THURSDAY, APRIL 21, 1904.

THAMES ESTUARINE FISHERIES.

Kent and Essex Sea Fisheries Committee. Report on the Sea Fisheries and Fishing Industries of the Thames Estuary. Prepared by Dr. James Murie. Ordered to be Printed at Meeting of the Kent and Essex Sea Fisheries Committee, December 7, 1903. Part i. Pp. 250. (London: Waterlow Bros. and Layton, Ltd., 1903.)

THIS report has been prepared primarily for the information of the Kent and Essex Sea Fisheries Committee by a subcommittee of that body appointed "to investigate the fisheries and recommend such steps as they may from time to time think best for their development."

The subcommittee's idea as to the scope of the report which they asked one of their members, Dr. Murie, to draw up was to select some typical fishing station and report on the conditions there, "instead of merely outlining what should be the basis of facts to be acquired at each special station." Leigh, in Essex, an important fishing centre on the north shore of the Thames Estuary, was the locality selected for the purpose, the selection being doubtless influenced by the fact that at Leigh resided Dr. Murie, who, besides being an active member of the committee, is an accomplished zoologist, and has long been in close touch with the fisheries of his neighbourhood. Dr. Murie was accordingly appointed to report on the fisheries of Leigh. He, however, found it necessary to extend the original plan of the work and to make it more general. The subcommittee was unanimously agreed as to deficiency of trustworthy information in regard to the conditions under which the various fisheries in the district are conducted. Further, as these conditions are dependent on certain biological data, it was necessary that some account of the natural history and inter-relations of the marine animals in the district should be presented. The present volume (part i. of the report) is devoted solely to the marine biology of the Thames Estuary. Information in regard to the fisheries themselves and a discussion of their economics are reserved for part ii.

Although deep-sea trawlers work from Ramsgate, Dover, &c., the main interest of the Kent and Essex district centres in the estuarine fisheries, that is to say, in the operations of shrimpers, whitebaiters, &c., and in the great shell-fish industries. In such an area the interests of one class of fishermen are sometimes at variance with those of another class. In considering the claims of one against the other, it is necessary to bring a knowledge of biology to bear on the subject; it is not enough to weigh the evidence of the fishermen themselves.

In this volume Dr. Murie gives a very readable and scientifically accurate account of the natural history of the marine animals inhabiting the Thames Estuary. This part is more than a mere fauna of the area, for the animals are considered especially in their relation to the fisheries. The geological origin of the estuary and the general physical and biological conditions obtaining therein are first described. Dr. Murie then proceeds to explain the influence of tides and winds and of North Sea currents in determining the drift of fish food and fish eggs, and hence the distribution of the fishes, concluding the section by remarking that "a paucity or abundance of fish is indissolubly linked with the less appreciable presence or otherwise of minor (often microscopic) life extant—not, therefore, as frequently emphasised, solely owing to objectionable instruments or methods of capture."

In the next section are described the rise in the fisheries of Leigh and the various changes which have taken place in methods of fishing from early times up to the present day in that locality. Then follows a large section on natural history proper, comprising all the known data which are of interest from a fisheries standpoint with respect to the various forms of animal life found in the estuary, a list which begins with porpoises and whales and ends with shrimps and prawns.

The author deals in no amateur fashion with these topics. He is thoroughly acquainted with the literature of fish and fisheries, both of early and of recent date. He has, for instance, made good use of such repositories of research as the scientific blue-books of the Scottish Fishery Board and the *Journals* of the Marine Biological Association. His own observations on the distribution, rate of growth, spawning and seasonal fluctuations of the food-fishes, molluscs, and Crustacea are of considerable value. On such matters as the location of the spawning places of the flat fishes, he seems inclined to lend too ready an ear to the opinions of fishermen, although it is not shown that the latter are capable of distinguishing with sufficient accuracy degrees of ripeness in a fish. A fish with a "full roed" ovary may be a long way in time and space from actual spawning. Even Dr. Murie himself does not seem to be very clear on this point. When he speaks of a fish the ovary of which was in the "pinky vascular stage" as being in "a moderately advanced stage," we are not satisfied with so vague a description; we require a more definite criterion of ripeness for scientific purposes.

Probably few experts will agree that the evidence which Dr. Murie adduces of spawning of flounders in brackish water is adequate. The presence in a given locality of full roed females, and later of flounder larvæ half an inch long, does not appear to prove, or even to suggest, that flounders spawn in that locality. In regard to the rate of growth of various food-fishes, the author furnishes some interesting data, but he has not dealt with these in a sufficiently detailed way to render them of much use as a contribution to the subject. He has not adopted, as other modern investigators have, Petersen's method of separating the fishes into annual groups or generations by the principle of the mid-size.

Altogether the book contains a mass of valuable and detailed information respecting the marine biology of this important estuary. Such information is an indispensable preliminary to an intelligent grasp of those practical problems to which the attention of the com-

mittee and of others interested will be directed in the second part of this report.

Dr. Murie confirms what has often been stated for other localities, viz. that the shrimpers destroy enormous quantities of the younger members of valuable species of flat fish. Whether the destruction alluded to is justified by the apparently unfailing perennial abundance of the brood fishes is doubtful. As has been pointed out by Dr. Petersen, there may be plenty of eggs and young fry of a given species, and yet the number of the larger and relatively much more valuable fishes may be seriously declining, as is maintained by many to be the case with plaice and soles. The question rather is whether the little flat fishes which escape the shrimpers in the Thames Estuary are numerous enough to replenish the stock of the larger fishes in the deeper waters off shore. In this connection local interests ought to be subordinated to those of the country in general, and therein seems to lie the danger of a too concentrated attention to purely local interests to which sea fisheries committees are naturally liable.

A STUDY OF GENIUS.

A Study of British Genius. By Havelock Ellis. Pp. xiv+300. (London: Hurst and Blackett, Ltd., 1904.) Price 7*s.* 6*d.* net.

MR. HAVELOCK ELLIS points out that owing to the completion of the "Dictionary of National Biography" it has at last become possible to obtain a comprehensive view of the men and women who have built up English civilisation, and in order to ascertain the composition of these elements of intellectual ability which the British Islands have contributed to the world, and as a help to the study of the nature of genius generally, he has freely made use of this monumental work. The author took as a basis of eminence those to whom at least three pages are devoted in the "Dictionary," but he also included some about whom less was said if they had shown intellectual ability of a high order, and conversely he eliminated those about whom much was written if they did not possess intellectual ability. The final selection yielded 975 British men of a high degree of intellectual eminence and 55 women. These 1030 persons are discussed from various points of view, and in appendices lists are given of their names, their activities, their places of origin, the occupation of their fathers, and other data.

Apparently the counties that have contributed most largely to the making of English men of genius are Norfolk, Suffolk, Hertfordshire, Warwickshire, Worcestershire, Herefordshire, Buckinghamshire, Cornwall, Dorsetshire, Oxfordshire and Shropshire; perhaps Somerset, Devonshire, Gloucestershire, Wiltshire and Essex should be added to this list. Mr. Havelock Ellis recognises three great foci of intellectual ability in England:—(1) the East Anglian focus; (2) the south-western focus; and (3) the focus of the Welsh Border. The first of these is the most recent and the most mixed ethnologically, as East Anglia is very open to invasion, and all kinds of foreigners have settled there. The second is the largest and the oldest, and the population has much darker hair; it may be called the Goidelic-Iberian district. The district is defended by Wansdyke and Bokerley Dyke. The third is termed the Anglo-Brythonic district. The Anglo-Danish part of England—Lincolnshire, Nottinghamshire, Derbyshire, Yorkshire, and thence into Scotland—has its own peculiar anthropological characters. Its children have usually been more remarkable for force of character than for force of intellect. East Anglia is productive of great statesmen, ecclesiastics and scholars, and of musical composers and painters. It has no aptitude for abstract thinking; its special characters seem to be humanity, patience, grasp of detail, and love of liberty. The people of the south-western focus are sailors rather than scholars, and courtiers rather than statesmen; they are innovators and pioneers in the physical and intellectual worlds, and, above all, are impressive, accomplished, and irresistible personalities. The genius of the Welsh Border is artistic in the widest sense, and notably poetic; there is a tendency to literary and oratorical eloquence, frequently tinged with religious or moral emotion, and there are no scientific men of the first order. The genius of Scotland has been mainly produced by the tract between the Cheviots and the Grampians.

In science Scotland stands very high, Ireland extremely low. It is in the exact sciences that the Anglo-Dane triumphs; but the science of the district is not exclusively mathematical, and geology especially owes much to the Anglo-Dane. The East Anglian is a natural historian in the widest sense, and shows little or no mathematical aptitude. It is not easy to see anything specific or definitely Brythonic in the scientific activities of the Welsh Border; at most it may be said there is some tendency for science here to take on a technological or artistic character. The scientific characters of the south-western focus are quite clear; what we find here is the mechanical impulse, and more especially the physiological temper; inventors are numerous.

This is only one of the various subjects dealt with in this interesting book; in the chapter on heredity and parentage we find it stated that inheritance of ability is equally frequent through father and mother; genius-producing families are apt to be large, and the men of ability tend to be the offspring of predominantly boy-producing parents, and perhaps women of ability tend to belong to girl-producing parents. There is a tendency for men of ability to be either the youngest or more especially the eldest of the family. The fathers of our eminent persons have been predominantly middle-aged or even elderly, while the mothers have been at the period of greatest vigour and maturity.

Eminent persons have frequently shown marked constitutional delicacy in infancy and early life, but many developed quite exceptional physical health and vigour. The chief feature in childhood, brought out by the present data, is precocity, and this character is discussed at some length. The relation of eminence to patho-

logical conditions is duly considered, and Mr. Havelock Ellis summarises his conclusions as follows :—

"We cannot, therefore, regard genius either as a purely healthy variation occurring within normal limits, nor yet as a radically pathological condition, not even as an alternation—a sort of allotropic form—of insanity. We may rather regard it as a highly sensitive and complexly developed adjustment of the nervous system along special lines, with concomitant tendency to defect along other lines. Its elaborate organisation along special lines is often built up on a basis even less highly organised than that of the average man. It is no paradox to say that the real affinity of genius is with congenital imbecility rather than with insanity."

The criticism will doubtless be made that in many cases the individuals dealt with by Mr. Ellis are too few in number to give trustworthy results; but this is a matter that was beyond his control, and no one can say that he has not made the most of available material.

TEXT-BOOKS OF PHYSICAL CHEMISTRY.

Introduction to the Study of Physical Chemistry. By Sir William Ramsay, K.C.B., F.R.S. Pp. 48. (London : Longmans, Green and Co., 1904.) Price 1*s.* net.

The Phase Rule and its Applications. By Alex. Findlay, M.A., Ph.D., D.Sc. Pp. lxiv + 313. (London : Longmans, Green and Co., 1904.) Price 5*s.*

IT will be readily admitted that there is on the part especially of our younger chemists, a growing appreciation of the methods and results of physicochemical investigation, and the issue of a series of text-books of physical chemistry under the able supervision of Sir William Ramsay will be a welcome stimulus to the prosecution of study and research on these lines. Dr. Findlay's book on the phase rule is the first of the series, and other volumes are promised, dealing respectively with stoichiometry, relation between chemical constitution and physical properties, electrochemistry, spectroscopy, thermodynamics, chemical dynamics and reactions. The advance being made in some of these departments is much more rapid than in others, and the plan of having a volume for each branch of the subject will make frequent revision possible where there is a call for it.

Taken altogether, these volumes will be an acceptable addition to our chemical literature, for up to now the English student of physical chemistry has been dependent chiefly on translated text-books for detailed treatment of certain advanced portions of the subject. One or two of the promised volumes, it is true, will cover well trodden ground, but they are requisite in the interests of the treatise as a whole, and the editor will doubtless see that harmony and uniformity are preserved in the several parts. He has written a general introduction to the series, giving a rapid survey of the main lines along which the development of physical chemistry has proceeded, and indicating the scope of the subjects to be dealt with in the special volumes.

The mere mention of the phase rule usually strikes dismay in the heart of the non-mathematical chemist, but it may be said at once that Dr. Findlay's treatment of the subject is almost entirely descriptive. The phase rule can be formulated in a simple enough manner, and its application can be appreciated even by those who may not feel at home with Willard Gibbs. Its merit is that it has rendered possible the classification of the various kinds of equilibria on a rational and scientific basis. The parallelism between many cases of physical and chemical equilibrium becomes intelligible; the phenomena of polymorphism, as exhibited, for example, by sulphur, tin, and benzophenone, can be treated systematically, and the conditions of stability of various polymorphic forms can be definitely formulated; the equilibrium between solid and liquid in binary systems can be fully interpreted, even when the two components form mixed crystals. In the exposition of these and many other points Dr. Findlay has done excellent work, and he has succeeded in producing an interesting and comprehensive estimate of the value of the phase rule in the classification and interpretation of equilibrium phenomena.

It is a very gratifying feature of the book that it contains full and up to date references to original work, and it is to be hoped that this feature will be prominent also in the subsequent volumes. After all, the best text-book can serve only to introduce the student to the actual workers in his science, and the more of such contact the better. Dr. Findlay has very properly been liberal in the reproduction of figures, for the exposition of the phase rule would be a difficult task indeed without those graphical methods of representation that have been so characteristic of its application. Tables of numerical data, taken from original papers, are abundant, and assist materially in the realisation of the actual experimental groundwork.

As a result of the physicochemical activity of the last twenty years, and of the corresponding introduction of mathematical methods of treatment, more demands than formerly are made on the reasoning powers of the chemical student. This is probably true also in connection with the phase rule, but no one who considers the material collected by Dr. Findlay will doubt that the application of these exact methods has secured a rich harvest of coordinated knowledge.

