electric power over long distances are excluded. The traffic expenses and the cost of repairs and renewals of carriages and waggons, general charges, &c., are practically independent of the kind of power used for locomotive purposes, and, moreover, the difference in weight of electric trains and the steam-hauled trains is on the average so great that no comparison can be instituted without ton-mile statistics.[1]

Method of Working.

With two exceptions, the method of working the electrified lines of this country is in the main the same. A third conductor rail is laid on insulators fixed to the ordinary track sleepers, and is maintained throughout the whole of its length at as nearly as possible a pressure of 600 volts, except in a few cases where the pressure is 500 or 550 volts. Collecting shoes sliding along the rails are fixed to the trains, and through them current is supplied to the armatures fixed to or geared with the axles. The current flows through the armatures back to the stations or sub-stations through the running rails, which are bonded for the purpose, or sometimes through a fourth rail carried on insulators fixed to the track sleepers, as in the cases of the District and Metropolitan Railways.

Differences in the equipment arise out of the geographical necessities of the distribution. For a short line the power is produced at a central station, and is distributed by feeders to the conductor rail direct. For longer lines power is produced at higher voltage (11,000 volts in the case of the District Railway), and is then distributed to sub-stations conveniently placed along the line, where it is transformed to a lower voltage, converted to direct current, and then by means of feeders is distributed at 600 volts or thereabouts to the third rail.

In 1908 the Midland Railway Company opened for traffic the electrified line connecting Lancaster, Morecambe, and Heysham. The method of electrification was a departure from the general direct-current practice hitherto applied to electrified lines in this country. Power was supplied to the trains at 6600 volts, single phase, at twenty-five alternations per second, along an overhead conductor. The pressure was reduced by transformers carried on the motor-coach itself, and was then used by single-phase motors. The traffic conditions on this line are simple.

[1] Most valuable information regarding the cost of converting the line between Liverpool and Southport from steam to electric working will be found in Mr. Aspinall's presidential address to the Institution of Mechanical Engineers.

In December, 1909, the electrified portion of the London, Brighton, and South Coast Railway from Victoria, round by Denmark Hill, to London Bridge was opened for traffic. This work marks an epoch in the history of electric traction in England. For the first time the single-phase system was applied to meet the exacting traffic conditions of a London suburban service where the main condition is that the trains should be accelerated rapidly. The system has shown that it can meet all the conditions of the service perfectly. Energy is purchased, and is distributed by overhead conductors direct to the trains at 6600 volts, single phase, at twenty-five alternations per second, where it is used by the single-phase motors after suitable transformation by apparatus carried under the motor carriage. The results of this electrification will be of unusual interest, because not only has the method applied shown itself to be quite suitable for dealing with a stopping traffic where quick acceleration is the dominating condition, but it contains the germ of practicable long-distance electrification. The near future may see the extension of the system to the line between London and Brighton, giving a frequent non-stop service which would bring Brighton in point of time nearer than the suburbs on opposite sides of London are to one another.

Power Signalling.

During the last ten years a considerable number of trial installations of power-signalling apparatus have been made by the railway companies of this country. The electric lines have generally adopted power signalling, and the District Railway has installed a complete system on all its lines and branches.

The term "power signalling" is applied to any equipment in which the actual movements of the points and signals are done by power, the signalman's work being thus reduced to the movement of small light control levers or switches. Of the several systems tried and proposed, three bulk largest in the equipments applied in this country, namely, the all-electric, the low-pressure pneumatic, and the electro-pneumatic systems.

The "all-electric" system is represented by installations of the McKenzie-Holland and Westinghouse system on the Metropolitan and Great Western Railways, by installations of the "Crewe" system on the London and North-Western Railway, and by installations of Siemens Brothers on the Great Western Railway. The general feature of the all-electric system is that the points are operated by motors sunk in a pit by the side of the rails; the signals are pulled off electrically, and all the apparatus is controlled electrically.

The low-pressure pneumatic system is represented by installations on the London and South-Western Railway and the Great Central Railway. The points and signal arms are moved by air compressed to about 20 lb. per square inch, and led to cylinders connected to the points and to the signal arms. The control is also done by means of compressed air, small pipes leading from each air cylinder to the cabin.

The electro-pneumatic system has found most favour in this country up to the present time. The equipment installed includes such notable stations as the Central at Newcastle with 494 levers, and the Glasgow Central with 374 levers, and the whole of the Metropolitan District system of underground railways. In this system an air cylinder is connected to each set of points and to each signal-arm. Air compressed at 65 lb. per square inch is supplied to the cylinders from a main running alongside the railway kept charged by small air-compressors placed at convenient intervals. Each air cylinder is provided with a small three-way air-valve operated by an electromagnet. The movement of each air-valve is controlled electrically from the cabin through the electromagnet associated with it. The system grouped round any one signal-cabin may be regarded as an engine fitted with a large number of cylinders, each working intermittently by compressed air, and where in each the valve-rod has been changed to an electric cable, all the cables being led to a signal-cabin, where the operation of the valves is done by means of an apparatus which is as easily played upon as a piano, with this difference, however, that the notes are mechanically interlocked, so that a signalman cannot play any tune he pleases, but only a tune which permits of safe traffic movement. Moreover, the instrument is so arranged that the movement of the small lever determining the movement of a signal-arm cannot be completed unless the signal-arm actually responds to the intention of the signalman, thus detecting any fault in the connections between the box and the arm.

The obvious advantage of power signalling is the large reduction of physical labour required from the signalman. His energy can be utilised in thinking about the traffic movements rather than in hauling all day at signal levers. One man at a power frame can do the work of three at the ordinary frame. The claims made for power signalling, in addition to the obvious advantage of the reduction of labour, are briefly that the volume of traffic which can be dealt with is largely increased, that the area of ground required for the installation is considerably less than with the ordinary system, with its rodding, bell-crank levers, chains, and pulleys, and that where the conditions are such that power signalling is justified the maintenance cost is less than with a corresponding system of normal equipment.

Automatic Signalling.

Several of the power-signalling installations are automatic in the sense that between signal-cabins on stretches of line where there are no junctions or cross-over roads requiring the movement of points, the movement of the signal arm protecting a section is determined by the passage of the train itself. The most important equipment of this kind is that installed on the group of railways forming the "Underground" system. This includes the District Railway with all its branches. On this line the particular system installed is the electro-pneumatic, modified to be automatic except at junctions. Signal-cabins are placed only at junctions and at places where points require to be operated. The stretch of line to be automatically signalled is divided into sections, and the entrance to each section is guarded by a signal-post. Calling two successive sections A and B, the train as it passes from Section A to Section B must automatically put the signal at the entrance to B to danger, and at the same time must pull off the signal at the entrance to A. These operations require the normal position of the signal-arm to be "off" instead of at danger, as in the usual practice. The position of the arm in this system conveys a direct message to the driver. If "on" he knows that there is a train in the section; if "off" he knows that the section is clear. Each signal-arm is operated by an air motor, as briefly described above, but the cables from the valves are now led to relays at the beginning and end of the section which the signal protects. The contrivance by means of which the train acts as its own signalman is briefly as follows. One rail of the running track is bonded, and is connected to the positive pole of a battery or generator. The opposite rail is divided into sections, each about 300 yards long, bonded, but insulated at each end from the rails of the adjacent sections, and each section is connected to a common negative main through a resistance. A relay is placed at the beginning and at the end of each section, and is connected across from the positive to the negative rail. Current flows and energises the relay, in which condition the relay completes a circuit to the electromagnet operating the admission valve of the air cylinder on the signal-post, air is admitted, and the signal-arm is held off. This is the normal condition at each end of the circuit. When a train enters a section it short-circuits the relays through the wheels and axles, in consequence of which the relays, de-energised, break the circuit to the admission valve, which closes, and allows the air in the cylinder to escape, and the signal-arm, moved by gravity alone, assumes the "on" or danger position. At the same time the short circuit is removed from the section behind directly the train leaves it, the relays are at once energised, the admission valve to the air cylinder on the protecting post of the section is opened, air enters, and the signal is pulled down to the "off" position.