J. C. P.

OUR BOOK SHELF.

Notes on Electric Railway Economics and Preliminary Engineering. By W. C. Gotshall. Pp. iv+251. (New York : McGraw Publishing Co., 1903.)

Engineering Preliminaries for an Interurban Electric Railway. By E. Gonzenbach. Pp. 71. (New York : McGraw Publishing Co., 1903.)

THE economic side of engineering is one which the student is generally left to pick up as best he can on his way through life. Little attention is paid to it as a rule in the course of his technical training, and it is not until he starts on practical commercial work that he begins to realise that pounds, shillings and pence enter as much into the engineer's formulæ as the fundamental units of length, mass and time. These two books should be very useful, therefore, not only to the budding electric railway engineer, but also to all students of engineering, as serving to show the many

things needed besides technical knowledge to make a good engineer.

Mr. Gotshall's work is distinctly the more ambitious of the two, in that it seeks rather to point out the general principles applicable to all cases of electric railway projection, whereas Mr. Gonzenbach confines himself to the consideration in outline of a particular case. The student will derive from Mr. Gotshall's book a good idea of the importance of every detail in the original scheme, and will see how greatly the operating costs and the dividends may be affected by careful design throughout. He will also be able to glean some useful hints on the methods of dealing with promoters, landowners, and so forth, with whom, if he is ever called upon to draw up a scheme for an electric railway, he is likely to have much to do. Many of the details and particulars in both books are naturally not applicable to this country, but this does not materially detract from their value. M. S.

The Pests and Blights of the Tea Plant. Second edition. By Sir G. Watt and H. H. Mann. Pp. xv+429. (Calcutta, 1903.)

THIS work first appeared in 1898 as a report of particular investigations on tours, but is now a large volume of more than 400 pages, with numerous illustrations. The amount of information collected is enormous, and one may understand that no tea-planter can dispense with the work, the more so since such subjects as hybridisation and the different races of tea seed, weeding, tilling and cultural operations generally, drainage and manuring of tea, pruning and plucking, &c., are fully dealt with, in addition to the enumeration and description of the multitude of insect and fungus enemies which the long suffering shrub harbours.

By means of conspicuous marginal notes the authors have undone most of the disadvantages inevitable from their general method of lumping together scraps of information derived from all kinds of sources, the relative value of which, moreover, is generally capable of being sifted because the references are given; in spite of this, however, and indispensable as the encyclopædic information is, we think much might be done in improving the style if the materials were better woven into a more narrative and continuous form. Why is it that the introductory sections on general physiology of plants—the fundamental study without which the sequel is useless—are so often badly done in such works as this? Does it mean that the great schools of science have even yet not impressed their learning on the officials entrusted with such important treatises, or is it that an older generation of workers not familiar with modern researches dominates the situation?

Highways and Byways in Sussex. By E. V. Lucas. With illustrations by Frederick L. Griggs. Pp. xx+416. (London: Macmillan and Co., Ltd., 1904.) Price 6*s*.

MR. LUCAS himself aptly describes his book. He tells the reader:—"My aim has been to gather a Sussex bouquet rather than to present the facts which the more practical traveller requires," and he has succeeded in writing a delightful, chatty account of a county in which Londoners have an especial interest. The history, architecture and folk-lore, the animal and plant life of the county, and the customs and characteristics of the people are all noticed by Mr. Lucas and skilfully woven into a pleasing narrative. The illustrations, of which there are nearly eighty, are excellent, and add greatly to the charm of the book.

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.*]

Learned Societies.

THERE are two other defects of the present system of reporting on papers to which I desire to direct attention. In the first place there are certain mathematicians who resemble the Athenians in the time of St. Paul, who "spent their time in nothing else, but either to tell, or to hear some new thing." They are consequently averse to reporting in favour of a paper unless it contains new results. Against this excessive craving after novelty I emphatically protest. Many interesting results frequently drop out incidentally in the course of a long and complicated investigation, whilst others have been originally obtained by some cumbrous, troublesome and antiquated process,[1] and in my judgment a paper which supplies concise, simplified and improved demonstrations of results of this character is quite as valuable as one which is devoted to the investigation of new results.

In the next place, as a general rule, none of the councillors present have read the paper unless any of them happen to be referees. Moreover, a good many of the councillors present, even if they had tried to understand the paper, would be quite incapable of expressing an opinion as to its merits, and I well recollect that I myself have sometimes experienced considerable embarrassment when invited to vote officially as a councillor against the publication of a paper which lay outside my own line of reading, and I have sometimes got over the difficulty by abstaining from voting.[2]

I regard Prof. Bryan's suggestions as altogether impracticable. In the first place no person possessing ordinary common sense would run the risk of adverse criticism by consenting to report on a paper relating to a subject with which he was only slightly acquainted. In the next place no author, except a very junior one, would consent to subject his papers to the extensive revision, which Prof. Bryan appears to contemplate, at the suggestion of an *unknown* and possibly a very junior referee. He would probably regard such suggestions as a piece of impertinence (and I recollect one such case in connection with a foreign mathematician), and he would make short work of them by insisting on the society printing his paper as it stands or returning the manuscript for publication elsewhere.

I believe that every Royal Academician possesses the privilege of hanging a certain number of his pictures every year, and I see no reason why a similar privilege should not be extended to members of learned societies with regard to the publication of their papers. A. B. BASSET.

Fledborough Hall, April 16.

Department of International Research in Terrestrial Magnetism of the Carnegie Institution.

THE trustees of the Carnegie Institution at their annual meeting last December authorised the establishment of what is to be known as the "Department of International Research in Terrestrial Magnetism." An allotment of twenty thousand dollars was made with the expectation that if the proposed work should be successfully organised, a similar sum would be granted annually for the period requisite to carry out the plan submitted by the writer, as endorsed by leading investigators, and published in "Year-book" No. 2 of the Carnegie Institution.

The undersigned has been appointed director of the department, and has been given full authority to organise it, beginning with April 1. Arrangements have also been made so that the magnetic survey and magnetic observatories of the United States, conducted under the Coast and Geodetic Survey, will remain in his charge as heretofore.

[1] The method by which Euler's equations for the rotation of a rigid body used to be proved is an example.

[2] A very glaring example of the imperfections of the present system will be found in the *Phil. Trans.*, A. 1892, in connection with Mr. J. J. Waterston's paper.

The general aim of the work is "to investigate such problems of world-wide interest as relate to the magnetic and electric condition of the earth and its atmosphere, not specifically the subject of inquiry of any one country, but of international concern and benefit." The prime purpose, therefore, of this department is not to *supplant* any existing organisation, but rather to *supplement*, in the most effective manner possible, the work now being done, and to enter only upon such investigations as lie beyond the powers and scope of the countries and persons actively interested in terrestrial magnetism and atmospheric electricity.

At first principal stress will be laid upon the complete reduction, discussion and correlation of the existing observational data, and upon early publication of the results in suitable form, in order to exhibit the present state of our knowledge. In this way will be revealed the gaps to be filled, and the direction of future and supplementary investigations will be suggested. While, however, this will constitute at first the chief work of the department, it is likewise proposed to embrace favourable opportunities for supplementing, by observation, the existing data and to co-operate with others in the observing of such of the earth's magnetic and electric phenomena as are of momentary occurrence, and the investigation of which is of great importance.

Details as to the method of work to be followed by the department and the investigations undertaken will be made known later. It is proposed that, whenever feasible, those having certain pieces of work already in hand shall be invited to associate themselves with the department.

A word of explanation as to the "international" character of the undertaking. As all the funds are supplied by the Carnegie Institution, it will not be possible to organise this department in accordance with the customs governing organisations the funds of which are contributed by various nations in concert, such as, for example, the International Geodetic Association, the "International Catalogue of Scientific Literature," &c. While, however, the basis of organisation cannot be "international" in the sense usually defined by such bodies, it is the intention to conduct the work with the counsel of an advisory board composed of representative persons, irrespective of country. The work itself, as already stated, is not confined to any one country, and in this sense the department is to be truly "international."

That an important step has been taken by the Carnegie Institution will be patent to all who are interested in the development of our knowledge of the earth's magnetism and electricity. Prof. Neumayer, one of the representative investigators who endorsed the undertaking and promised support, expressed himself thus when this project was submitted to the Carnegie Institution:—

"I am of opinion that if this plan reaches its fulfilment it is the most important step ever taken for the development of our knowledge of the earth's magnetism. The thought which underlies it must appeal to everyone who has ever been engaged in geomagnetic investigations. In no other branch of geophysics is it more essential to extend the inquiries over the entire earth. Magnetic research, to be successful, requires the cooperation of the most competent investigators of all countries."

All communications intended for the department should be addressed as below. L. A. BAUER.

Department of Terrestrial Magnetism, Carnegie Institution, Washington, D.C.

The Formation of Coral Reefs.

IN NATURE for February 18 there is a paper by Mr. J. S. Gardiner giving a concise account of his theory of coral reefs. A more extended paper by him on the same subject appeared in the *Geographical Journal* for 1902, and was followed last year by one by Mr. Günther on erosion on the west coast of Italy; the latter author proves, on a coast with a very strong sand scour and with loose calcareous rocks on the fore-shore, that below "wind and water" mark no erosion to any appreciable extent goes on. Mr. Günther's observations coincide with those of every day experience, and should no one have already protested against Mr. Gardiner's views, will you let me record my most vigorous dissent? The principles of geology are so little understood, and it requires such a level head in sorting out the true from the false from among the apparently conflicting evidences that one has to deal with, that I think when such a glaring misconception of the processes of nature as that of Mr. Gardiner's is repeated in scientific journals some stand should be made before more mischief is done. It is a disadvantage on my part not to have worked on coral reefs myself, but I have been working for ten years on a coast which is fringed with coral reefs only a short way from where I have seen it, and I have therefore been able to study the base of the reefs without the disguising covering of coral limestone. I have seen beaches crowded with the shells of animals still living in the adjoining sea, raised two and three hundred feet above sea-level, and a short distance away I have seen consolidated sand-dunes going far below sea-level; while from the submerged plateau the edge of which is called the Agulhas Bank, Dr. Gilchrist has dredged large water-worn boulders far out to sea. South Africa generally is a rising area, but in a sinking area the exact converse is true, namely, that with a general sinking local elevations must occur. This last is not a new statement of fact, but a well established experience, and one that has been treated of again and again, for instance, by Suess, in his "Antlitz der Erde," vol. ii. chapter i., and is one which I believe can be proved on any coast—it is well brought out in Mr. Günther's paper, and in many descriptions of coral islands; with such a statement before one, I am at a loss to understand where the room comes in for Mr. Gardiner's theory, or where are the difficulties which led to the manufacture of the hypotheses of Messrs. Murray and Agassiz. The one fundamental idea that dominates the whole conception of the earth's structure is that the crust is never at rest, but is incessantly rising and falling; and a corollary is that each great rise or fall is never continuous, but is the result of the surplus of a series of + and − movements. If we are to adopt Mr. Gardiner's view that submarine erosion can cut down solid rock to 200 fathoms below the surface of the water, geology must be deposed from its pedestal as a science, and relegated to the class which includes gnostic theology and such like. ERNEST H. L. SCHWARZ.

South African Museum, Cape Town, March 9.

MR. SCHWARZ, as far as I understand him, questions the effects, if any, of submarine erosion and the necessity for any view except that of subsidence to explain the formation of coral reefs. I fail to see the parallel between the west coast of Italy and the Maldives, but it is obvious that wherever submarine currents exist there must be erosion, its extent depending on their force, &c. I would refer Mr. Schwarz to the detailed work on currents and the effects of organisms in my full paper on the Maldive and Laccadive Archipelagoes in the "Fauna and Geography of the Maldives and Laccadives." He will find there certain references, but in the same connection he should read Prof. Agassiz's numerous papers issued from the Museum of Comparative Zoology at Harvard, and Prof. Max Weber's and Captain Tydeman's reports on the Siboga Expedition.

In common with most recent workers on the subject I have treated of my difficulties in respect to the acceptance of the subsidence theory in the paper already cited and in my report on Fiji, and Mr. Schwarz will pardon me if I do not feel disposed to re-state them. The gentlemen he refers to have probably stated theirs. We are doubtless well aware of the general facts mentioned by Mr. Schwarz, and I feel sure that we shall be only too happy if he will explain our difficulties and assist us in arriving at *the truth* on this important question.

I may take this opportunity of pointing out that, according to the report of the Coral Reef Committee, Funafuti has probably been largely formed by subsidence, and hence may be an example of the fourth mode of formation mentioned in my article. J. STANLEY GARDINER.

Zoological Laboratory, Cambridge, March 31.

Demonstration of Magnetostriction.

IN a recent number of NATURE (March 24) Prof. H. Nagaoka describes a method for demonstrating the change of length of an iron wire by magnetisation. I have for

several years used the following arrangement for this purpose.

A small weight is suspended by an iron wire constituting a torsion pendulum. Direct current is sent through this suspending wire and through a magnetising coil which surrounds it. This direct current is reversed in the magnetising coil (or in the suspending wire) in rhythm with the free oscillations of the pendulum. This causes the outside portions of the suspending wire to be magnetised successively along right and left helical lines, and the accompanying changes of length along the lines of magnetisation cause the wire to twist slightly to right and to left with the reversals of current. After several reversals of current the oscillations of the torsion pendulum become easily perceptible. W. S. FRANKLIN.

Physical Laboratory, Lehigh University, South Bethlehem, Pa., April 6.

Wawo and Palolo Worms.