The speed at which traffic can be operated by this system of power signalling is remarkable. At Earl's Court junction box forty trains an hour can be passed each way—that is, eighty per hour—handled by the one signalman in the box. As the train approaches the box, both its approach to the section and its destination must be

notified to the signalman. When it is remembered that with ordinary signalling, to take an express train, for example, a signalman hears some twenty-four beats on the gongs in his box, and sends signals to the front and rear box, which give altogether some twenty-four beats on the gongs in these two boxes, forty-eight definite signals in all, for every express train he passes into the section which his signals protect, it will be understood that the system must be profoundly modified to admit such a speed of operation as eighty trains per hour per man. The modification is radical. No gong signals are used at all. There is a small cast-iron box standing opposite the signalman with fifteen small windows in it, each about 1½ inches square. Normally, each window frames a white background. A click in the box announces the approach of a train, and a tablet appears in one of the empty windows showing by code the destination of the train. The signalman presses a plug in the box, a click is heard, and a tablet is seen in a precisely similar apparatus in the next box. When the train passes the man presses another plug, and the tablet disappears.

Four wires run between the signal-boxes along the railway, and by combining the currents along the four wires in various ways fifteen definite signals can be obtained, a number sufficient for the District traffic. Each of the fifteen combinations is arranged to operate one particular tablet in the box. Current from these four wires is tapped off at intermediate stations, and is used to work a train indicator showing the passengers assembled on the platform the destinations of the next three trains. The whole equipment is a triumph of ingenuity and engineering skill, and is a splendid example of the way electricity may be used to improve the railway service, quite apart from its main use in connection with the actual driving of the trains.

The facts and problems I have brought before you will, I think, show the important influence that scientific discovery has had upon our railway systems. Scientific discovery and mechanical ingenuity have reduced the cost of locomotive working to a point undreamt of by the pioneer locomotive builders. Electric railways are the direct fruit of the discoveries of Faraday. The safety of the travelling public was enormously increased by the invention of continuous brakes and by the discovery of the electric telegraph, and is greatly increased by the development of modern methods of signalling; and the comfort of travellers is increased by modern methods of train-lighting, train-warming, and the train kitchen. Inventions of a most ingenious character have from time to time been made in order to furnish a steady and ample light in the carriages. The smoothness of travelling on our main lines is evidence of the thought which has been lavished both on the wheel arrangements of the carriages and on the permanent way. Problems in connection with the continuous brake are many and interesting. Some of the problems of modern signalling would have quite baffled the scientific electrician of a quarter of a century ago. When engineers endeavour to apply the results of scientific discovery they often find themselves confronted by new problems unperceived by the man of science. Together they may find a solution, and thus enlarge the boundaries of knowledge, and at the same time confer a practical advantage on the community. The pure man of science, the practical engineer, act and react on one another both to the advantage of pure science and to the advantage of the national welfare. The future success of our railways depends upon the closer application of scientific principle both to the economic and engineering problems involved in their working, some decrease in unprofitable competition with one another, and a more just appreciation on the part of the State of the part railway companies play in our national well-being.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY W. CROOKE, B.A., PRESIDENT OF THE SECTION.

ONE-AND-THIRTY years have passed since the British Association visited this city. At that time anthropology was in the stage of probation, and was represented by a branch of the section devoted to biology. Since then its progress in popularity and influence has been continuous, and its claims to be regarded as a science, with aims and capabilities in no way inferior to those of longer growth, are now generally admitted. Its advance in this country is largely due to the distinguished occupant of this chair at our last meeting in Sheffield. During the present year Dr. E. B. Tylor has resigned the professorship of anthropology in the University of Oxford. Before this audience it is unnecessary for me to describe in detail the services which this eminent scholar and thinker has rendered to science. His professorial work at Oxford; his unfailing support of the Royal Anthropological Institute and of this section of the British Association; his sympathetic encouragement of a younger generation of workers—these are familiar to all of us. Many of those now engaged in anthropological work at home and abroad date that interest in the study of man, his culture and beliefs, which has given a new pleasure to their lives, from the time when they first became acquainted with his "Primitive Culture" and "Researches into the History of Mankind." These works enjoy the almost unique distinction that, in spite of the constant accumulation of new material to illustrate an advancing science, they still maintain their authority; and this because they are based on a thorough investigation of all the available material and a profound insight into the psychology of man at the earlier stages of culture. He has laid down once for all the broad principles which must always guide the anthropologist: that a familiarity with the principles of the religions of the lower races is as indispensable to the scientific student of theology as a knowledge of the lower forms of life, the structure of mere invertebrate creatures, is to the physiologist. "Few," he assures us, "who will give their minds to master the general principles of savage religion will ever think it ridiculous or the knowledge of it superfluous to the rest of mankind. . . . Nowhere are broad views of historical development more needed than in the study of religion. . . . Scepticism and criticism are the very conditions for the attainment of reasonable belief." I need hardly say that his exposition of the principles of animism, as derived from the subconscious mental phenomena of dreams and waking visions, has given a new impulse and direction to the study of the religion of savage races.

Dr. Tylor, on his retirement from the active work of teaching, carries with him the respectful congratulations and good wishes of the anthropologists here assembled, all of whom join in the hope that the Emeritus Professor may be able to devote some of his well-earned leisure to increasing the series of valuable works for which we are already indebted to him.

In his address from this chair Dr. Tylor remarked that twenty years before that time it was no difficult task to master the available material. "But now," he added, "even the yearly list of new anthropological literature is enough to form a pamphlet, and each capital of Europe has its anthropological society in full work. So far from any finality in anthropological investigation, each new line of argument but opens the way to others behind, while those lines tend as plainly as in the sciences of stricter weight and measure towards the meeting ground of all sciences in the unity of nature."

Since these words were written there has been a never-ceasing supply of fresh literature, which is well represented in the publications of the present year. Every contributor to this science must now be a specialist, because he can with advantage occupy only one tiny corner of the field of humanity; and even then he is never free from a feeling of anxiety lest his humble contribution may have been anticipated by some indefatigable foreign scholar. In short, the attempt to give a general exposition of the sciences devoted to the study of mankind has been replaced by the monograph. Of such studies designed to coordinate and interpret the facts collected by workers in the field we welcome two contributions of special importance.

Prof. J. G. Frazer has given us a monumental treatise on totemism and exogamy, in which, relying largely on new Australian evidence and that collected from Melanesia by Dr. Haddon and his colleagues, Dr. Rivers and Dr. Seligmann, he endeavours to prove that totemism originated in a primitive explanation of the mysteries of conception and childbirth. As contributing causes he discusses the

influence of dreams and the theory of the external soul, the latter being occasionally found connected with totemism; and he points out that one function of a totem clan was to provide by methods of mimetic or sympathetic magic a supply of the totem plant or animal on which the existence of the community depends, this function being not metaphysical or based on philanthropic impulse, but on a cool but erroneous calculation of economic interest. He has also cleared the ground by dissociating totemism from exogamy, the latter, as an institution of social life, being, he believes, later in order of time than totemism, and having in some cases accidentally modified the totemic system, while in others it has left that system entirely unaffected. The law of exogamy is, in his opinion, based mainly on a desire to prevent the union of near relations, and on the resulting belief in the sterilising effects of incest upon women in general and edible animals and plants. In dealing with totemism as a factor in the evolution of religion he gives us a much-needed warning that it does not necessarily develop, first into the worship of sacred animals and plants, and afterwards into the cult of anthropomorphic deities with sacred plants and animals for their attributes. In the stage of pure totemism totems are in no sense deities, that is to say, they are not propitiated by prayer and sacrifice; and it is only in Polynesia and Melanesia that there are any indications of a stage of religion evolved from totemism, a conclusion which demolishes much ingenious speculation. It is hardly to be expected that in a field covered by the wrecks of many controversies these views will meet with universal acceptance. But the candour with which he discards many of his own theories, and the infinite labour and learning devoted to the preparation of his elaborate digest, deserve our hearty recognition.

In his treatise on "Primitive Paternity," Mr. E. S. Hartland deals with the problems connected with the relations of the sexes in archaic society. Mother-right he finds to be due not so much to the difficulty of identifying the father as to ignorance of physiological facts; and he supposes that the transition from mother-right to father-right originated not from a recognition of the physical conditions of paternity, but from considerations connected with the devolution of property; as Prof. Frazer states the case, it arises from a general increase in material prosperity leading to the growth of private wealth.

We also record the steady progress of the great "Encyclopædia of Religion and Ethics," under the editorship of Dr. J. Hastings, which promises to provide an admirable digest of the results of recent advances in the fields of comparative religion and ethnology.