IN your interesting note on the palolo worm of Samoa (NATURE, March 31, p. 523) an error has crept in about the *wawo* of Rumphius, which is said to be doubtless the same as the Pacific palolo. Thanks to the kindness of Prof. Max Weber, the head of the Dutch Siboga Expedition, that explored the seas of the Malay Archipelago during the years 1899–1900, I had the opportunity of examining a cluster of these worms from Banda, where they are called *oelie* by the natives; especially in the months of March and April, the second and third nights after full moon they are swarming there in great numbers at the surface of the sea.

In the "Rumphius-gedenkboek," consecrated to the memory of the eminent naturalist of Amboyna, who died two hundred years before, which was edited by the Koloniaal Museum at Haarlem in 1902, I published a short description and some figures of this interesting worm. Though, like the Pacific palolo, a member of the family of Eunicidæ, the *wawo* or *oelie* belongs to the genus Lysidice, and is a rather small worm, measuring about 65 millimetres in length. Nearly all the specimens were in a state of sexual maturity, their bodies crammed with sperm or ova, but without showing any epitokal characters; the number of males and females appears to be nearly equal. In our preserved specimens nearly all the colour has vanished, but during lifetime males and females undoubtedly are differently coloured, probably green and red, as stated by Mr. van Hasselt, the assistant-resident, who collected the worms. R. HORST.

Museum of Natural History, Leyden.

[THE writer of the notice merely followed the original author, Mr. Woodworth, in identifying the "wawo" with the palolo. On referring again to Mr. Woodworth's article, he finds the mode of expression somewhat ambiguous, so that it might possibly bear another interpretation.—EDITOR.]

The Base of Napier's Logarithms.

IN your issue of March 3 (p. 409) I read:—"The base of Bürgi's logarithms is nearly e, and that of Napier's nearly e^{-1}." In the "Encyklopädie der Elementaren Algebra und Analysis," by Heinrich Weber, Leipzig, 1903, p. 108, I read:—"Die Basis der Neperschen Logarithmen stimmt also sehr nahe mit der Zahl e überein."

Can your reviewer kindly explain on which side lies the truth? ADOLFO BOSSETTI.

Turin, Italy.

WHAT Napier actually gives in his table is a series of natural sines with a corresponding series of logarithms which diminish as the sines increase. If a Napierian logarithm is considered to be the logarithm of the sine opposite to which it stands, the base is approximately e^{-1}; but we may, if we like, regard the logarithms as logarithms of cosecants, and the base is then approximately e. Or again (as in "Encycl. Brit.," xvii., 179) we may take Napier's sines as actual integers, and use log Nap n for the logarithm placed opposite n in the table; then we have approximately

$$\log \text{Nap } n = 10^7 \log_e (10^7/n).$$

Thus opposite 5000000, which is entered as the sine of 30° to radius 10^7, we have a logarithm which, read as an integer, is approximately $10^7 \log_e 2$. Inspection of Napier's table gives more information than any brief description can do; as will be seen from what has been said, the definition of a Napierian logarithm and of its base depends to some extent upon how we translate his phraseology into modern notation. G. B. M.

BORINGS INTO A CORAL REEF.[1]

THE work before us consists of a series of reports by different authors in connection with the three expeditions that were sent to Funafuti in 1896, 1897 and 1898. Their object was to obtain by boring a vertical core of at least 100 fathoms from the rock of a typical atoll, to settle, if possible, the vexed question of its formation. Naturally the different parts of the work are of unequal value. Indeed, all must be regarded as of quite subsidiary importance to that on the core, and are of interest mainly in so far as they throw light on its composition.

Little modern scientific work shows a better record of determination and thoroughness than this. The first expedition under Prof. Sollas was a failure, but the experience gained in its two borings of 105 and 72 feet made possible the subsequent success of the later expeditions, and the reports of its members threw a flood of light on the atoll itself, its fauna and flora. The most valuable direct result was the production of a chart giving a more thorough and detailed survey of an atoll than had ever before been attempted. The great care exercised by Captain Field and the officers of H.M.S. *Penguin* in this work has made feasible, by a re-survey of the atoll in a few decades, a comparison to show the changes that are at present in progress. To it we owe the possibility of the detailed geological survey of the atoll by Prof. David and Mr. Sweet (Section v.), which will be of material assistance for the same purpose. The magnetic survey, too, worked out by Captain Creak (Section iii.), by pointing out in the areas of greatest disturbance the probable positions where magnetic rocks might nearest approach the surface, suggested the idea of driving a boring down through the bottom of the lagoon, subsequently brilliantly carried out by Mr. Halligan with the aid of the captain and officers of H.M.S. *Porpoise* (Section vii.), Fig. 1.

The second expedition carried the bore to 698 feet, but was unsatisfactory in view of the small amount of core obtained. It, however, completed the geological survey of the islets. Finally, the third expedition drove the same boring beyond 1100 feet, the greater part of its core being almost continuous, and put down a second in the lagoon to a depth of 245 feet from the surface. Collections were also made from the outer slopes to 200 fathoms, and the biology of the atoll was studied by Mr. Finckh (Section vi.).

The latter section is, perhaps, the least satisfactory part of the whole report, mainly because the examination of the core suggests so many questions to which no answer is given. Its most interesting observations are those on the rates of growth of various organisms, a mass of Halimeda three inches in height and thickness in six weeks being quite remarkable. Attention is directed to the barrenness of the eastern or windward reef as compared with the western or leeward reef. No explanation beyond that of an "epidemic" is afforded, though whether any is necessary beyond the known effects of sediment on coralline life and the undercurrents on exposed reefs, both far more important to windward, is doubtful. The section gives

[1] "The Atoll of Funafuti." Being the Report of the Coral Reef Committee of the Royal Society. Pp. xiv+428; illustrated, and with 19 geological maps. (Published by the Royal Society.)

the idea that the Funafuti reefs are now very different from what they were when the core was being formed. Practically Lithothamnion, Halimeda, Heliopora, Millepora, Porites, Madrepora and Pocillopora are stated to be the only sedentary organisms of importance at the present day, the section being little more than an essay on them. We look in vain for precise accounts of upgrowing shoals more than two or three fathoms deep, of the silting up of the lagoon, and of the outward extension of its encircling reefs. Does the boring alga Cliona occur in the living reef corals, and do boring worms affect them?

The detailed account of the collections from the outer slope is not included in the present report, a matter of regret when one considers their importance in connection with the depth of formation of the core and with certain theories of coral reef construction. As it is, the general report on them forms one of the most interesting sections of the volume, and it is greatly to be hoped that the specimens will subsequently be deposited with the core. The face of the cliff, 40 to 140 fathoms, is apparently composed mainly of the remains of the same organisms as form the shelf above, while the area at its base, from 140 to 200 fathoms, is covered by a talus of the same. A few true corals and some Halimeda (one piece 86 fathoms) were obtained below 40 fathoms, but this depth is considered to be about their true limit. Lithothamnion and Polytrema grew in abundance from the surface to 200 fathoms, while Cycloclypeus, a foraminiferan sparingly present in the core between 570 and 1070 feet, was found from 30 to 200 fathoms. In addition some deep-sea corals and other organisms were secured, but the dredgings were evidently too few—the naturalists had only an open row boat—for deductions to be drawn as to the occurrence of individual species and genera.

The main part of the work, that on the boring, appropriately commences with a general introduction by Prof. Judd, in whose hands its supervision was placed. From the main hole, 1114½ feet, about 384 feet of core was obtained. It was carefully labelled, and boxes of sand collected at intervals to fill up its gaps. From the middle of each piece of rock a slice was taken longitudinally, the total length of these being the total length of the core. These slices were then examined, and from all portions which presented difficulty microscopic sections were ground. The corals of much of the core being in the form of casts, a set of wax impressions of recent forms was made for comparison. Prof. Judd personally contributes a most valuable article on the chemical composition of the core (Section xiii.), while to Dr. Hinde we owe its detailed examination and the elucidation of the nature of its organisms, with the exception of the Foraminifera, assigned to Mr. Chapman (Section xi.). Lastly, Dr. Cullis gives a full report on its mineralogical changes (Section xiv.).

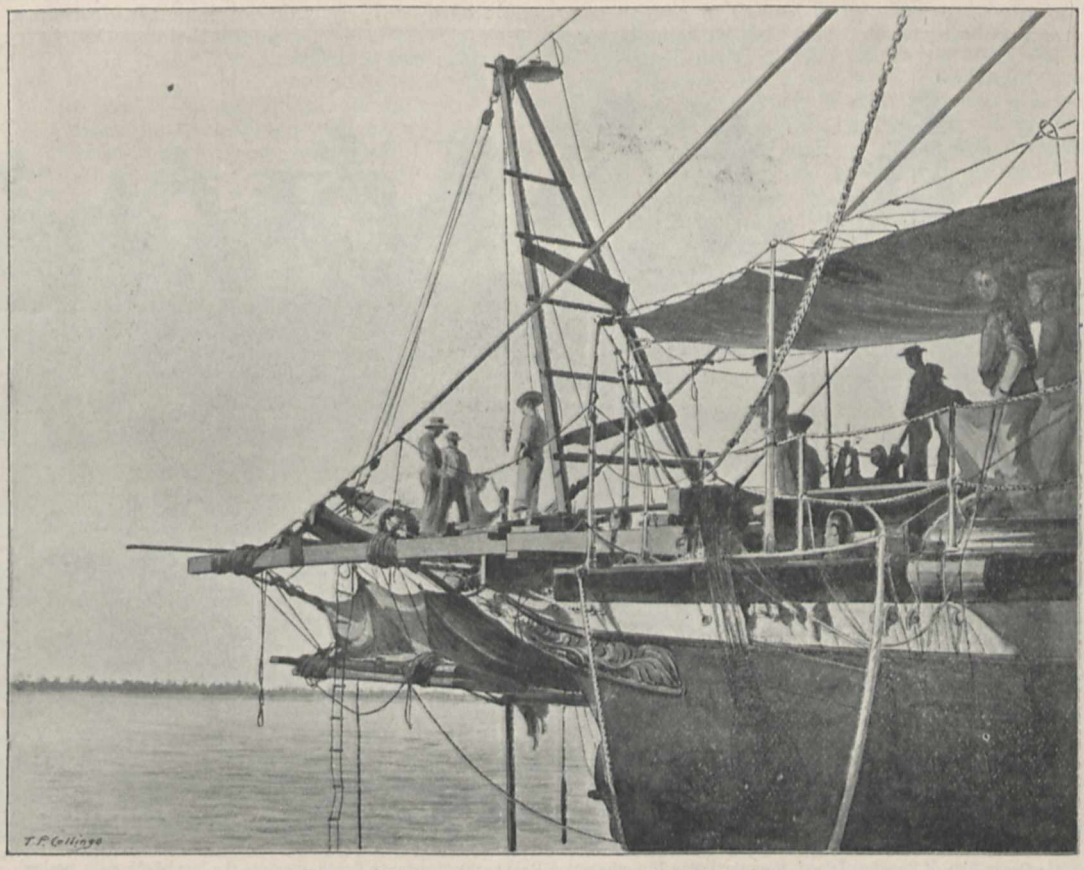


FIG. 1.—The Lagoon Boring Apparatus on H.M.S. *Porpoise*.

From the surface to a depth of 748 feet only 72¾ feet of core were brought up. The first 150 feet gave 26 feet, consisting mainly of corals and the regular reef organisms very little changed in any way. Deeper the aragonite of the corals was found to have been gradually dissolved, other organisms of more resistant structure persisting, until at about 400 feet such core as there is consists of cavernous limestone, formed

largely of Foraminifera with casts of corals, the whole cemented together by crystalline calcite. Foraminifera predominate still more between 637 and 748 feet, where the rock becomes soft and chalky looking, crystalline dolomite largely replacing calcite as the cementing material. From this depth to the bottom, 366½ feet, the core was 311½ feet long, the rock being a hard dolomitic limestone, with frequent cavities where organisms had been dissolved out. Corals are only represented by casts, and these are generally very badly preserved, though in some places protected by incrustations of Polytrema or Lithothamnion. Here and there occurs a disposition to form alternate bands of corals and Foraminifera mixed with detritus, the thickness of the latter considerably exceeding that of the former.

The whole core was divided into 1065 lengths, each of which has been separately examined and described by Dr. Hinde. The core from the borings of the first expedition was similarly treated, as was also that from the lagoon boring, though the latter was largely fragmentary in its nature. It was situated about one and a half miles from the middle of the eastern rim of the lagoon, and commenced at a depth of 101 feet. Two borings were made, the deeper reaching a depth of 144 feet below the floor of the lagoon. To a depth of 70 feet an uncemented material was obtained consisting mainly of Halimeda fronds and a few Foraminifera. Below, this was gradually replaced by a porous, rubbly limestone formed of the same genera of corals as now live in the lagoon, together with Foraminifera, the whole cemented by calcite into a hard rock.

In our opinion it is unfortunate that Prof. Judd and Dr. Hinde have not clearly expressed their opinions on the formation of the atoll, really the sole question which the various expeditions were sent out to solve. Their matured judgment, after examining the whole core, could not but have been of great value. It is quite clear, however, that they consider the whole core, running through nearly 200 fathoms, to consist of the same materials and to have been formed in the same way. Lithothamnion, Polytrema, and certain Foraminifera extend through the whole of it, but also live down to 200 fathoms. Unfortunately our knowledge of the bathymetrical limits of corals is less certain, but, so far as it at present goes, they cannot have grown at a greater depth than 50 fathoms. The characteristic sedentary organisms of 50 to 200 fathoms are stated to be absent from the core, and, if this be the case, it seems almost certain that Funafuti in its upper 200 fathoms owes its formation to some change or changes of level in the sea floor.