It is now admitted by all students of classical literature that the material collected from the lower races is an indispensable aid to the interpretation of the myths, beliefs, and culture of the Greeks and Romans. Most of our universities provide instruction of this kind; and Oxford has opened its doors to a special course of lectures dealing with the relation of anthropology to the classics. One of its most learned mythologists, Dr. L. R. Farnell, when about half-way through his treatise on the cults of the Greek states, admitted the increasing value of the science in elucidating the problems on which he was engaged. Even with this well-advised change of method he has left the field of peasant religion, nature-worship, and magic, which must form the starting-points for the next examination of Greek beliefs, practically unworked. The formation of a Roman Society, working in cooperation with and following the methods which have been adopted by the Society for the Promotion of Hellenic Studies, is a fresh indication of the increasing importance of the work upon which we are engaged.

In the field of archæology Dr. A. J. Evans has commenced the publication of the Minoan records, which open up a new chapter in the early history of the Mediterranean. It is now certain that the origin of our alphabet is not to be found, as De Rougé supposed, in the hieratic script of Egypt, but in the Cretan hieroglyphs; and that the influence of the Phœnicians in its development was less important than has been generally supposed. Before the full harvest of these excavations can be reaped we may have to await the discovery of some bilingual document, like the Rosetta Stone, which will solve the mysteries of the Minoan syllabary.

As regards physical anthropology, the validity of the use of the cephalic index, particularly in discriminating the elements of mixed populations, has been questioned. The recent Hunterian lectures delivered by Prof. A. Keith, as yet published only in the form of a summary, are designed to place these investigations on a more scientific basis. In particular increased attention is being given to the influence of environment in modifying a structure generally so stable as the human skull. Thus it has been ascertained that the immigrant into our towns, by some process of selection or otherwise, develops a longer and narrower head than the countryman. The recent American Commission, under the presidency of Prof. Boas, reports that "racial and physical characteristics do not survive under the new climate and social environment. . . . Children born even a few years after the arrival of their parents show essential differences as compared with their European parentage. . . . Every part of the body is influenced, even the shape of the skull, which has always been considered to be the most permanent hereditary characteristic." Similar results appear from a comparison of the American negro with his African ancestor.

I may here refer briefly to the work on folk-lore. Though in recent years it has not maintained the importance which it at one time secured in the proceedings of this section, we still regard it as an essential branch of the study of man. The Folk-lore Society, after thirty-two years' useful work, finds that much still remains to be done in these islands to secure a complete record of popular beliefs and traditions, many of which are rapidly disappearing. It has therefore formulated a scheme for more systematic investigation in those districts which have hitherto been neglected. A committee including representatives of the two allied sciences is also engaged on the necessary task of revising and defining the terminology of anthropology and folk-lore.

The materials collected by field workers in various regions of the world, and popular accounts of savage religion, customs, and folk-lore continue to arrive in such increasing numbers that the need of a central bureau for the classification of this mass of facts has become increasingly apparent. It is true that we have suffered a set-back, it is to be hoped only temporary, in the rejection of an appeal made to the Prime Minister for a grant-in-aid of the Royal Anthropological Institute. But if we persist in urging our claims to official support the establishment of an Imperial Bureau of Ethnology cannot be long deferred.

One result of this accession of fresh knowledge, largely due to improved methods of research, is to modify some of our conceptions of savage psychology. We now understand that side by side with physical uniformity there may be wide differences arising from varieties of race and environment. It is becoming generally recognised that we can no longer evade the difficulty of interpreting beliefs and usages by referring them to that elusive personality, primitive man. Between the embryonic stage of humanity and the present lie vast periods of time; and no methods of investigation open to us at present offer the hope of successfully bridging this gap in the historical record. To use the words of Prof. Frazer: "It is only in a relative sense, by comparison with civilised men, that we may legitimately describe any living race of savages as primitive." Hence the hypothesis of the unilinear evolution of culture which satisfied an earlier school will no longer bear examination.

Further, not to speak of the artistic endowments of palæolithic man, we find to our surprise that a race like the Australian Arunta, whose lowness in the scale of humanity does not necessarily connote degradation, has worked out with exceptional ability through its tribal council their complex and cumbrous systems of group marriage and totemism. They have developed a cosmogony which postulates the self-existence of the universe; they have reached a belief in reincarnation and transmigration of the soul. So far from their social system being rigid it is readily modified to suit new conditions. They live in peace with neighbouring tribes, and have established the elements of international law. On the moral side, though there is much that is cruel and abhorrent, they are not wanting in kindliness, generosity, gratitude. The savage, in short, is not such an unobservant simpleton as some are inclined to suppose; and any interpretation of his

beliefs and usages which ignores this fact is certain to be misleading.

This popularisation of our science has not, however, been universally welcomed. It has been urged with much reason that this overabundance of material tends to encourage an unscientific method, particularly the comparison of isolated facts without due regard to the context of culture to which they are organically related. There is much force in this contention; and probably when the work of this generation comes to be critically reviewed we shall be rightly charged with rashly attempting a synthesis of facts not generically related, with reposing too much confidence in evidence collected in a haphazard fashion, and with losing sight of their historical relations in our quest after survivals. Those who have practical experience of work among savage or semi-savage races understand the difficulty of collecting information on subjects outside the range of their material interests. Only a skilled linguist is able to interpret their hazy religious beliefs. We fail to evolve order from what is and always must be chaotic; we fail to discriminate religion from sociology because both are from the savage point of view identical; and generally it is only the by-products of religion, such as demonology, witchcraft, mythology which reward our search. The most dogmatic among us, when they consider the divergent views of Messrs. Spencer and Gillen and Strehlow, may well hesitate to frame theories about the Arunta.

In the next place it has been objected that the scientific side of anthropology is in danger of being submerged by a flood of amateurism. It is only within recent years that a supply of observers trained in scientific methods has become available. Much of the work in India, the dominions, and other parts of the Empire has been done by amateurs, that is to say, by officers in the service of the Crown, missionaries, or planters, who understand the languages, manners, and prejudices of the people, but have not received the advantage of scientific training. Some of this work is, in its kind, useful; but there seems reason to believe that inquiries conducted by this agency have almost reached their limit. The existing material may be supplemented and corrected by workers of the same class; but from them no important additions to our knowledge can reasonably be expected.

Criticisms such as these have naturally suggested proposals for improving the qualifications of this agency by providing a course of training for public servants before they join their appointments; and excellent arrangements with this object have been made by several of our universities. In addition to this schemes are in the air for the establishment of a School of Oriental Studies in London or of a College for Civilians in Calcutta. We must, however, recollect that the college established by Lord Wellesley at the beginning of the last century with the intention, to use his own words, of promoting among junior officers "an intimate acquaintance with the history, language, customs, and manners of the people of India," failed to meet the aims of its founder. We must also remember that recruits for the Colonial services do not undergo any training in this country; and that in the case of the Covenanted Civil Service of India the period extends only to a single year, during which the candidate is expected to learn the rudiments of at least one Oriental language and to acquire some knowledge of the law and history of India. It seems obvious that this leaves little time for the scientific study of anthropology; and the most that can be expected is to excite in the young official a desire to study the native races and to define the subjects to which his attention may usefully be directed. There is, again, the obvious risk of letting loose the half-trained amateur among savage or semi-savage peoples. He may see a totem in every hedge or expect to meet a corn-spirit on every threshing-floor. He may usurp the functions of the arm-chair anthropologist by adding to his own proper business, which is the collection of facts, an attempt to explain their scientific relations. As a matter of fact, the true anthropologist is born, not made; and no possible course of study can be useful except in the case of a few who possess a natural taste for this kind of work.

Having then practically exhausted our present agency it is incumbent upon us to press upon the Governments throughout the Empire the necessity of entrusting the supervision of ethnographical surveys to specialists. This principle has been recognised in the case of botany, geology, and archæology, and it is high time that it was extended to anthropology. It is the possession of such a trained staff that has enabled the American Government to carry out with success a survey of the natives of the Philippine Islands; and it is gratifying to record that the Canadian legislature, in response to resolutions adopted by this section at the Winnipeg meeting, has recently voted funds to provide the salary of a superintendent of the ethnological survey. We may confidently expect that other Governments throughout the Empire will soon follow this laudable example. These Governments will, of course, continue to collect at each periodical census those statistics and facts of sociology and economics which are required for purposes of administration. But beyond these practical objects there are questions which can be adequately investigated only by specialists.