Had there been such a subsidence practically *all* the corals of the core should be in their positions of growth. Corals are frequently stated in the report to be so, but the question as to whether they are or are not is such an important one that the full evidence should have been given. Coral colonies differ largely in different parts of their surfaces, but that any conclusions could be drawn from casts as to their positions of growth seems doubtful. Again, the relatively small size of the corals found in the core—five or six or more corals per foot—does not agree with the usual descriptions that have been given of coral growth *in situ*, and seems better explained by the consolidation of a heap of dead corals. If the rock were formed by a growing reef in shallow water it should be observed that no reef similar in its constitution was found by Mr. Finckh. However, the authors evidently consider that they have proved a vertical thickness of nearly

FIG. 2.—Ocean Side of Funafuti Island, from the living Lithothamnion Reef to the Hurricane Beach, opposite the Site of the main Boring.

200 fathoms of rock not showing organisms other than live in the upper 50 fathoms, and in that case the conclusion can hardly be avoided that subsidence has taken place.

The analysis of the core rock shows that down to about 640 feet it is a limestone, between 10 and 35 feet containing more than 10 per cent. of magnesium carbonate with two maxima of about 16 per cent., but below this averaging about 4 per cent. Still deeper it becomes dolomitic, containing upwards of 40 per cent of magnesium carbonate, but in one area, 820 to 870 feet, averaging less than 15 per cent., with further falls at 1061 and 1080 feet. The presence of 4 to 5 per cent. of magnesium carbonate is explained by the leaching out (solution) of the more soluble calcium carbonate, while the magnesium carbonate is left to enrich the rock. This factor will not serve to explain either the large amount near the surface or the enormous increases at certain depths, but the reader should carefully consider for himself Prof. Judd's discussion of the chemical changes.

Considered in its entirety, the work has been well and carefully done. It adds immensely to our knowledge of the possible means of the formation of coral reefs, and shows that subsidence may have at any rate played a dominant part in the formation of Funafuti. The illustrations are well chosen and all that could be desired. The geology is illustrated by an admirable series of maps. Indeed, the work reflects immense credit on all who have been connected with it, and cannot but be of great permanent value.

THE FORTHCOMING CAMBRIDGE MEETING OF THE BRITISH ASSOCIATION.

THE fourth meeting of the British Association at Cambridge will be held this year from August 17 to August 24. In 1833, the third year of its existence, the association met at Cambridge under the presidency of Prof. Adam Sedgwick; Sir J. F. W. Herschel presided over the second meeting in 1845, and the third Cambridge meeting was held in 1862 under the presidency of Prof. Willis.

The arrangements are already sufficiently advanced to admit of a preliminary forecast of the programme of the meeting next August. The invitation to the association to visit Cambridge in 1904 was presented by the university and the town, and by the county councils of Cambridgeshire and the Isle of Ely, and these bodies are all represented on the various committees entrusted with the local arrangements. The Mayor and Corporation have kindly consented to the use of the Guildhall for the purposes of a reception room; the Corn Exchange will be utilised for the president's address on August 17, and the lectures will be given in the new theatre.

The sectional meetings will in most cases be held in the buildings of the several science departments. The sections are the following:—A, mathematical and physical science, president, Prof. Horace Lamb, F.R.S.; B, chemistry, president, Prof. Sydney Young, F.R.S.; C, geology, president, Mr. Aubrey Strahan, F.R.S.; D, Zoology, president, Mr. William Bateson, F.R.S.; E, geography, president, Mr. Douglas W. Freshfield; F, economic science and statistics, president, Prof. William Smart; G, engineering, president, Hon. Charles A. Parsons, F.R.S.; H, anthropology, president, Mr. Henry Balfour; I, physiology, president, Prof. C. S. Sherrington, F.R.S.; K, botany, president, Mr. Francis Darwin, F.R.S.; L, educational science, president, the Right Rev. the Lord Bishop of Hereford.

A "Handbook to the Natural History of Cambridgeshire," specially written for the meeting under the editorship of Dr. J. E. Marr and Mr. A. E. Shipley, will be published by the University Press; the syndics of the Press have decided to present a copy to each ticket-holder, provided that the number to be supplied for the purpose does not exceed 2000 copies. A special edition of Mr. J. W. Clark's "Guide to the Town and University" will be presented to each member of the association, also a series of excursion guides, together with a coloured map of East Anglia supplied by the Director-General of the Ordnance Surveys.

Emmanuel College has agreed to entertain the secretaries of sections. The majority of the colleges have expressed their willingness to entertain free of charge a limited number of distinguished guests, and some of the colleges have agreed to place rooms at the disposal of members of the association, making a charge for meals and attendance. Girton and Newnham Colleges, and the Ladies' Training College, have also agreed to extend hospitality and lodging accommodation to British and foreign visitors.

A considerable number of favourable replies have been received in answer to invitations issued to American and foreign men of science; it is expected that at least 100 visitors from abroad will be present.

The master and fellows of Trinity College have kindly granted the use of the college for a conversazione and reception to be held on Thursday, August 18. The Lord-Lieutenant of Cambridgeshire and the Mayor of Cambridge will entertain the members and associates at a garden-party in the Botanic Garden on Monday, August 22. The High Sheriff of Cambridgeshire has also expressed his intention of giving a garden-party during the meeting.

It is hoped that a *table d'hôte* lunch will be served on week-days in certain college halls. Light refreshments will be served each day (including Sunday) in the Masonic Hall, adjoining the museums and close to the reception room, from 12 to 8 p.m. It has also been arranged to have an open-air café and beer-garden on ground adjoining the museums, which will be open on week-days from 11 to 6.

The committee has provisionally arranged eleven excursions for Saturday, August 20. These include Audley End and Saffron Walden, Brandon and Didlington Hall (flint-knapping industry and Lord Amherst's collection of Egyptian antiquities), Cromer (geological), the Dykes of Cambridgeshire; Ely, Hatfield and St. Albans, Lincoln, Lynn, Castle Rising and Sandringham, Norwich, Wicken Fen, Wisbech and Woad Works.

On Thursday afternoon, August 18, the registrary of the university, Mr. J. Willis Clark, will deliver a lecture on "The Origin and Growth of the University." The evening lecture on Friday, August 19, will be on "Ripple-marks and Sand-dunes," by Prof. George Darwin, and on Monday, August 22, the second evening lecture will be delivered by Prof. Osborne, of New York, who will give an account of "Recent Explorations and Researches on Extinct Mammalia." On Saturday, August 20, Dr. J. E. Marr will lecture to the operative classes on "The Forms of Mountains."

On Friday, August 19, a garden-party will be given by the principal of Girton College, and on Tuesday afternoon, August 23, members of the association will be entertained at Newnham College.

A classified list of lodgings and hotel accommodation is now being prepared for the use of intending visitors. Information in regard to lodgings may be obtained from Mr. A. Hutchinson, Pembroke College. General inquiries should be addressed either to the local secretaries, British Association, or to Mr. A. C. Seward, Emmanuel College, Cambridge.

NOTES.

We notice with deep regret that Sir Clement Le Neve Foster, F.R.S., professor of mining in the Royal College of Science, died in London on Tuesday, at sixty-three years of age.

The Faraday lecture of the Chemical Society was delivered at the Royal Institution on Tuesday by Prof. W. Ostwald, his subject being "Elements and Compounds." At the end of the lecture, Prof. Tilden, who occupied the chair as president of the society, presented Prof. Ostwald with a medal bearing the image of Faraday, which had been specially struck in commemoration of the occasion. A vote of thanks for the lecture was proposed by Prof. Dewar, seconded by Prof. Thorpe, and supported by Lord Rayleigh.

Mr. Francis Galton is about to address a circular letter and a schedule of questions to each fellow of the Royal Society on "Ability in Families." He asks for a return of those relatives in specified near degrees who have achieved any kind of "noteworthy" success. This is defined to be a success in any pursuit whatever that ranks among those who follow that pursuit at least as high as success in gaining the title of F.R.S. ranks among men of science. Nothing is desired that is otherwise than honourable to members of the family, and nothing that has not already appeared in print, though it would be very difficult, if not impossible, for a stranger to hunt it all out for himself. This new form of hereditary inquiry is expected to be fruitful of results, and will probably be extended in other directions after the experience of the present attempt.

The death is announced of Dr. A. P. Aitken, professor of chemistry and toxicology in the Royal (Dick) Veterinary College, Edinburgh, since 1875.

Mr. Percy Longmuir, of University College, Sheffield, has been appointed junior assistant in the metallurgical department of the National Physical Laboratory. Mr. Longmuir is a pupil of Prof. Arnold, and has for two years been engaged in research as a Carnegie scholar of the Iron and Steel Institute. He will at present assist Dr. Carpenter in carrying on the work undertaken by the laboratory for the Alloys Research Committee of the Institution of Mechanical Engineers.

As the searches hitherto made for Baron Toll's polar expedition have been in vain, a reward of 5000 roubles (500*l*.) is offered by the Academy of Sciences at St. Petersburg for finding the whole expedition party, or any part of it, and a reward of 2500 roubles (250*l*.) for giving the first exact indications of tracing the party. The expedition, which was sent out by the Academy of Sciences, left the Bennett Island, lying north of New Siberia, on October 26 (November 8), 1902, taking a southern direction. It has been suggested that the expedition may have drifted towards Franz Josef Land, and it is therefore desired to direct the special attention of whalers to this notice.

The Weights and Measures Bill, designed to secure greater uniformity in the administration of the law relating to weights and measures, was read a second time in the House of Commons on April 15. In moving the second reading, Mr. Bousfield explained the provisions of the Bill, and pointed out that the fourth section of the Bill had reference to the metric system. It was proposed that after January 1, 1908, the two abnormal systems of troy weight and apothecaries' weight should be abolished in favour of the metric system. This would produce no disorganisation of trade, and would be an instalment of the reform desired, which, although a measure was now before the other House, it was unlikely that any Government would make *en bloc*, as it would at first result in unpopularity. In the subsequent debate many objections were raised to this section of the Bill, and it was on the understanding that the section referring to the metric system was to be withdrawn that the Bill was read a second time.

We regret to see the announcement of the death of Sir Henry Thompson, distinguished as a surgeon and by his active interest in many departments of science. Sir Henry Thompson was born at Framlingham, Suffolk, on August 6, 1820, and received his early education at University College, London. He gained the Jacksonian prize of the Royal College of Surgeons in 1852 and 1860 for essays on surgical subjects. In 1866 he was appointed professor of clinical surgery in University College Hospital; and in 1884 he became professor of pathology and surgery to the Royal College of Surgeons. He took a leading part in the establishment of cremation in this country as a proper method of disposal of the dead, and was president of the Cremation Society from its foundation in 1874. He was the author of numerous works, including volumes and papers on the branches of surgery in which he was an acknowledged master, on motor cars, horses, diet and death certification, and also of two novels. For several years he cultivated astronomical studies, and had a well equipped observatory constructed at Molesey, but this was abandoned after a time, and the two fine refractors were presented to the Royal Observatory, Greenwich. Later, in 1897, Sir Henry Thompson added to his gift the thirty inch photographic reflector which bears his name. He was knighted in 1867 and created a baronet in 1899, and was the recipient of many honours and distinctions from professional and other learned societies, both at home and abroad.

Prof. C. L. Bristol, professor of biology, New York University, asks us to announce that English and Continental naturalists will be gladly welcomed at the Bermuda Biological Station for Research. Harvard University and New York University unite with the Bermuda Natural History Society in inviting zoologists and botanists to spend six weeks in this temporary biological station, to be situated, as last year, at the Flatts, Bermuda. The laboratory is a new building, and is furnished with all the ordinary glassware, reagents and apparatus provided in modern marine laboratories; but microscopes, dissecting instruments, slides and cover glasses are not supplied by the station. The means of collecting include a steam launch forty-five feet long and crew, a fish-well sailboat and crew, rowboats, a two-horse carriage carrying ten or twelve persons, nets, seins, water glasses, towing and dredging apparatus, &c. Zoologists and botanists who desire to take advantage of the opportunities offered by the station should send applications as early as possible, and not later than May 1, either to Prof. E. L. Mark, 109 Irving Street, Cambridge, Mass., or to Prof. C. L. Bristol, New York University, University Heights, New York City.

There is at Durango, Mexico, a great mass of iron ore which has figured in story and fable for 300 years, and was thought to be a meteorite by Humboldt, who, however, did not quite reach Durango in his explorations. Mr. Le Roy, the United States Consul at Durango, now reports that the mass proves to be a remarkable dyke, emerging from a rocky plain at the elevation of 6300 feet, rising from 400 feet to 650 feet in height itself, and forming a mass of iron ore a mile long and one-third of a mile wide. It has been calculated that it contains 500 to 660 million gross tons above the surface, while there are no means of knowing

what may be below. The ore is a hard specular hematite, with, on an average, 60 per cent. of metallic iron, much of it going up even to 67 per cent.

THE recent annual presidential address of Mr. T. Fairley to the Society of Analysts has been published as a separate pamphlet, a copy of which has reached us. The president, we notice, directed attention to the fact that we are falling behind both Germany and America in research work in analytical chemistry, and proceeded to urge each member of the society to do his utmost, not only to remove this reproach, but to seek to restore to this country a front rank in the cultivation of this branch of chemistry.