The duties of such a director will necessarily be threefold: First, to sift, arrange, and coordinate the facts already collected by non-scientific observers; secondly, to initiate and control special investigations, in particular that intensive study of smaller groups within a limited area which, in the case of the survey of the Todas by Dr. Rivers, has so largely contributed to our knowledge of that tribe. Such methods not only open out new scientific fields, but, and this is perhaps more important, establish a standard of efficiency which improves later surveys of these or neighbouring races.

The field for inquiry throughout the Empire is so vast that there is ample room for expeditions independent of official patronage. In some respects the private traveller possesses advantages over the official—in his freedom from the bondage of red tape and from the suspicion which inevitably attaches to the servant of Government that his inquiries are conducted with the object of imposing taxation or of introducing some irksome measures of administration. He is always sure to receive the aid of local officers, whose familiarity with the native races must be of the highest value.

The third duty of the director will be to organise in a systematic way the collection of specimens for home and colonial museums. Our ethnographical museums, as a whole, have not reached that standard of efficiency which the importance of the Empire and the needs of training in anthropology obviously require; and our students have to seek in museums at Berlin and other foreign cities for collections illustrative of tribes which have long been subject to British law. It is only necessary to refer to the recent handbook of the ethnographical collections in the British Museum to see that there are wide gaps in the series which might easily be filled by systematic effort. No time is to be lost, because the tragedy of the extinction of the savage is approaching the final act, and our grandchildren will search for him in vain except perhaps in the slums of our greater cities.

Assuming then that in the near future anthropological inquiries will be organised on practical lines, I invite your attention to some special problems in India which deserve intensive study, and which can be solved in no other way. India is a most promising field for such inquiries. Here the student of comparative religion can trace with more precision than is possible in any other part of the Empire the development of animism and the interaction on it of the forces represented by Buddhism, Hinduism, Islam, and Christianity. The anthropologist can observe the most varied types of moral and material culture, from those represented by the heirs of its historic civilisation down to forest and depressed tribes little raised above the level of savagery.

The first question which awaits examination is that of the prehistoric races and their relation to the present population. Unfortunately the materials for this inquiry are still imperfect. The operations of the archæological survey, with the scanty means at its disposal, have rightly been concentrated upon the remains of architecture in stone, which starts from the Buddhist period, and upon the conservation of the splendid buildings which are our inheritance from older ruling powers. The prehistoric materials have been collected by casual workers who were not always careful to record the localities and circumstances of the discovery of their contributions to the local museums. Many links are still wanting, some altogether absent from Indian

soil; others which systematic search will doubtless supply. We can realise what the position of prehistoric archæology in Europe would be if the series of Neolithic barrows, the bone carvings of the cave-dwellers, the relics from kitchen-middens and lake dwellings were absent. The caves of central India, it is true, have supplied stone implements and some rude rock paintings. But the secrets of successive hordes of invaders from the north, their forts and dwellings, lie deep in the alluvium, or are still covered by shapeless mounds. Tropical heat and torrential rain, the ravages of treasure-hunters, the practice of cremation have destroyed much of the remains of the dead. The epigraphical evidence is enormously later in date than that from Babylon, Assyria, or Egypt; and the oriental indifference to the past and the growth of a sacred literature written to subserve the interests of a priestly class weaken the value of the historical record.

Further, India possesses as yet no seriation of ceramic types such as that devised by Prof. Flinders Petrie which has enabled him to arrange the Egyptian tombs on scientific principles, or that which Prof. Oscar Montelius has established for the remains of the Bronze Age. Mr. Marshall, the Director of the Archæological Survey, admits that the Indian museums contain few specimens of metal work the age of which is even approximately known.

Though the record of the prehistoric culture is imperfect, we can roughly define its successive stages.

The palæolithic implements have been studied by Mr. A. C. Logan, whose work is useful if only to show the complexity of the problem. Those found in the laterite deposits belong to the later Pleistocene period, and display a technique similar to that of the river-drift series from western Europe. The Eoliths, which have excited such acute controversy, have up to the present not been discovered; and so far as is at present known the palæolithic series from India appears to be of later date than the European. Palæolithic man seems to have occupied the eastern coast of the peninsula, whence he migrated inland, using in turn quartzose, chert, quartzite, limestone, or sandstone for his weapons; that is to say, he seems not to have inhabited those districts which at a later time were seats of neolithic culture. Early man, according to what is perhaps the most reasonable theory, was first specialised in Malaysia, and his northward route is marked by discoveries at Johore and other sites in that region. Thence he possibly passed into India. The other view represents palæolithic man as an immigrant from Europe. At any rate, his occupation of parts of southern India was antecedent to the action of those forces which produced its present form, ere the great rivers had excavated their present channels, and prior to the deposition of the masses of alluvium and gravel which cover the implements which are the only evidence of his existence.

Between the palæolithic and the neolithic races there is a great geological and cultural gap; and no attempt to bridge it has been made except by the suggestion that the missing links may be found in the cave deposits when they undergo examination.

There is reason, however, to believe that the neolithic and the Iron Age cultures were continuous, and that an important element in the present population survives from the neolithic period. Relics of the neolithic are much more widely spread than those of the palæolithic age. They extend all over southern India, the Deccan, and the central or Vindhyan range. Up to the present they are scanty in the Punjab and Bengal; but this may be due to failure to discover or identify them. Mr. Bruce Foote has discovered at various sites in the south factories of neolithic implements associated with wheel-made pottery of a fairly advanced type, showing that the Stone Age has survived side by side with that of metal down to comparatively recent times. The Veddas of Ceylon, the Andamanese, and various tribes on the north-east frontier, in central and southern India, are, or were up to quite recent times, in the Age of Stone. In fact, when we speak of ages of stone or metal we must not regard them as representing division of time but generally continuous phases of culture.

There is no trustworthy evidence for the existence of an Age of Bronze. The single fine implement of this metal which has been discovered is probably, like the artistic vessels from the Nilgiri interments, of foreign origin; and other implements of a less defined type seem to be the result of imperfect metallurgy. This is not the place to discuss the problem of the origin and diffusion of bronze. Babylon, Asia Minor, and China have each been supposed to be a centre of distribution. The Egyptian specimen attributed to the third dynasty, say before the fourth millennium B.C., is believed by Prof. Petrie to be the result of a chance alloy; but the metal certainly appears in Egypt about 1600 B.C., and it is believed to have originated in central Europe, where the Zinnwald of Saxony or the Bohemian mines provided a supply of tin. The absence of a Bronze Age in India has been explained by the scarcity of tin and the impossibility of procuring it from its chief source in the Malay-Burman region, where the mines do not seem to have been worked in ancient times. But another view deserves consideration. Prof. Ridgeway has shown that all the sites where native iron is smelted are those where carboniferous strata and ironstone have been heated by eruptions of basalt; and iron was thus produced by the natural reduction of the ore. In Africa as well as India the absence of the Bronze Age seems to be due to the abundant supplies of iron ores which could be worked by processes simpler than those required in the case of bronze. In India iron may have been independently discovered towards the close of the neolithic period, and iron may have displaced copper without the intervention of bronze.

However this may be, the Copper Age in India, which has been carefully studied by Mr. V. A. Smith, is of great importance. Implements of this metal in the form of flat and bar celts, swords, daggers, harpoon, spear, and arrow heads, with ornaments and a strange figure probably human, have been found at numerous sites in northern India. In western Europe, according to Dr. Munro, the Copper Age was of short duration; but Mr. Smith believes that in India the variety of types indicates a long period of development.

No mention of iron occurs in the Rig-veda; but it appears in the Atharvan, which cannot be dated much later than 1000 B.C. It is now recognised that there is a still obscure stratum of Babylonian influence underlying the Aryan culture; and if, as is generally supposed, the manufacture of iron was established by the Chalybes at the head-waters of the Euphrates, who passed it down the delta, its use may have spread thence among the Indo-Aryans. It certainly appears late in the south Indian dolmen period; and we have the alternatives of believing that it was introduced there by the Dravidian trade with the Persian Gulf, which certainly arose before the seventh century before Christ, or that it was independently discovered by the Dravidians who still extract it in a rude way from the native ores.

The great series of dolmens, circles, and kistvaens which cover the hills and plateaux of the Deccan and the region to the south seem to belong to the Iron Age. Whether the construction of these monuments was due to the migration of the dolmen-building race from northern Africa, or whether the builders were a local people utilising the material on the spot must remain uncertain. The excavations conducted by Mr. Breeks and others disclose tall jars, many-storeyed cylinders of varying diameter, with round or conical bases, fashioned to rest on pottery ring-stands, like the classical amphoræ, or to be imbedded in softer soil. The lids of these vessels are ornamented with rude, grotesque figures of men, animals, or more rarely inanimate objects, depicting the arms, dress, ornaments, and domesticated fauna of the period. It has been suspected that these figurines may be of a date earlier than the implements of iron with which they are associated, and that they were deposited with the dead in a spirit of religious conservatism. At any rate, the costumes and arms represented on the older pottery present no resemblance to those depicted on the later series of dolmens and kistvaens. The pottery also seems to belong to different periods, the larger jars being of a later date than the true funereal urns which are found at a lower level, and contain a few cremated bones, gold ornaments, bronze and iron rings, with beads of glass or agate. These people clearly regarded bronze as an article of luxury, as it appears in the form of ornaments or in the series of splendid vases preserved in the Madras museum. It is difficult to suppose that these were of local origin; more probably they were imported in the course of trade along the western coast or from more distant regions.

Another and equally remarkable phase of culture, com-

bining distinctly savage features with a fairly advanced civilisation, is illustrated by the Adittanalur cemetery in the Tinnevelli district recently excavated by Mr. Rea. Two skulls discovered here are prognathous, suggesting a mixture of the Negrito and Dravidian types. There is no trace of cremation, and in most cases the smallness of the urn openings implies that the corpses were exposed to birds of prey, and that only such bones as could be discovered after removal of the flesh were collected for interment; or, according to another interpretation of the facts, we have an instance of the custom of mourners carrying with them, like the modern Andamanese, the relics of the dead. These interments certainly extended over a long period, neolithic weapons being found in some graves, while in others iron arms were discovered fixed point downwards near the urns, as if they had been thrust into the ground by the mourners. In the richer graves gold frontlets, like those of Mycenæ and other Greek interments, were fastened over the forehead of the corpse. These were, like the Greek specimens, of such a flimsy type that they could never have been used in real life. It is a remarkable instance of a survival in custom that at the present day some tribes in this region tie a triangular strip of gold on the forehead of the dead, the import of which, on the analogy of the death masks of Siam, Cambodia, ancient Mexico, and Alaska, we may interpret as an attempt to guard the corpse from the glances of evil spirits while the spirit is on its way to deathland, or to be used in processions of the corpse.

The question remains: To what races may we attribute these successive phases of culture in southern India? The Tamil literature, as interpreted by Bishop Caldwell and Mr. V. Kanakasabhai, shows the existence of an advanced type of archaic culture in this region; but the evidence to connect this with the existing remains is as yet wanting. We may reasonably assume that neolithic man survives in the existing population, because we have no evidence of subsequent extensive migrations, except the much later arrival of Indo-Aryan colonies from the north, and that of the Todas, whom Dr. Rivers satisfactorily identifies with the Nayars and Nambutiri Brahmans of Malabar. The occurrence of a short-headed strain among some tribes in western India probably represents some prehistoric migration by sea or along the coast line from the direction of Baluchistan or the Persian Gulf. The suggestion that it is the result of a Scythian or Hun retreat from northern India in the face of an advancing Aryan movement is not corroborated by any historical evidence, and is in itself improbable. The customs of dolmen and kistvaen burial still persist among some of the present tribes, and they display some reverence for the burial places of their forgotten predecessors. This feeling may, however, be due to the habitual tendency of the Hindu to perform rites of propitiation at places supposed to be the haunts of spirits, and need not necessarily connote racial identity.

The most primitive type identifiable in the population of south India is the Negrito, which appears among the Veddas of Ceylon, and among the Andamanese, who retain the Negrito skin colour and hair, but have acquired, probably from some Mongoloid stock, distinct facial characters. It has been the habit with some writers to exaggerate the Negrito strain in the south. But tribes like the Badagas and Kotas, which have been classed as representative of this type, possess none of the Negrito characters, which appear only among the more primitive Kurumbas, Malayans, Paniyans, and Irulas. In all the modern tribes the distinctive Negrito marks—woolliness of hair, prognathism, lowness of stature, and excessive length of arm—have become modified by miscegenation or the influences of environment.

The resemblances in culture of the Indian Negrito with the cognate races to the east and south-east of the Peninsula are too striking to be accidental. The Kadirs of Madras climb trees like the Bornean Dayaks, clip their teeth like the Jakun of the Malay Peninsula, and wear curiously ornamented hair combs like the Semang of Perak, among whom they serve some obscure magical purpose. The Negrito type deserves special examination in relation to the recent discovery of Pygmies in New Guinea, and the monograph on the Pygmy races in general by Dr. P. W. Schmidt, who regards them as the most archaic human type, from which he supposes the more modern races were developed, not by a process of gradual evolution, but *per saltum*. If there be any force in these speculations he is justified in expressing his conviction that the investigation of the Pygmy races is, at the present moment, one of the weightiest and most urgent, if not the most weighty and most urgent, of the tasks of ethnological and anthropological science.

This Negrito stock was followed and to a considerable extent absorbed by that which is usually designated the Dravidian. The problem of the origin of this race has been obscured by the unhappy adoption of a linguistic term to designate an ethnical group, and its unwarrantable extension to the lower stratum of the population of northern India. At present the authorities are in conflict on this, the most important question of Indian ethnology. One school denies that this people entered India from the north or north-west on the ground that the immigration of a dolichocephalic race from a brachycephalic area is impossible, and insists that the distinction between the so-called Dravidians and Kolarians is linguistic, not physical. The other theory postulates the origin of the Dravidians from the north-west, that of the Kolarians from the north-east; and avoids the difficulty of head form by referring the Dravidians to one of the long-headed races of central or western Asia or north Africa, or by suggesting that their skull form has become modified on Indian soil by environment or miscegenation.

Recent investigations, archæological or linguistic, throw some new light on this complex problem. Sir T. Holdich, in his recent work "The Gates of India," asserts that Makrán, the sea-board division of Baluchistan, is full of what he calls "Turanian," or Dravidian remains. He explains the position of the Brahui tribe in Baluchistan, on whom the controversy mainly turns, by assuming that while they now call themselves Mingal or Mongal and retain no Dravidian physical characters, the survival of their Dravidian tongue is due to the fact that it is their mother language, preserved by Dravidian women enslaved by Turco-Mongol hordes. Relics of the original Dravidian stock, he suggests, may be found in the Ichthyophagi, or fish-eaters, whom Nearchus, the admiral of Alexander the Great, observed on the Baluchistan coast, living in dwellings made of whale-bones and shells, using arrows and spears of wood hardened in the fire, with claw-like nails and long shaggy hair, a record of the impression made upon the curious Greeks by the first sight of the Indian aborigines.

In the next place, inquiries by Dr. Grierson in the course of the Linguistic Survey prove that what is called the Mon-khmer linguistic family, which preceded the Tibeto-Burmans in the occupation of Burma, at one time prevailed over the whole of Further India, from the Irawadi to the Gulf of Tongking, and extended as far as Assam. To this group the Munda tongue spoken by some hill tribes in Bengal is allied; or, at least, it may be said that languages with a common substratum are now spoken not only in Assam, Burma, Annam, Siam, and Cambodia, but also over the whole of Central India as far west as the Berars. "It is," says Dr. Grierson, "a far cry from Cochin-China to Nimár, and yet, even at the present day, the coincidences between the language of the Korkus of the latter district and the Annamese of Cochin-China are strikingly obvious to any student of language who turns his attention to them. Still further food for reflection is given by the undoubted fact that, on the other side, the Munda languages show clear traces of connection with the speech of the aborigines of Australia." The last assumption has been disputed, and it is unnecessary to discuss this wider ethnical grouping. Though identity of language is a slippery basis on which to found an ethnological theory, it seems obvious that the intrusive wedge of dialects allied to the Mon-Khmer family implies that the Central Indian region was at one time occupied by immigrants who forced their way through the Eastern Himalayan passes, their arrival being antecedent to the migration which introduced the Tai and Tibeto-Burman stocks into Further India.