THERE was a considerable attendance at the triennial meeting of the German Meteorological Society held at Berlin during Easter week, under the presidency of Prof. von Bezold, the meetings being held at the Institut für Meereskunde. Numerous papers were read and discussed, those on April 7 and 9 being mainly meteorological, and those on April 8 electrical and magnetical, the one which occasioned the most animated discussion being communicated by Prof. Holdefleiss, Halle—"Ueber die meteorologischen Ursachen des Auswinterns des Getreides." On the afternoon of April 7 the members were conducted over the Meteorological Institute in the Schinkelplatze; that of April 8 was devoted to the Physical Observatory at Potsdam; that of April 9 to the meteorological and military balloon and kite flying establishments at Tegel, and the evening to the Geographical Society's meeting; and Sunday evening to the Astronomical Observatory at Treptow. At Tegel the Luftschiff military section charged a balloon of 600 cubic metres within three minutes; within fifteen minutes it had been attached to its car, and, with two officers on board, had disappeared beyond the clouds. The military authorities also carried out wireless telegraphy experiments by means of kites. Dr. Assmann, in charge of the meteorological station, had observations taken at a considerable elevation by means of a kite, and also dispatched a small rubber free balloon with a set of instruments attached.

IN accordance with an imperial decree, the duties of the Earthquake Committee of the Academy of Sciences of Vienna have been transferred to the Central Meteorological Office, the director of which is Dr. J. M. Pernter. The title of the institution is now changed to K.k. Zentralanstalt für Meteorologie und Geodynamik.

IN our issue of December 10, 1903 (p. 135), attention was directed to some of the leading features of a paper read by Dr. H. R. Mill at a meeting of the Institution of Civil Engineers on November 24, on the mean and extreme annual rainfall over the British Isles. A complete copy of this valuable paper has now been received, containing an abstract of the discussion upon it. It is accompanied by three tinted maps showing respectively the mean rainfall in 1870–99, the maximum rainfall in 1872, and the minimum in 1887. There are also three outline maps showing the positions of stations used, and the distribution of the extremes of annual rainfall, the years of occurrence being entered in the geographical positions of the stations. A glance at the map of stations shows that great care has been exercised in their selection, and that materials were forthcoming (except in one or two of the Irish districts) for a remarkably uniform distribution of stations over the whole of the British Islands.

THE great dustfall of February, 1903, has been discussed by Dr. H. R. Mill and R. G. K. Lempfert, and the results published in the *Quarterly Journal* of the Royal Meteorological Society of January last. Before the completion of this investigation an elaborate discussion of the same phenomenon was published by Dr. E. Hermann, of Hamburg, in the *Annalen der Hydrographie* for October and November, 1903. The English authors have approached the subject from a somewhat different point of view from that taken by Dr. Hermann, and have concerned themselves mainly with the relation between the fall of dust and the larger motions of the atmosphere, illustrated by a series of maps embracing the North Atlantic and the western portion of Europe. They have also paid more particular attention to the fall over the British Islands. The area over which it fell thickly in England and Wales is estimated at not less than 20,000 square miles, to the south of a line drawn from Anglesey through Wrexham and Northampton to Ipswich, and the total deposit in England is estimated at not less than ten million tons. There is strong evidence in favour of the dust being of African origin, and that it travelled at a very high altitude. The paper includes some interesting descriptions of competent observers, and a valuable note of a microscopical examination of a number of specimens of the dust by Dr. J. S. Flett, of H.M. Geological Survey.

PROF. H. F. OSBORN sends us an interesting photograph of the Tasmanian wolf taken by Mr. E. T. Keller, and here reproduced. The photograph illustrates an interesting observation made by Mr. Keller that in the resting position

FIG. 1.—Resting Position of the Tasmanian Wolf.

the stiff tail is used to support the animal. Prof. Osborn remarks:—"I have not seen this interesting fact recorded elsewhere. It is, however, possible that it is well known among students of the habits of this animal."

THE occasional appearance during winter of pipistrelle bats, hedgehogs, and frogs, according to a paper by Mr. C. B. Moffat in the April number of the *Irish Naturalist*, is, in Ireland at any rate, much more frequent than is commonly supposed. In the same issue Mr. G. C. Gough discusses the formation of iron-ore in Lough Neagh, and concludes that this is chiefly due to the decomposition of the magnetite in the surrounding rocks.

AMONG the contents of the *Jahrbuch* of the Nassau Naturalists' Union, published at Wiesbaden, is an article by the editor, Dr. A. Pachenstacher, on the hawk-moths and Bombycidæ collected by Baron Carlos von Erlanger during his travels in Shoa, Gallaland, and Somaliland in 1900 and 1901. In another paper Dr. W. Schuster describes the enormous number of long-eared owls nesting in the warm Mayence basin.

FOLLOWING its removal to surroundings better suited to studies of this nature, Christ's Hospital, Horsham, has founded a natural history society of its own, the first report of which is now before us. Naturally, the start has been somewhat uphill work; but, nevertheless, considerable progress has been made, and all the sections are in working order. Funds appear to be much needed for the museum.

TO the February issue of the *Proceedings* of the Philadelphia Academy Mr. J. A. G. Rehn contributes a paper on the Central and South American bats of the genus Chilonycteris, in which all the species are critically reviewed. The most striking feature about these bats is the occurrence of a rufous and a dark brown phase in each species. In some the two phases are very marked, but in others they are connected by intermediate shades. It is not stated whether the two phases (which also occur in bats of two allied genera) have any connection with locality.

IN the report of the Trivandrum Museum for 1903 attention is directed to two dolphins obtained during the year. One has been identified by Mr. Lydekker with *Tursiops catalania*, hitherto known only from Australian seas, while the second has been made the type of a new species, *Sotalia fergusoni*. Descriptions of both were sent to the Bombay Natural History Society. Mr. Ferguson, who is about to retire from the post of director, summarises the progress that has been made in the museum during his term of office. When he took over the duties in 1888 the collection consisted of "odds and ends," without any representation either of the arts and manufactures or of the fauna of Travancore. This "curiosity shop" has been replaced by a representative series of local arts and manufactures, as well as by nearly complete collections of the vertebrates.

AN important paper, by Dr. Bashford Dean, on the hag-fishes of Japan, is published in the *Journal* of the Tokyo University School of Science (vol. xix. art. 2). Two new species are described, one remarkable for its large size and the normal possession of eight gill-openings, and the other constituting a new generic type (Paramyxine). Japan appears to be the most favourable locality at present known for the study of hag-fishes. "In no other known locality are four species, representing three genera of these important chordates, found living practically side by side—for in the neighbourhood of Misaki they occur within a distance of 30 kilometres. Here, too, a form of myxinoid can be obtained in greater abundance than in any locality known to me, and there is also a promising field for collecting developmental stages."

THE "Nature of Heredity" forms the subject of an address delivered in April, 1903, before the South African Association for the Advancement of Science by Dr. A. Dendy, which is published in the first volume of the report of that body. To give a summary of the author's arguments in such a difficult subject would far exceed the limits of our space, but it may be mentioned that Dr. Dendy is of opinion that the views of the late Prof. Cope on heredity come nearer the truth than those of any other writer. There are three special points:—(1) the importance of the cell-nucleus as an apparatus for storing up and giving out stimuli; (2) the possibility of the transference of stimuli between somatic cells and germ-cells (or their nuclei) without any material connection; and (3) the extension of what may be called Herbert Spencer's principle of equilibration to the phenomena of heredity and development, to which, in Dr. Dendy's opinion, sufficient consideration has not been given.

THE submarine valleys off the American coast and in the North Atlantic are described by Prof. J. W. Spencer (*Bull. Geol. Soc. America*, vol. xiv.), who sees evidence in these drowned lands of canyons and other deeply excavated features.

SOME Jurassic fossils from Rikuzen, in Japan, are described by Prof. Matajiro Yokoyama (*Journ. Coll. Sci., Tokyo*, vol. xviii.). These include Schlotheimia, Lytoceras (near to *lineatum*), and other ammonites, as well as belemnites; also *Trigonia v-costata*, and species of Gervillia and Perna.

WE have received several of the *Bulletins* of the Geological Survey of Western Australia. Among these, No. 10 contains descriptions, by Mr. R. Etheridge, of Carboniferous fossils from the Gascoyne district; No. 9 is on the lead and copper ores of Northampton, by Mr. A. Gibb Maitland; and No. 8 is on the Murchison goldfield, by Mr. C. G. Gibson.

IN a lecture on the Assuân Reservoir and Lake Moeris (E. and F. N. Spon, 1904), Sir William Willcocks advocates the formation of a modern Lake Moeris to the south of the ancient lake which for more than 2000 years served to control the floods of the Nile. The new lake would occupy the Wadi Rayan depression. In support of his argument that further measures are necessary, he mentions that since the Assuân dam was completed the whole of the water has been devoted to special tracts, and the Government is reluctantly compelled to refuse further applications for water.

THE fundamental facts of statical electricity are concisely described, with illustrative experiments, by Herr B. Kolbe in his "Einführung in die Elektrizitätslehre, I. Statische Elektrizität," of which a second revised edition has been published by Herr Julius Springer, Berlin.

MESSRS. ISENTHAL AND CO., 85 Mortimer Street, London, W., have published a new illustrated catalogue of apparatus for electrotherapy. The illustrations and descriptions of the apparatus are of a very instructive character. Among other instruments included may be mentioned the Röntgen ray apparatus of all kinds, that for the therapeutical uses of currents of high frequency and high potential, and that for photo- and thermotherapy.

THE Geological Survey of Canada has published a report on "Altitudes in the Dominion of Canada," by Mr. James White, geographer to the Department of the Interior. The report is accompanied by an excellent relief map of North America, and by four sheets of profiles. Three sheets are concerned with the Canadian Pacific Railway—this railway being chosen as showing the profile of the country along the only transcontinental line in Canada—and one shows the River St. Lawrence and the Great Lakes.

THE report of the first meeting of the South African Association for the Advancement of Science, held in April of last year, has been received. It is unnecessary to enumerate in detail the contents of the volume, which runs to 556 pages, for the chief events of the meeting were described in our issue for May 21, 1903 (p. 59). The presidential address by Sir David Gill, F.R.S., and the addresses of the presidents of the four sections into which the work of the association was divided, are all printed at length. Meteorological papers were numerous and important in Section A, though the other subjects, chemistry, astronomy, mathematics, and physics, with which the section is also concerned, are all represented. The subjects in Section B

were chiefly of a biological and geological character; in Section C various engineering questions were discussed, and in Section D great prominence was given to education, philosophy and sociology. The volume deals with forty-seven papers, which are with a few exceptions printed in full or abstracted.

UP to the present the alloys of nickel and iron have attracted attention chiefly on account of the fact that alloys containing about 35 per cent. of nickel have an exceedingly small coefficient of expansion, which in certain cases may even become negative. Their elastic properties appear, however, to be of equal interest and importance, and a paper on this subject, by M. Guillaume, in the *Séance* of the French Physical Society, contains a number of important data. At ordinary temperatures the modulus of elasticity reaches a maximum at 29 per cent. and a minimum at 45 per cent. of nickel, and between these limits the modulus of elasticity *increases with the temperature*, whilst two alloys must exist in which the modulus is independent of the temperature. These results can be explained by supposing that the change from β to γ iron is accompanied by a large increase in the modulus of elasticity, and that in the alloys referred to this transition is brought down to the ordinary temperatures and extended over several degrees.

IN recent months some attention has been paid to the problem of bringing about electrolytic decomposition by means of alternating currents. The most important paper that has appeared on the subject is that by Le Blanc and Schick in the *Zeitschrift für physikalische Chemie*, in which experiments are described on the dissolution of metals in various solvents by the aid of alternating currents of frequency ranging from 72 to 38,600 alternations per minute. In the simpler cases, such as the dissolution of copper in sodium hydrogen sulphate, the weight of metal dissolved is very small, and even at a frequency of only 72 is less than one-third of that calculated from Faraday's law. On the other hand, potassium cyanide, especially in concentrated solutions and with a high current density, dissolves the metal freely even with very high frequencies, and in one experiment the weight of copper dissolved amounted to no less than 66 per cent. of the theoretical quantity when the frequency was above 30,000; this result is probably due to the formation of complex double cyanides in which the metal forms part of the acid radicle, and so is hindered from being re-deposited on the electrode.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mr. J. A. L. Campbell; a Vulpine Phalanger (*Trichosurus vulpecula*) from Australia, presented by Mr. Herbert A. Parkes; an African Civet Cat (*Viverra civetta*) from Africa, presented by Lieut. H. Nelson, R.A.; three Reeve's Pheasants (*Phasianus reevesi*) from northern China, presented by Miss J. Mann; a Blue-fronted Amazon (*Chrysotis oestiva*) from South America, a Princess of Wales's Parrakeet (*Polytelis alexandrae*) from Australia, presented by Mrs. St. Clair Christophers; a Bonnet Monkey (*Macacus sinicus*) from India, a Blackish Macaque (*Macacus fusco-ater*) from the Celebes, a Striped Hyæna (*Hyaena striata*) from North Africa, a Virginian Opossum (*Didelphys virginianus*) from North America, a Burrowing Owl (*Speotyto cunicularia*) from South America, a Grey Parrot (*Psittacus erithacus*) from West Africa, five Eyed Lizards (*Lacerta ocellata*), south European, deposited; a Mouflon (*Ovis musimon*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

RETURN OF BROOKS'S COMET.—A telegram received from the Kiel Centralstelle on April 17 announces that Brooks's comet was observed at Geneva at 9h. 50m. (Geneva M.T.) on April 16. Its position at that time was R.A. = 16h. 58m. 8s., decl. = +44° 10′, and it was slowly travelling northward. Both a nucleus and a tail were seen.

A second telegram received on April 18 announces that Prof. Kobold observed the comet on April 17, and found its position, at 11h. 34m. 0s. (Kiel M.T.), to be R.A. = 16h. 56m. 23·8s., decl. = +44° 43′ 47″.