When the solution of this problem is seriously undertaken under expert guidance, the first step will be to make an exhaustive survey of the group of forest tribes, from the Santáls and Paháriás on the east, passing on to the Kols and Gonds, and ending with the Bhíls on the west. At present our information of the inter-relations of these tribes is fragmentary, and their superficial uniformity does not exclude the possibility that they represent more than one

racial element. It will also be necessary to push inquiry beyond the bounds of the Indian Empire, and, like the trigonometrical surveyor, to fix the base line as a datum in India, and extend the triangulation through the borderlands. It is in these regions that the ethnological problems of India await their final solution. Many of these countries are still beyond our reach. Until the survey of the routes converging at Herat, Kabul, or Kandahar is complete, the extent of the influence of the western races—Assyrian, Babylonian, Iranian, Arab, and Greek—cannot be determined. Recent surveys in Tibet have thrown much light on that region, but it is still only very partially examined. In Nepal the suspicious native Government still bars the way to the Buddhist sites in the Tarai and the Nepal valley, and thus a wide chapter in the extension of Hindu influence beyond the mountain range remains incomplete.

The second great problem is the origin and development of caste. We have yet to seek a definition which will cover the complex phases of this institution, and effect a reconcilement between the views of Indian observers who trace it to the clash of races or colours, and that of the sociologists, who lay little stress on race or colour and rely more upon the influence of environment, physical or moral. We must abandon the insular method which treats it only in relation to India, and ignores the analogous grouping of rank and class which was prepotent in Western Europe and elsewhere, and is now slowly losing ground in the face of industrial development. It is by the study of tribes which are on the borderland of Hinduism that we must look for a solution of the problem. The conflict of the Aryan and aboriginal culture, on which the religious and social systems of Hinduism were based, is reproduced in the contact between modern Hinduism and the forest tribes. Since the Hindus are the only members of the Aryan stock among whom we find endogamous groups with exogamous sections, the suggestion of Prof. Frazer that they may have borrowed it from the non-Aryans gains probability. The Dravidians within the Indian totemic area have worked out an elaborate system of their own, which is well described in the recent survey of the Malayans by Mr. F. T. Richards. How far this is connected with their preference for mother-right and their strong family organisation, of a more archaic type than the joint family of the Aryans, is a question which deserves examination. The influence, again, of religion must be considered, and this can be done with the most hopeful results in regions like eastern Bengal, where a people who have only in a very imperfect way adopted Hinduism are now being converted wholesale to Muhammadanism.

Again, when we speak of the tribe in India, we must remember that it assumes at least seven racial types, ranging from the elaborate exogamous groups of the Rajputs to the more archaic form characteristic of the Baloch and Pathán tribes of the western frontier, attached to which are alien sections affiliated by the obligation to join in the common blood-feud, which in process of time develops into a fiction of blood-brotherhood. Thus among the Marri of Baluchistan we can trace the course of evolution: admission to participate in the common blood-feud, admission to participation in a share of the tribal land, and finally admission to kinship in the tribe.

This elasticity of structure has permitted not only the admission of non-Aryan tribes into the Rajput body in modern times, but prepares us to understand how the majority of the Rajputs were created by a similar process of fusion, the new-comers being known as the Gurjaras, who entered India in the train of the Huns in the fifth or sixth centuries of our era. The recognition of this fact, by far the most important contribution made in recent times to the ethnology of India, is due to a group of Bombay scholars, the late Mr. A. M. T. Jackson, whose untimely death at the hand of an assassin we deeply regret, and R. G. and D. R. Bhandarkar. Mr. D. R. Bhandarkar has recently proved that a group of these Gurjara Huns, possibly the tribal priests or genealogists, were admitted first to the rank of Brahmans, and then, by a change of function, of which analogies are found in the older Sanskrit literature, becoming Rajputs, are now represented by the Guhilots, one of the proudest septs. This opens up a new view of tribal and caste development. Now that we can certainly trace the blood of the Huns among the Rajput, Jat, and Gujar tribes, a fresh impulse will be given for the quest of survivals in belief and custom connecting them with their Central Asian kinsfolk.

In what I have said I have preferred to speculate on a problem for work in the future rather than dwell upon the progress which has been already made. In the sphere of religion we have passed the stage when, as Prof. Max Müller said, "the best solvent of the old riddles of mythology is to be found in the etymological analysis of the names of gods and goddesses, heroes and heroines," or when the "disease of language" theory was generally accepted. The position, in fact, has completely changed since Comparative Religion has adopted the methods of Anthropology. The study of myths has given way to that of cults, the former being often only naïve attempts to explain the latter. India offers wide fields for inquiry by these new methods, because it supplies examples of cult in its most varied and instructive phases. The examination of Hinduism, the last existing polytheism of the archaic type, is likely to explain much hitherto obscure in the development of other pantheons. It is no longer possible to refer the complex elements of this or any other group of similar beliefs to a single class of physical concepts. The sun, the dawn, the golden gates of sunset, or the dairy no longer furnish the key which unlocks the secret. It is by the study of the Animism, Shamanism, or Magic of the lower tribes that Hinduism can be interpreted. This analysis shows that behind the myths and legends which shroud the forms of the sectarian gods the dim shape of a Mother goddess appears, at once chthonic or malignant because she gives shelter to the dead, and beneficent because she nurtures the sons of men with the kindly fruits of the earth. Beside her, though his embodiment is much less clearly defined, stands a male deity, her consort, and by a process of magic, mimetic, sympathetic, or homœopathic, their union secures the fertility of the animal and vegetable creation.

Much, however, remains to be done before the problems of this complex polytheism can be fully solved. The action of archaic religions, as has been well said, "takes place in the mysterious twilight of sub-consciousness"; and the foreign observer is trammelled by the elaborate system of tabu with which the Hindu veils the performance of his religious rites. This feeling extends to all classes, and the ceremonial of the jungle shrines is as little open to examination as the *penetralia* of the greater temples. The great army of mendicant friars jealously conceals the secrets of its initiation, rites, and beliefs, and this field of Indian religious life remains practically unworked. Much may be done by the training of a body of native observers who are not subject to the tabu imposed upon the foreigner. Here the difficulty lies in the contempt displayed by the higher educated classes towards the beliefs and usages of the lower tribes. There are some indications that this feeling is passing away, and in recent years much useful ethnological work has been done by native scholars.

The problems of ethnology, so far as they are concerned with the origin of prehistoric races and their relation to the existing population, are more or less academic. Ethnography, which examines the religious, cultural, and industrial conditions of the people, has more practical uses. At the present time it is incumbent upon us to preach, in season and out of season, that the information which it is competent to supply is the true basis of administrative and social reform. If, for example, we were now in possession of the facts which an anthropometrical survey of our home population would supply, many of our social problems would assume a clearer aspect. Such, for instance, are the questions of degeneration due to slum life and malnutrition, the influence of alcoholism on industrial efficiency, the condition of dangerous and sweated industries, and that of the aliens settled in our midst. It is characteristic of the genius of the English people, that while we are not yet prepared to admit the need of such a survey, the provision of medical inspection and relief for children in elementary schools will soon render it inevitable.

This is more clearly the case in those regions where a large native population is controlled by a small European minority. The Negro question in America teaches us a useful lesson, applicable to native races in most parts of

the Empire. In India, whenever the Government has made really serious mistakes, the failure has been due to ignorance or disregard of the beliefs or prejudices of the subject people. A little more than a century ago a mutiny of native troops at Vellore was due to injudicious attempts to change a form of headdress which they believed to be a symbol of their religion or caste; ignorance of the condition of the Santáls allowed them to be driven to frenzy by the extortions of moneylenders which culminated in a serious outbreak; the greased cartridges of the Great Mutiny, and the revolt against measures, adopted in defiance of native feeling to check the plague epidemic, teach a similar lesson.

In India at the present time "the old order changeth, yielding place to new"; and at no period in the history of our rule was it more necessary to effect a reconciliation between the foreigner and the native. While the tabus of marriage relations and commensality will for an indefinite period prevent the amalgamation of the races, much of the present disquiet is due to ignorance and misunderstanding on both sides. The religious and social movements now in progress deserve the attentive study of the British people. In religion various attempts are being made to free Hinduism from some of its most obvious corruptions, to harmonise Eastern and Western ideals, and to elevate the former so as to enable them to resist the pressure of the latter. Such is Vedantism, a revival of the ancient pantheistic philosophy, which not only claims supremacy in India, but asserts that its mission is to replace the dying faiths of the Western world. The spread of monotheism, as represented by Bhagavata beliefs, is equally noteworthy; and the effect of the revival of the cults of Ganpati, god of luck, and of Sivaji, the Mahratta hero, on the political situation in the Deccan deserve the most careful consideration.