The above data show that on April 16 the comet was nearly on a straight line joining σ and ι Herculis, and rather nearer to the former than the latter, also that the comet is apparently travelling towards Draco.

ABSORPTION OF STAR-LIGHT BY A COMET'S TAIL.—In No. 3914 of the *Astronomische Nachrichten* Dr. Max Wolf discussed a photograph which led him to the conclusion that the light of the star B.D. +63°·1056 was affected by selective absorption in passing through the tail of comet 1903 IV. on July 25, 1903.

The consideration of later observations has led him, however, to doubt the reality of the apparent absorption, which he now considers may have been due to a photographic effect produced by the comet's light on the film of the negative (*Astronomische Nachrichten*, No. 3934).

THE SPECTRA OF NOVÆ.—In an article published in No. 3917 of the *Astronomische Nachrichten*, Herr H. Ebert explains how the multiple character of the lines in the spectra of new stars may readily be accounted for by supposing it to be due to "anomalous refraction" in the layers of vapours, of different characters and densities, through which the light has to pass between the source and the observer. By a number of curves and diagrams he shows that in the complex strata, which may be reasonably supposed to exist in the vapours surrounding a new star, the light would be refracted hither and thither until, when it emerged from the outer layers, the distribution of the brightness in the spectrum would have been considerably modified by anomalous refraction.

The "shifting" of spectral lines in the experiments which have been performed by several observers on the spectrum of the spark discharge under various liquids may, according to Herr Ebert, be readily explained by this theory.

NEBULOSITY AROUND NOVA PERSEI.—In No. 2, vol. xix., of the *Astrophysical Journal*, Mr. Otto Luyties, of Baltimore, discusses the theories which have been promulgated in reference to the nature and the expansion of nebulosity around Nova Persei, and points out the effect which the shape of the body concerned might have upon the observed velocities. He states that the previous estimations of the parallax of the Nova nebula and of the rate of its expansion have been partly based on the probably erroneous assumption that the emanations which caused the illumination were originally propagated in a direction at right angles to the line of sight. If, however, the mass illuminated were spherical in form, the resulting distortion on the photographic plate would lead to serious misconceptions as to the rate of expansion and the nature of the emanation. Mr. Luyties then discusses the possible effects of such distortion, both for the case of radial illumination from the centre and for that in which the emanation proceeded from a point on the boundary of the sphere, and shows that the correction for such distortion, when a likely value is allotted to the parallax, could be made to account readily for the apparent retardation of the illuminations, and for other anomalies which have been observed, when the actual velocity of the emanations was of the order of that of light.

STELLAR DISTRIBUTION.—A communication from Mr. J. E. Gore to No. 343 of the *Observatory* gives the results obtained from a count of the stars of each magnitude from the third to the sixteenth on a chart of the Pleiades published in Klein's Star Atlas. This chart covers three square degrees, and Mr. Gore finds that the actual value of the ratio for all magnitudes is considerably less than 4, which is the theoretical value if all the stars were equally distributed in space.

The total number of stars counted on the chart was 1281, and this would give for the whole sky, if of uniform richness, a total of 17,615,031.

THE MULTIPLE ORIGIN OF HORSES AND PONIES.[1]

HITHERTO it has been generally assumed that wild horses have been long extinct, that all domestic horses are the descendants of a single wild species, and that, except in size, ponies in no essential points differ from horses.

Now that systematic attempts are being made to improve native breeds of horses in various parts of the world, it is obviously desirable to settle once for all whether, as is alleged, occidental as well as oriental and African races and breeds have sprung from the same wild progenitors, and more especially if *all* ponies are merely dwarf specimens of one or more of the recognised domestic breeds of horses.

To be in a position to arrive at a conclusion as to the origin of the various kinds of domestic horses, and at the same time find an answer to the important and oft-repeated question, What is a pony? one must clear up as far as possible the later chapters in the history of that section of the Equidæ to which the true horses belong.

It is generally admitted that the ancestors of the living Equidæ reached the Old World from the New, the later immigrants crossing by land bridges in the vicinity of Behring Straits. If horses came originally from the New World, to the New World we may first turn for information as to their remote progenitors.

According to recent inquiries, North America possessed in pre-Glacial times at least nine perfectly distinct wild species of Equidæ. Some of these were of a considerable size—*e.g. Equus complicatus* of the southern and middle western States, and *E. occidentalus* of California were as large as a small cart-horse. Others were intermediate in size—*e.g. E. fraternis* of the south-eastern States; and at least one—*E. tau* of Mexico—was extremely small. Some of the American pre-Glacial Equidæ were characterised by very large heads and short strong limbs, some by small heads and slender limbs; and though the majority conformed to the true horse type, two or three were constructed on the lines of asses and zebras.

When true horses first made their appearance in America the climate and the land connections between the Old World and the New were very different from what they are to-day. One result of these differences was that before the close of the Pliocene period—*i.e.* prior to the great Ice age—it was possible for American horses to find their way into Asia and thence into Europe and Africa. One of the earlier immigrants (*Equus stenonis*) has left its remains in the Pliocene deposits of Britain, France, Switzerland, Italy, and the north of Africa. While *E. stenonis* was extending its range into Europe and Africa, two others (*E. sivalensis* and *E. namadicus*) were finding their way into India, and yet other species were doubtless settling in eastern Europe and Central Asia.

It may hence be safely assumed that as Africa now contains several species of zebras, Europe at the beginning of the Pleistocene period was inhabited by several species of horses.

We know that before the beginning of the historic age horses had become extinct in North America, but we have not yet ascertained what was the fate of the equine species which reached, or were evolved in, the Old World before or during the great Ice age. It is believed by some palæontologists that the Indian species, *E. sivalensis* and *E. namadicus*, became extinct, and that *E. stenonis* gave rise through one variety (*E. robustus*) to the modern domestic breeds, and by another (*E. ligeris*) to the Burchell group of zebras. *E. sivalensis*, unlike *E. stenonis*, but like the still earlier three-toed horse Hipparion and certain prehistoric South American species, was characterised by a depression in front of the orbit for a facial gland (probably similar to the scent-gland of the stag), and usually by large first premolar (wolf) teeth in the upper jaw. In some recent horses having eastern blood in their veins there seems to be a vestige of the pre-orbital depression, and in some of the horses of south-eastern Asia (*e.g.* Java and Sulu ponies), as in some zebras (*e.g.* Grévy's zebra and a zebra of the Burchell type found near Lake Baringo), there are large functional first premolars. It is hence possible that lineal but somewhat modified descendants of *E. sivalensis* of the Indian Pliocene may still survive, and that *E. sivalensis* was a lineal descendant of Hipparion.

We are, however, more concerned with the ancestors of the domestic horses of Europe and North Africa than with oriental horses.

From osseous remains already found we know horses were widely distributed over Europe during the Pleistocene period, and that they were especially abundant in the south of France in post-Glacial times. It has not yet, however, been determined how many species of horses inhabited Europe during and immediately after the Ice age, nor yet to which of the pre-Glacial species prehistoric horses were genetically related. Bones and teeth from deposits and caves in the south of England seem to indicate that during the Pleistocene period several species of horses ranged over the west of Europe. The Pleistocene beds of Essex have yielded bones and teeth of a large-headed, heavily built horse, which probably sometimes measured more than 14 hands (56 inches) at the withers. From the "elephant bed" at Brighton portions of a slender-limbed horse have been recovered, and Kent's cave, near Torquay, has yielded numerous fragments of two varieties or species which differed somewhat from the Essex and Brighton species. The "elephant-bed" horse has hitherto been described as very small, but if one is to judge by the bones in the British Museum it may very well have reached a height of 50 or even 52 inches (12·2 or 13 hands). The Kent's cave horses were probably from 13 to 14 hands high. One in its build approached the Essex horse, the other the slender-limbed species of the "elephant bed" at Brighton. If there were two or more species in Pleistocene times in the south of England (then part of the Continent), it is probable that yet other species inhabited south and middle Europe and the north of Africa.

As already mentioned, horses were extremely abundant in the south of France in the not very remote post-Glacial period.[1] Evidence of the existence of large herds we have at Solutré, where for a number of years there was an open-air Palæolithic encampment. Near the Solutré encampment (which lies in the vicinity of the Saône, about midway between Chalons and Lyons), the bones of horses[2] and other beasts of the chase were sufficiently abundant to form a sort of rampart around part of the settlement. It is difficult to say how many species of horses are represented at Solutré, but there seems no doubt that the majority belonged to a stout, long-headed, but short-limbed animal, measuring about 54 inches (13·2 hands) at the withers. Though of smaller size, the typical Solutré horse had nearly as large joints and hoofs as the Essex Pleistocene species. Like the Essex horse, it seems to have been specially adapted for living in low-lying marshy ground in the vicinity of forests, and for feeding during part of the year on coarse grasses, shrubs, roots, and other hard substances, for the crushing of which large teeth set in long powerful jaws were indispensable.

That lightly built as well as stout species existed in post-Glacial as in Pleistocene times is made evident by bones found in caves and by drawings and sculptures made by Palæolithic hunters. Of the existence of two kinds of horses in post-Glacial times, practically identical with the stout and slender-limbed Pleistocene species, the cave of Reilhac, near Lyons, is especially eloquent. It is, however, mainly by the engravings on the walls of caves in the Dordogne, Gard, and other districts in the south of France that the existence in late Palæolithic times of various kinds of light and heavy species of horses is made manifest.

In the cave of La Mouthe, *e.g.*, two horses are incised on the same panel—perhaps by the same hand—one of which (Fig. 1) has a very long head attached nearly at right angles to a short thick neck, while the other has a small head, Arab-like ears, and a long slender neck such as we are wont to associate with racehorses.

In the Combarelles cave (Commune of Tayac), the walls

[1] By Dr. J. Cossar Ewart, F.R.S. Abridged from *Trans.* Highland and Agricultural Society of Scotland, vol. xvi., 1904.

[1] An account of the prehistoric horses of Europe, by Dr. Robert Munro, will be found in the *Archæological Journal*, vol. lix. No. 234.

[2] Toussaint, of the Lyons Veterinary College, believes that at Solutré there were fragments of at least 100,000 horses, all of which had been used as food.

of which for more than a hundred yards are crowded with animal figures, there are, in addition to twenty-three nearly full-sized engravings of horses, numerous studies of equine heads. Some of the Combarelles horses decidedly differ from those of La Mouthe. There is, *e.g.*, a large drawing of a heavily built horse (Fig. 2) with a coarse head, an arched muzzle, a thick under lip, rounded quarters, and a tail with long hair up to the root. At another part of the cave there is what appears to be a natural size engraving (Fig. 3) of a head which in outline is wonderfully suggestive of an Arab, and at yet another part of the cave a horse with a pony-like head is represented, behind which stands an animal with a head like that of a modern Shire horse.

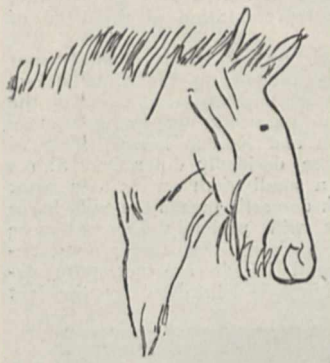


FIG. 1.—Horse with a long head, from an engraving in the cave of La Mouthe. (Munro's "Prehistoric Horses.")

In addition to the types figured on the walls of caves, there are others carved on pieces of horn and other durable substances. The majority of the horses engraved on horn are characterised by a very large coarse head, but a few (*e.g.* the horse from the Kesserloch cave near Schaffhausen) are remarkable for the small size of the head, the fine muzzle, and small ears.

As already indicated, the men of the early Stone age have left us drawings of some four or five different kinds of horses, some with large heads and stout limbs, some with fine heads and slender limbs, some with a nearly straight croup and a well-set-on tail, others with rounded quarters and the root of the tail far below the level of the croup. Drawings made at the present day will be of little use some centuries hence in providing an answer to the question, How many species of horses existed in Europe at the beginning of the twentieth century? They will confuse rather than enlighten future inquirers, because for several generations breeders of horses, like breeders of cattle and dogs, have with the help of selection and isolation succeeded in creating numerous artificial strains. Is there any reason for supposing the evidence afforded by the prehistoric drawings is more valuable to us than recent drawings will be to our successors thousands of years hence, should they desire to ascertain how many species of horses Britons possessed at the end of the nineteenth

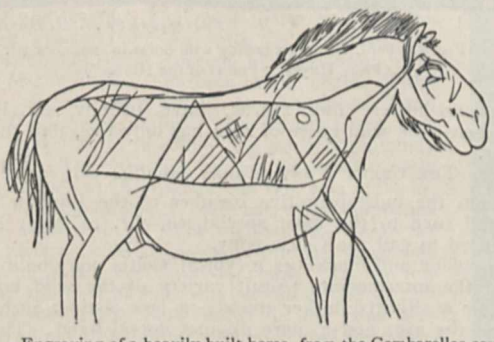


FIG. 2.—Engraving of a heavily built horse, from the Combarelles cave ($\frac{1}{16}$). (Munro's "Prehistoric Horses.")

century? That depends on whether in Palæolithic times the horse was domesticated in Europe.

It is extremely probable that the men of the early Stone age had now and again tame horses, just as nowadays we have at times tame zebras, but it is most unlikely that they had herds of horses which they systematically bred and reared as stockmen now breed and rear cattle.

That the domestication of the horse as now understood was not attempted in Palæolithic times may be inferred from the fact that the majority of the horses in the Solutré bone-mounds were from five to seven years old. Had horses been bred for food as we nowadays breed cattle, young individuals would have been most abundant at Solutré.