The social movement is the result of that fermentation which is in progress among the subject peoples in many parts of the world. While the educated Indian claims social equality with the foreigner, he is occupied with a serious problem at his own doors. The degraded castes, popularly called the "untouchables," are revolting against the obloquy which they have long endured at the hands of the higher races. Many of them have sought relief by joining the Christian or Muhammadan communities, and the progress of conversion is so remarkable as to excite the surprise and alarm of the orthodox classes. Measures have been designed to improve their almost intolerable position. It remains to be seen how far any concessions which are likely to satisfy them can be reconciled with the ideals of the caste system.

It is true that the people of India prefer to celebrate many of their religious and social rites free from observation of the foreigner, and that there are forbidden chambers in the Oriental mind which no stranger may enter. But the experience of those best qualified to express an opinion is that a sympathetic interest in the religious and social life of the people, so far from tending to increase the existing tension, is a valuable aid towards the promotion of mutual goodwill and sympathy. Orthodox native States not only show no aversion to ethnographical inquiry, but are themselves actively engaged in such surveys. Even the Rajputs, who ordinarily display little taste for scientific work, are beginning to undertake the collection of the bardic chronicles which embody their tribal folk-lore and traditions.

When the divergencies in the beliefs and institutions of the foreigner and the indigenous races are realised and understood, a compromise must be effected, each side discarding some hereditary prejudices—the Hindu that aversion to the manners and customs of the European which is the chief barrier to the promotion of intercourse between the races; the European that insularity of thought which makes it difficult for him to understand all that is valuable in novel types of belief and culture, as well as that lack of imagination which inclines him to exaggerate what seems to him intolerable in the economical condition, the social organisation and beliefs of races whose environment differs from his own.

Anthropology has thus a practical as well as a scientific side. The needs of inquirers whose interest mainly lies in the investigation of survivals and in the stages of evolution in culture and belief can, as I have endeavoured to show, be met only by the adoption of improved methods of inquiry and a more rigorous dissection of evidence. Unfortunately the inadequate resources of the societies devoted to the study of man, as contrasted with the extent of the sphere of inquiry and the importance of the savage or semi-savage races as factors in the progress of the Empire, prove that the practical value of anthropology is as yet only imperfectly realised. If its progress is to be continuous we must convince the politician that it has an important part to play in the schemes in which he is interested. Thus it is certain that in the near future the relations between the foreigner and the native races will demand the increasing attention of statesmen at home and abroad. Here anthropology has a wide field of action in the examination of the causes which menace the very existence of the savage; of the condition of the mixed races, like the Mulatto or the Eurasian; of the relations of native law and custom to the higher jurisprudence; of the decay of primitive industries in the face of industrial competition. One of its chief tasks must be the examination of the physical and moral condition of the depressed classes of our home population, and the effect of modern systems of education on the mind and body of the child. It will thus be in a position to assist the servants of the State to meet the ever-increasing responsibilities imposed upon them; and it will help to dispel the ignorance and misconceptions which prevail even among the intelligent classes in this country in regard to the condition of the native races, who, by a strange decree of destiny, have been entrusted to their charge. By such practical contributions to the welfare of humanity it will not only secure the popular interest which is a condition of efficiency, but engage the ever-increasing attention of those to whom its scientific side is of paramount importance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. ARTHUR HALE has been appointed second demonstrator in the chemical department of the Finsbury Technical College.

AMONG the public introductory lectures to be given at University College (University of London) during October, we notice the following:—October 3, niton: one of the argon series of gases, Sir W. Ramsay; October 4, the origin of scenery, Prof. E. J. Garwood; October 6, the life and times of Sennacherib, Dr. T. G. Pinches; recent investigations into the mental growth of children, Dr. C. Spearman; October 10, climatic control, Prof. L. W. Lyde; instinct, Prof. Carveth Read; October 13, experimental phonetics, Mr. D. Jones.

WE see from the calendar of the day section of the Bradford Technical College for next session that, to meet the growing demands and necessities of the textile and other departments, a block of buildings is in course of erection in close proximity to the present college. The buildings for the textile department, when completed and equipped, will be worthy of the chief centre of the wool industry in this country. The new equipment will be of a complete character, enabling wool to be taken in the fleece and turned out, in conjunction with the dyeing and finishing department, in the dyed and finished state. In connection with this extension of the college, it has been decided to put down a plant for the department of engineering which, although primarily intended for educational purposes, will at the same time serve to supply light and power to the present building, the new extensions, and the school of art. From the point of view of both mechanical and electrical engineering students this will constitute a valuable advance. The whole of the plant has been so designed that any one set may be available for demonstration or experiment without interfering with the supply of current for lighting or power. More extended trials will be carried out during the summer months, when only a small portion of the plant is required for generating purposes. Students will thus have excellent opportunities of obtaining practical instruction in steam and electrical engineering, and of becoming acquainted with the running of a power station.

WITH what thoroughness the more recently established of the provincial universities are performing their new duties is well brought out by an examination of their calendars for the session 1910–11, which is now commencing. The calendar of the University of Leeds, for instance, runs to some six hundred pages, and gives particulars of courses of work for undergraduates wishing to take degrees in arts, science, technology, and medicine, and for other students desirous of studying for special purposes in the laboratories of the University. In the case of the University of Bristol, in addition to the necessary regulations for degrees, diplomas, and certificates, particulars are given of the university work done in associated institutions, of courses to meet particular local needs, and so on. Reference to courses of a special character brings to the mind again the work of the London polytechnics. The prospectus of the Borough Polytechnic Institute for the coming session shows that, in addition to the numerous trade classes held in previous years, special lectures and practice have been arranged in waistcoat-making and trade millinery for women, classes in masonry and lectures on the chemistry and manufacture of food-stuffs, and the analysis of laundry trade materials. At the City of London College the needs of commercial men especially are provided for, and the new syllabus is very strong in classes intended for young men engaged in offices and warehouses. The prospectus of the Belfast Technical Institute shows that, while specialising to some degree in classes intended to train men employed in textile and engineering industries, the authorities have in no way forgotten the needs of other workers. It would be difficult to find an industry in the city in which any considerable number of men and women are engaged that has not been considered in drawing up the scheme of work of the institute.

SOCIETIES AND ACADEMIES.

GLASGOW.

Institute of Metals, September 21.—Donald **Ewen** and Prof. T. **Turner**: The shrinkage of antimony-lead alloys and of the aluminium-zinc alloys during and after solidification. From the investigation of the shrinkage of the brasses it has been suggested that, for an alloy of given composition, a direct proportion exists between the amount of expansion on solidification and the distance of the solidus from the liquidus at this composition on the equilibrium diagram. The results of shrinkage tests on two further series of alloys are included in this paper; they show that the above theory is incapable of general application, and appear to indicate that it obtains only in the case of alloys containing solid solutions.—F. **Johnson**: The effect of silver, bismuth, and aluminium on the mechanical properties of "tough-pitch" copper containing arsenic. Contrary to the general belief, it was found that bismuth *increased* the tensile strength, as did silver also. It was found that silver had little effect upon the toughness of the arsenical copper, which, again by virtue of the presence of arsenic, was tougher than electrolytic copper made under similar conditions. The effect of silver on the hot-working properties was found to be negligible up to 0·3 per cent.; that of bismuth noticeable above 0·02, and serious above 0·05 per cent.; whilst that of aluminium was ruinous at 0·3 per cent. In view of the possibility of modern commercial copper containing other impurities which could modify the limiting proportion allowable of the above-mentioned impurities, it is difficult to fix a limit beyond which they should not occur. It may, however, be safely said that silver occurs in such traces that its presence may be ignored. Its influence will be beneficial rather than harmful. Bismuth should, preferably, be entirely absent, and may be expected to cause trouble in any process of mechanical treatment at a red-heat, if present above 0·01 per cent. As regards the presence of this impurity in the finished material, however, little concern may be felt, as the amount which will render arsenical copper unfit for working hot, will have no serious effects on the mechanical properties of the finished material in the cold.—A. D. **Ross**: Magnetic alloys formed from non-magnetic materials. The paper deals with investigations carried out chiefly on ternary alloys consisting of copper, manganese, and one of the elements aluminium, tin, bismuth, and antimony. All the groups show fair magnetic quality, but the most interesting are the ternary alloys containing respectively aluminium and tin. Some of the former are, under small magnetising forces, much more magnetic than cobalt, and have little coercive force. The tin alloys are less permeable, but exhibit greater hysteresis. Most of the alloys have their magnetic quality improved if they are annealed for a short time at a moderate temperature, 150°–200° C. Prolonged annealing has invariably an adverse effect, the hysteresis loss increasing rapidly with time. The behaviour of the alloys on cooling to the temperature of liquid air is peculiar and characteristic. For low and moderate fields the process results in general in a decided increase in susceptibility, whereas almost all other magnetic materials are rendered less susceptible.