If it is admitted that the engravings on the walls of caves and on pieces of horn fairly accurately represent animals which actually existed at the end of the Ice age, and if it is also admitted that the creation of new varieties by artificial selection was never attempted until at the earliest the arrival of the Neoliths, it follows that in post-Glacial as in Pleistocene times there were several perfectly distinct wild species of horses in Europe.

For some reason or other it has hitherto been very commonly assumed that, as in recent times the wild striped horses of South Africa—the quagga and zebras—have been gradually supplanted by occidental or oriental domesticated horses, the wild horses of Europe were gradually displaced by domesticated varieties introduced by the Neoliths. It seems to me quite unnecessary to assume that the indigenous varieties so long familiar to the Palæolithic inhabitants were exterminated.

The advent of the Neoliths, instead of implying the extermination of indigenous varieties, in all probability meant the introduction of yet other varieties.

I may here repeat that now, as throughout the nineteenth century, it is generally assumed that all the domestic breeds—small as well as large—have sprung from a single wild species. The great French naturalist Cuvier not only believed that all living horses belonged to one species (the *Equus caballus* of Linnæus), but also that there was no specific difference between living breeds and the fossil horses of the Pleistocene period. Prof. Sanson, of the French National College of Agriculture, in his "Traité de Zootechnie" (1901), assuming a single origin for domestic breeds, divides recent horses into two groups—a long-headed and a short-headed group—each of which consists of several races, while Captain Hayes, in his recently published "Points of the Horse" (1904), says, "no breed of horses possesses any distinctive characteristic which serves to distinguish it from other breeds," and adds that "as a rule locality . . . and artificial selection are the chief factors in the formation of breeds." Elsewhere Captain Hayes states, "As far as I can learn, no attempt has been made to separate ponies from horses except on the purely artificial basis of height."[1] Even those who are prepared to admit that recent horses may have sprung from several wild species allege that owing to domestication, intercrossing, and artificial selection it is no longer possible to indicate the distinguishing characters of the two or more wild species which took part in forming the present races and breeds.

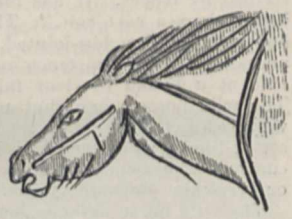


FIG. 3.—Head of a horse with a profile like that of an Arab, from the Combarelles cave ($\frac{1}{8}$). (Munro's "Prehistoric Horses.")

THE WILD HORSE (*Equus caballus prjevalskii*).

The wild horse may be first considered. For many years the semi-wild Tarpan of the Russian steppes was regarded as the nearest living relative of the wild ancestor of the domestic breeds, but in 1881 the existence of a true wild horse was announced by the Russian naturalist Polyakov. This horse occurs in the vicinity of the Gobi desert and the Great Altai Mountains, one variety living to the south-east, another to the west, and a third to the south of Kobdo. All three varieties are of a yellow-dun colour, the south-eastern (Zagan-Nor) form being especially characterised by a dark muzzle, dark points, and a dark mane and tail; in the western (Urungu) variety the muzzle is nearly white, the limbs are light down to the fetlocks, and the mane and tail are of a reddish-brown tint, the southern (Altai) form being nearly intermediate in its coloration. The markings consist of a narrow dorsal band, faint indications of shoulder stripes, and indistinct bars in the region

[1] "Points of the Horse," pp. 422-425.

of the knees and hocks. In all three varieties the mane is short and upright in the autumn, but long enough in spring to arch to one side of the neck; in summer the upper two-thirds of the dock of the tail carries short hair, the distal third long hair, which continues to grow until it reaches the ground; in winter the upper two-thirds of the tail carries hair from 2 to 4 inches in length. The hair of the body and limbs is short in summer, but under the jaw and over the greater part of the body and limbs it is from 3 to 4 inches in length in winter.

The hoofs are narrower and have longer "heels" than in the common horse, but, as in the common horse, each limb is provided with a chestnut and with an ergot, the hind chestnut (hock callosity) being very long and narrow.

In the variety (Fig. 4) occurring in the Altai south of Kobdo—probably the most primitive of the three—the head is large and coarse, and, compared with the length of the body, longer than in any domestic breed. In a side view it is noticed that the forehead is prominent (bumpy), the lower part of the face straight or slightly convex, the under lip long, and that the head forms nearly a right angle with the short neck. The eyes are lateral in position, and appear unusually close to the ears owing to the great length of the space between the eye and the nostril. The ears are long and generally project obliquely outwards (Fig. 4), as in many cart-horses. The croup is nearly level, but the hocks are usually bent and turned in. Judging by the behaviour, during the last two years, of the wild horse in my possession, I am inclined to think his less remote ancestors, though in all probability members of the steppe fauna, lived for a time (perhaps during the Ice age) in the vicinity of forests. As is the case with other gregarious animals, he strongly objects to be separated from his companions, and he also objects to have his movements circumscribed by fences. It has often been said "nothing jumps better than a cart colt." The cart colt jumps because he has sprung from big-jointed, broad-hoofed, forest-haunting ancestors whose existence often depended on their being able at a bound to clear fallen trees and other obstacles. The wild horse when shut up in a loose-box by himself is very restless, and keeps rearing up against the door until set at liberty; if placed in a paddock away from his special comrades he generally succeeds in either scrambling over or breaking down the fence.

The wild horse never encounters fences in the Gobi desert, but, probably because he had forest-bred ancestors which had often to cross fallen trees, he endeavours without a moment's hesitation to clear all obstacles that come in his way, while true desert forms endeavour to break through them.

It has been suggested that the wild horse of the Gobi desert is not a true wild animal, but only a domesticated breed that has reverted to the wild state.[1] Against this view I may mention (1) that all the wild horses are of a yellow-dun colour, and that though those to the west of Kobdo differ in tint from those to the east, the eastern and western varieties seem to be connected by the less specialised variety to the south of Kobdo; (2) that travellers in Central Asia all agree in stating that the Mongolian ponies vary greatly in colour—in a Chinese hymn known as the "Emperor's Horses" as many as thirteen colours are referred to; (3) the descendants of the horses which escaped from the Spaniards in America after several centuries of freedom were of all sorts of colours; and (4) in horses which live in sub-Arctic areas the hair at the root of the tail tends to increase so as to form a sort of tail-lock, which when caked with snow protects the hind-quarters during snow-storms; the complete absence of this tail-lock—fairly well developed in one of my Mongolian ponies—is a very strong argument against the assumption that Prjevalsky's horse is nothing more than a domesticated breed that has reverted to the wild state.

The wild horse of the Gobi desert is certainly the least specialised of all the horses living at the present day. In being of a yellow-dun colour, in shedding annually the hair of the mane and the hair from the upper two-thirds of the tail, in having ergots and chestnuts on the hind- as well as on the fore-limbs, and in having canines and fairly large upper first premolars, Prjevalsky's horse is distinctly primeval. Only in the all but complete absence of stripes and in having very long powerful jaws armed with relatively large teeth can the Gobi horse be said to be specialised.

It is extremely probable that Prjevalsky's horse was familiar to the troglodytes who inhabited the Rhone valley in prehistoric times. One might even go further and say that in Fig. 1, from an engraving in the cave of La Mouthe, we have a fairly accurate representation of the head of Prjevalsky's horse.

It is, of course, impossible to say which of the recent breeds are most intimately related to the Gobi horse. Though the head and ears are suggestive of some of the heavier occidental breeds, in its trunk and limbs it more closely resembles Mongolian and Korean horses, some of which, like Prjevalsky's horse, decidedly differ from Shires and Clydesdales in having a small girth owing to a want of depth of body. To which domestic breeds the wild horse has contributed characters will probably become more manifest after he has lived for some time under domestication. That heavy occidental breeds are not pure descendants of Prjevalsky's horse is suggested by the fact

Photograph by M. H. Hayes.

FIG. 4.—Prof. Ewart's yearling wild horse in summer coat. (From Hayes' "Points of the Horse.")

that cart-horses, like zebras, have usually six lumbar vertebræ—the wild horse of Asia has only five, like the wild asses.

THE CELTIC PONY (*Equus caballus celticus*).

From the most primitive member of the Equidæ family I shall turn to the most specialised, viz. to what I have ventured to call the Celtic pony.

In colour and markings a typical Celtic pony only differs from the intermediate (Altai) variety of the wild horse in having a slightly darker muzzle, a less distinct light ring round the eye, and a more distinct dorsal band. The hair is similar in structure, but slightly longer in the Celtic pony during winter (Fig. 5), more especially under the jaw—where it forms the so-called beard—over the hind-quarters, and on the legs. In the mane, tail, and callosities the Celtic pony is very different from the wild Gobi horse. The mane is made up of a mesial portion (nearly twice the width of the entire mane in an Arab) consisting of strong dark hair, and of two lateral portions the hair of which is lighter and finer and less circular in section than the hair of the central portion. The mane in the adult grows at the rate of from 9 to 10 inches per annum, and as only about one-third of the hair is shed annually, the mane

[1] It was formerly stated that the wild horse was simply a hybrid between a Mongolian pony and a kiang. I recently showed that a hybrid of this kind is quite different from the wild horse. See *Proc.* Roy. Soc. Edin., vol. xxiv. part v., 1902–1903, and NATURE, vol. lxviii. p. 271.

reaches a considerable length. Owing to the great width of the middle portion the one half of the mane generally falls to the right side, the other to the left. The front part of the mane hangs down over the face to form a forelock (Fig. 5).

Photograph by G. A. Ewart.

FIG. 5.—A typical Celtic pony in winter coat. (Note the "beard," forelock, and tail-lock.)

The most remarkable feature of the Celtic pony is the tail. To begin with, the dock is relatively very short—so short that one is apt to suppose it has been docked. The distal two-thirds of the dock carries long dark hairs, the majority of which continue to grow until they trail on the ground. During winter and spring the proximal third of the dock—about 4 inches—carries stiff hair from 3 to 6 inches in length, which forms what may be known as a caudal fringe or tail-lock (Figs. 5 and 6). In the case of Arabs and other semi-tropical horses the first 1 or 2 inches of the dock are usually covered with short fine hair like that over the hind-quarters, but in the Celtic pony fine wiry hairs from 4 to 5 inches in length extend right up to the root of the dock under cover of the body hair of the croup. The most distal hairs of the tail-lock overlap, but are quite distinct from, the long persistent hairs carried by the lower two-thirds of the dock. The hair in the centre of the fringe, of the same colour as the dorsal band (Fig. 6), projects obliquely backwards; the hair at the sides is light in colour and projects obliquely outwards. The presence of this very remarkable bunch of hair at the root of the tail was quite incomprehensible until I noticed what happened during a snowstorm. The moment the storm set in the pony orientated herself so that the snow was driven against her hind-quarters. In a few minutes the lock of hair was spread out to form a disc, to which the snow adhered, and thus provided a shield which effectively prevented the flakes finding their way around the root of the tail, where they would have soon melted and effectively chilled the thinly clad inner surface of the thighs. Provided with a caudal shield, long thick hair over the hind-quarters and back, and a thick mane covering both sides of the neck and protecting the small ears, a Celtic pony is practically snow-proof. While the storm lasted the pony in question stood perfectly still, with her head somewhat lowered, save when she shifted her position as the wind veered from north-west to north. Very different was the behaviour of an Arab, and a thoroughbred Highland colt close by. After trying various attitudes, the Arab, carrying her head low and to one side, made a rush for the shelter of an adjacent wood; the half-bred colt—prevented by her Celtic blood from running away—tried in vain one position after another, and long before the storm ceased looked thoroughly miserable and began to shiver as if chilled to the bone. It hence follows that the tail-lock is not, as I at first assumed, an inheritance from a primitive ancestor akin to the wild horse, but a highly specialised structure which eminently adapts the Celtic pony for a sub-Arctic environment. I need hardly say the caudal fringe is not a product of artificial selection, for even in Iceland, where it reaches its maximum development, neither its existence nor its use has, so far as I can gather, ever been referred to. It need only be added that to maintain a tail-lock of this kind it is necessary that the short wiry hairs of which it consists require to be renewed once a year.

Photograph by G. A. Ewart.

FIG. 6.—Celtic pony, to show tail-lock in midwinter.

In separating asses and zebras from horses, stress has hitherto been laid on the difference in the mane and tail, and especially on the absence of hind chestnuts. As already pointed out, the wild horse during summer in its mane and tail agrees with asses and zebras. The mane and tail are hence no longer of specific importance. This is also true of the chestnuts, for in the Celtic pony, as in asses and zebras, the hind chestnuts (hock callosities) are completely absent. In the wild horse, as in the vast majority of heavy and cross-bred horses, the hind chestnuts reach a considerable size, but in asses and zebras and the Celtic pony I have failed to find any rudiments of hind chestnuts either before or after birth. Further, in the Celtic pony the front chestnuts are small, and, still more remarkable, the fetlock

callosities (ergots) have entirely vanished; in asses and zebras the ergots are always present, and in some cases still play the part of pads. The Celtic pony is hence not only more specialised—further removed from the primitive type—in its mane and tail, but also in having lost the fetlock pads (ergots) and the hock (heel) callosities. Nature makes little effort to get rid of useless vestiges, so long as they are harmless. When an ergot or a chestnut is accidentally torn off there is considerable loss of blood. It is conceivable that in the remote past horses which happened to be born without ergots proved better adapted for a life in the sub-Arctic regions—were less likely to suffer from injury when moving through frozen snow and to become a prey to wolves—and hence had a better chance of surviving and leaving descendants.[1]

There is also evidence of specialisation in the teeth of the Celtic pony. In many horses—*e.g.* the horses of south-eastern Asia—the canines and upper first premolars (wolf teeth) are well developed, but in the Celtic pony the first premolars seem to be invariably absent, while the canines are either absent or very minute even in old males. In all the typical Celtic ponies I have seen the head is small, Arab-like in outline, and well put on to a relatively long neck; the muzzle is fine and slightly arched, the under lip short and well moulded, the nostrils are wide, and the eyes on a level with the forehead, while the ears are short, white-tipped, and carried as a rule in an upright position. Owing to the shortness of the jaws the proportion of the head to the body is as 1 to 2·50 instead of 1 to 2·20, as in the wild horse.