September 22.—G. D. **Bengough** and O. F. **Hudson**: The heat-treatment of brass: Experiments on 70 : 30 alloy. The authors have studied the general effect of heat-treatment on the mechanical properties of 70 : 30 brass, and have paid special attention to the question of burning. Bars and wires made by different manufacturers were used in order to ascertain to what extent variations in character of the alloy and size of section influenced the results. The mechanical tests of the bars and wires after they had been annealed for half an hour show, in agreement with the results of previous workers, that the best annealing temperature is between 600° and 700° C. For this time of annealing a temperature within a few degrees of the melting point does not seriously injure 70 : 30 brass which is free from tin and lead, but, if maintained for a sufficiently long time, a temperature nearly 100° C. lower will burn the brass.—Dr. C. H. **Desch**: Some common defects occurring in alloys. After references to the defective state of our knowledge of the "diseases" of non-ferrous metals and alloys, as compared with that possessed by manufacturers and users of iron and steel, the importance of the equilibrium diagram as a guide in undertaking investigations of this kind is emphasised, and some of its limitations are mentioned. Some of the principal defects observed in non-ferrous alloys are then briefly reviewed, as a basis for discussion.—H. S. **Primrose**: Metallography as an aid to the brass founder. The results of a systematic investigation of the gun-metal castings in a large engineering foundry are discussed in the light of microscopical examination, in addition to the ordinary tensile testing. The reason why metallography is steadily superseding the old methods of judging by fracture is shown by comparison of photomicrographs of the internal structure. The crystalline formation being profoundly influenced by the rate of cooling as well as by the initial casting temperature, the microstructure of test bars, variously cooled and cast at different points, is contrasted to indicate how the best physical tests are got from a perfect interlocking structure. The different causes of blow-holes are described, and their detection by the microscope discussed with reference to micrographs of the various types. How these defects can be obviated or subsequently eliminated is illustrated by examples taken from actual cases.

PARIS.

Academy of Sciences, September 19.—M. Armand Gautier in the chair.—E. **Bertin**: The arrest of steamships either by reversing the engine or by allowing to slow down by friction of the water. With reciprocating engines reversal causes a rapid slowing down, but with steam turbines the reversing effect is much less. Formulæ are worked out for the reduction in velocity both with and without reversed turbines.—M. **Pougnet**: The action of the ultra-violet rays upon plants containing coumarin, and some plants the smell of which is due to the hydrolysis of glucosides. The ultra-violet rays produce the smell rapidly in coumarin plants, and also in plants the odour of which arises from the products of hydrolysis of a glucoside. The action is caused by the cells being killed by the ultra-violet light.—J. **Athanasin**: The functional mechanism of striated and non-striated muscular fibres.—J. **Deprat** and H. **Mansuy**: General stratigraphical results of the geological expedition to Yun-nan.—Ernest **van den**

Broeck and E. A. **Martel**: The conditions of effective filtration of the underground waters in certain chalk formations. In Belgium the crinoidal chalk at the base of the Carboniferous of the Dinant geological basin furnish filtered potable waters in a remarkably constant manner.

NEW SOUTH WALES.

Linnean Society, July 27.—Mr. C. Hedley, president, in the chair.—G. 1. **Playfair**: Polymorphism and life-history in the Desmidiaceæ. A number of new forms described.—L. A. **Cotton**: The ore-deposits of Borah Creek, New England, N.S.W. The Borah Creek Mine is situated in the New England district of New South Wales, within two miles of the Gwydir River. The ores contained in the mine are arsenopyrite, zinc blende, chalcopyrite, stannite, and galena. They are very uniformly distributed through the mine, both along the lode and in depth. The order of deposition of the minerals, which form symmetrical zones in the fissure, is arsenopyrite, pyrite, zinc blende, chalcopyrite, stannite, galena, and finally quartz. Comparison with other occurrences indicates the probability of a genetic relationship between the silver-lead deposits and the tin deposits. It is suggested that the Borah Creek deposits have been formed later than the tin deposits by deposition from highly aqueous and siliceous magmatic extractions containing relatively large amounts of metallic sulphides.—T. G. **Sloane**: Revisional notes on Carabidæ (Coleoptera), part iii. The tribes Oodini, Chlæniini, and Sphodrini, as represented in Australia, are reviewed, and the Australian genera of these tribes, as well as the species of every genus found in Australia, are tabulated. Synonymy is dealt with, and six species are described as new (Chlænius, 1 sp.; Anatrichis, 1 sp.; Coptocarpus, 2 spp.; Platynus, 2 spp.). Certain characters not hitherto deemed of importance in classification are discussed.

CAPE TOWN.

Royal Society of South Africa, August 17.—Mr. S. S. Hough, F.R.S., president, in the chair.—H. **Bohle**: The influence of uniformity and contrast on the amount of light required. The author dealt first with the adaptability of the human eye to various daylight illuminations, and gave a new definition of glare. When the eye looks at an illuminant of great intrinsic brilliancy in front of a dark background it tries to do two things at once: to open wide for the dark background and to close up for the intrinsic brilliancy. The author then considered the physiological effects of radiation, explained overheating of the eyes due to excess light absorption, and considered the effects of the ultra-violet rays of modern illuminants and of solar radiation. In addition he treated the effects of light radiation on germs of disease, the destructive action of rays when applied excessively, and finally dealt with the effect which uniformity and the avoidance of contrast in artificial lighting have on the amount of light required. He came to the conclusion that in a room with black walls an illumination of 35 to 40 candle-metres is required, whereas in a place with white ceilings and light walls the amount of light can be reduced to 30 candle-metres. For perfect uniformity in such places, as obtained with inverted lamps, 20 candle-metres give, in the opinion of the author, complete satisfaction. The effects of various lamp-shades on the uniformity of illumination were also shown.

CALCUTTA.

Asiatic Society of Bengal, September 7.—T. H. D. **La Touche**: The Lonar Lake.—B. L. **Chaudhuri**: *Triacanthus weberi*, sp. nov. It is one of the new fishes found widely distributed in the Bay of Bengal by the trawling operation of the *Golden Crown*. In the collection of the Indian Museum there are five species of this interesting genus besides this new one.—J. Coggin **Brown**: A description of a Lisu Jew's harp. The paper describes a Jew's harp which is the favourite musical instrument of the Lisu's, a tribe living in western China. It differs from those described from Assam, and approximates to those found in the Malay Peninsula. It consists of three delicate harps cut out of bamboo, and held upright between the thumb and first finger or between the first and second fingers of the left hand, while the tongues are made to vibrate with the right hand. The mouth acts as the sounding-board. The instrument is used by the young men in their serenades, and forms a part of the orchestra at all their festivals.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), parts ii. and iii. for 1910, contain the following memoirs communicated to the society:—

May 28.—R. **Courant**: The establishment of the Dirichlet-principle.—M. **Born**: Kinematics of a rigid body in relation to the principle of relativity.—P. **Koebe**: The uniformisation of algebraic curves by means of automorphous functions with imaginary substitution-groups (concluded).—R. **Gans**: The electron-theory of ferro-magnetism.—J. K. **Whittemore**: Convex curves.—H. **Bohr** and E. **Landau**: The behaviour of the functions $\zeta(s)$ and $\zeta(\lambda)(s)$ in the neighbourhood of the straight line $\sigma=1$.

June 11.—F. **Riesz**: Quadratic forms with an infinite number of variables.

The *Business Communications* of the society, part i. for 1910, contains reports on the Samoa Observatory (1909–10), on the progress of the complete edition of Gauss's works, and on subjects for prize dissertations. The obituary notices of F. Kohlrausch, by **Riecke**, and of T. W. Engelmann, by **Verworn**, are included.

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