Except in size I have been unable to discover any difference between the skeleton and teeth of the Celtic pony and those of the small horse of the "elephant bed" of the Brighton Pleistocene. In the most northern part of Iceland, where the few pure specimens of the Celtic pony survive, only a height of 12 hands (48 inches) is reached—under more favourable conditions the height would probably be 50 or 52 inches, the size of some of the "elephant-bed" horses and of the smaller variety of the desert-bred Arab, to which the small slender-limbed occidental pony closely approximates.

In temperament the Celtic pony is very different from the wild horse. Captain Hayes had no difficulty in handling the wild horse in my possession, but from first to last, though giving evidence of marked intelligence, it was absolutely irresponsive and spiritless. A Celtic pony, on the other hand, rapidly learns what the trainer wishes and responds with alacrity. In its keenness and speed, staying power and agility, a pure Celtic pony is as different from an ordinary heavy-headed Iceland pony (*i.e.* a dwarf horse) as an Arab is from a cart-horse.

The question may now be asked, Is my most typical Celtic pony a pure or nearly pure specimen of a once widely distributed wild species, or is it at most an approximation to an ideal type, living representatives of which no longer exist? I regard the pony described above as an almost pure representative of a once widely distributed wild species, for the following reasons:—(1) In its colour and markings it is almost identical with Prjevalsky's horse, and not unlike some of the varieties of the wild Asiatic ass. (2) The hind chestnuts and all four ergots are completely absent. (3) The tail-lock is perfectly adapted for its work—were the hairs shorter the fringe would be ineffective, were they longer the snow-shield, if ever formed, would rapidly disintegrate. (4) The first premolars are completely absent, and only one of the four canines is represented, and that only by a minute peg which barely projects beyond the gum. (5) The pony in question proved sterile with stallions belonging to five different breeds, as well as with a Burchell zebra and a kiang; but she at once bred when mated with a yellow-dun Connemara-Welsh pony, which closely approximates to the Celtic type. (6) Ponies having the more striking Celtic characteristics occur in isolated and outlying areas, where one would expect to find remnants of an ancient highly specialised species which perchance reached the Old World from the New in pre-Glacial times or during warm inter-Glacial periods—in, *e.g.*, Iceland (which has been almost completely isolated since the twelfth or thirteenth century), the Færöe Islands, Shetland, the Hebrides, the west of Ireland, and Finland.

Flat-nosed Variety of the Celtic Pony.—In the Færöes, the Hebrides, and in Shetland there are slender-limbed ponies which, except in their colour and the shape of the head, and in some cases the form of the hind-quarters, closely agree with my typical Celtic pony. In these ponies the depression below the eyes is more pronounced, and extends well-nigh to the muzzle, which is nearly flat. The nostrils look downwards, and the space between them, instead of being arched as in the Iceland specimen, is flat, and forms nearly a right angle with the face.

Some of these flat-nosed ponies are of a foxy-red colour, others are dark brown. According to Landt, the majority of the Færöe ponies a century ago were foxy-red—the St. Kilda ponies, eighteen in all, seen by Martin at the end of the seventeenth century, were also of a red colour—the others were with few exceptions dark. A foxy-red Færöe pony in my possession has neither a dorsal band nor bars on the leg, but it has a light mane and tail, a nearly straight croup, and well formed hind-quarters. All the other foxy-red Færöe ponies I have seen or heard of closely resemble the one in my collection.

The dark Færöe ponies, like the dark Barra ponies, only differ from the foxy-red ponies in not having in every case a straight croup and a high set-on tail, while the dark variety of the Celtic pony found in Shetland is in build more like the typical Iceland specimens than the Færöe variety.

Herodotus (*v.q.*) says of the horses of the Sigynnæ—the only tribe he knew the name of across the Danube—they "are shaggy all over the body, to five fingers in depth of hair: they are small, flat-nosed, and unable to carry men; but when yoked to chariots they are very fleet, therefore the natives drive chariots." This description, so far as it goes, is singularly accurate of the foxy-red Færöe ponies, even to their being very fleet "when yoked to chariots." It is extremely probable that in the red coloured Færöe ponies we have a remnant of a very old and once widely distributed variety, the origin of which is never likely to be revealed. For some unaccountable reason the silver mane and tail are as a rule either handed on untarnished to cross-bred offspring or they reappear in the second or one of the subsequent generations. It is hence possible that various large breeds—such as the Suffolk Punch, the white-maned horses of the Hebrides and of the north and west of Ireland, certain silver-maned Hungarian and Russian races, not to mention Chittabob and other English thoroughbreds—have all inherited their light manes and tails from an ancient foxy-red variety of the Celtic pony.

The origin of the dark brown variety of the Celtic pony is also wrapped in mystery. These dark brown ponies may represent another old variety from which the Exmoors have sprung—a variety which has contributed the tan-coloured muzzle and the ring round the eye so characteristic of many of the best Highland and Island garrons. One of these dark brown ponies, brought from Barra as a two-year-old, looked for a time like a miniature thoroughbred. Now as a three-year-old it might pass for one of the oldest and best type of the dark Færöe ponies. Neither the dark nor the red Færöe ponies ever possess all the Celtic characteristics; at the most they are three parts pure, and I may add they cross freely with Norwegian and other breeds, generally transmitting such Celtic "points" as they possess to their mixed offspring.[1] It is worthy of note that in some of the small-headed horses engraved in the Combarelles and other caves inhabited in Palæolithic times, the croup is straight and the tail set on high as in many Arabs; in others the tail, instead of being in a line with the croup, looks as if it had been an afterthought—an appendage inserted fairly well up in some cases, lower down in others, as is the case in many large and small horses with rounded quarters. In the engravings showing a small-headed horse with a straight croup we seem to have the foxy-red variety represented; in those with somewhat drooping quarters we may have a representation of the dark brown variety of the Celtic pony.

If one may judge from its specialisation and from its being now adapted for sub-Arctic conditions, the Celtic pony belongs to a variety which at a very remote period branched

[1] If, as seems likely, the absence of ergots (*i.e.* of spurs in the centre of the footlocks) is an advantage in arid regions, such as the Libyan plateau, we can understand their frequent absence in Barbs and Arabs.

[1] See Marshall and Annandale, *Proc.* Cam. Phil. Soc., vol. xii. part iv.

off from the main stem and possibly reached Europe and North Africa long before the advent of the Neoliths—to become the progenitors not only of occidental but also of African races.[1]

As might have been anticipated, Celtic characters can often be identified in British and other occidental breeds. Many thoroughbreds, which are an unequal blend of Barbs and of Arabs in which Eastern races often prevail, and of light and heavy occidental varieties, show traces of Celtic ancestors. Many small thoroughbreds "ride like a pony," or have a pony head, or pony legs, some even want the ergots or hind chestnuts, or the tail has a vestige of a fringe, or there is the gait and temperament, alertness and intelligence of the pony. Many of the Highland garrons have pony characteristics, and this is also true of all the old mountain and moorland breeds, more especially of the mealy-nosed Exmoor ponies and some of the better bred dun-coloured Connemaras.

Even in Clydesdales of the older type pony characters sometimes surge to the surface, while in cross-bred animals they sometimes predominate. Recently I heard of a powerful active 17-hands horse—with a wonderful reputation for speed, strength, and staying power—in which the hind chestnuts, greatly to the surprise of the owner, were completely absent. On making inquiries as to the pedigree of this horse, I ascertained he was bred in Caithness, and was the grandson of a Highland pony.

The Norse Horse (*Equus caballus typicus*).

During prehistoric times in certain parts of Europe a tundra fauna gave place to a steppe fauna, which later was succeeded by a forest fauna. Evidence of this succession we especially have in the rock-shelter at Schweizersbild, near Schaffhausen. In the lower deposits the remains of the reindeer, musk-ox, variable hare, Arctic fox, and other tundra forms occurred. Nearer the surface were relics of hamsters, the woolly rhinoceros, kiang, horse, and other denizens of the steppes; and on still higher layers the bones of the beaver, hare, and squirrel, the badger, pine martin, and wild boar, the stag, roedeer, urus, horse, and other recognised members of a true forest fauna.

In the case of the Equidæ it is often extremely difficult to determine to which species any given bones belong, and hence it is impossible to state definitely that the horses found along with the hamsters and other steppe forms essentially differed from those which were contemporaries of the stag and wild boar and other typical forest forms.

It may, however, be assumed that even in post-Glacial times the majority of the inhabitants of the steppes would when mature be quite or nearly whole coloured, while frequenters of the forests would as often be either striped or spotted—that, *e.g.*, the horse which frequented the Rhine valley along with the kiang and woolly rhinoceros would resemble the wild horse (*E. c. prjevalskii*) which, with the kiang, now lives in the vicinity of the Great Altai Mountains, while the horse which at a subsequent period was a contemporary of the wild boar, stag, and roedeer would be more or less richly striped, and in its limbs and general conformation adapted for a life in or near forests.

That there is some ground for this assumption will, I think, be admitted when due consideration is given to results obtained by crossing various kinds of horses with a Burchell zebra. When ponies of the Celtic type—*i.e.* ponies which in their colour are identical with Prjevalsky's horse, almost certainly the lineal descendant of the steppe horse of Palæolithic times—are crossed with a male Burchell zebra, hybrids are obtained which, while in build strongly suggesting a Burchell zebra, are as profusely striped as the great zebra of Somaliland—have at least five times as many transverse stripes across the trunk as occur in their zebra sire. When, however, pony mares of the Norwegian type are crossed with a Burchell zebra, the hybrids resemble in make their Norse dams, and in their markings closely approximate the common or mountain zebra. The explanation of these remarkable differences seems to be that in the case of the Celtic pony hybrids the remote (Grévy-like) ancestors of the Burchell zebra control the development and determine the plan of the decoration, while in the case of the Norse pony hybrids the remote striped-horse ancestors contribute the more obvious characters—the Norse ponies having more influence in determining the plan of striping than the highly specialised Celtic ponies, from which stripes had probably all but completely disappeared countless generations before they began to fade on the horses which belonged to the forest fauna.

It is probable that the highly specialised Celtic pony, as well as the primitive Gobi wild horse, belong to the steppe fauna, and it is equally probable that the yellow-dun (Fjord) horse, in which a striped coat may be said to be latent, belongs to the forest fauna. If this be admitted, it follows that the environment of the Norse race has been for untold ages so different from that of the Celtic pony and the wild horse that it centuries ago acquired the rank of a distinct species, or at least a well marked natural variety.

The question now arises, Does there exist in any of the outlying parts of the world (where artificial selection has been made use of to conserve old rather than to create new types) horses of a red rather than of a yellow-dun colour—more like the red deer than the kiang—horses with a sufficient number of imperfect stripes on the body and bars on the legs to indicate descent from ancestors decorated after the manner of the mountain zebra? As is now generally known, dun-coloured horses with remnants of a striped coat now and again make their appearance in all parts of both the Old and New World. It is also a matter of common knowledge that dark yellow-dun horses, sometimes with fragments of numerous stripes, are always to be met with in, amongst other places, Mongolia, Tibet, the North-West Provinces of India (especially in the State of Kattiawar), and in the north-west of Europe, more especially in Norway, the Highlands and islands of Scotland, and in Iceland. With the exception of the Kattiawars, which, probably as the result of rigid selection, stand apart, all the others have many points in common—some of the dun Mongol ponies agreeing closely with Norwegians—but they all—the Kattiawars more than the rest—decidedly differ from *E. c. prjevalskii*, the wild horse of the Great Altai Mountains, and from typical specimens of the light yellow-dun Celtic pony.

The most richly striped horses I have hitherto come across occur in the north-west of Scotland. One of these recently examined is alike in make, colour, and markings so unique, and looks so little modified by domestication and artificial selection, that it must, I think, be considered as a fairly typical specimen of a once wild species. The history of the yellow-dun striped race, to which the specimen alluded to belongs, has not yet been written, but there is little doubt that it was introduced into Scotland from Scandinavia about the end of the eleventh or beginning of the twelfth century. As this yellow-dun striped race may very well have been familiar to Linnæus, it may, I think, be taken as the type of the large occidental breeds, and known as the *Equus caballus typicus*. A typical specimen of the Norse variety is of a dark yellow-dun colour, with black "points" and a nearly black mane and tail. The mane is long and heavy, and tends to fall to both sides of the neck as in the Celtic pony. Only a few hairs at the root of the tail are shed in summer, and there is no attempt to form a tail-lock in winter, while the footlocks, never very long, are limited to the region of the ergots. The forehead is decorated with narrow stripes, which in their number and arrangement agree more with the mountain than with the true Burchell zebra. A broad dorsal band extends along the back to lose itself in the tail; there are stripes on the neck, and faint stripes extend a short distance from the dorsal band across the body, as in the British Museum quagga; while the legs, especially in the region of the "knees" and hocks, are marked by distinct bars.

The ears are short and are carried in a nearly upright position; the forehead (which is not particularly wide), in having two ridges extending upwards from the prominent

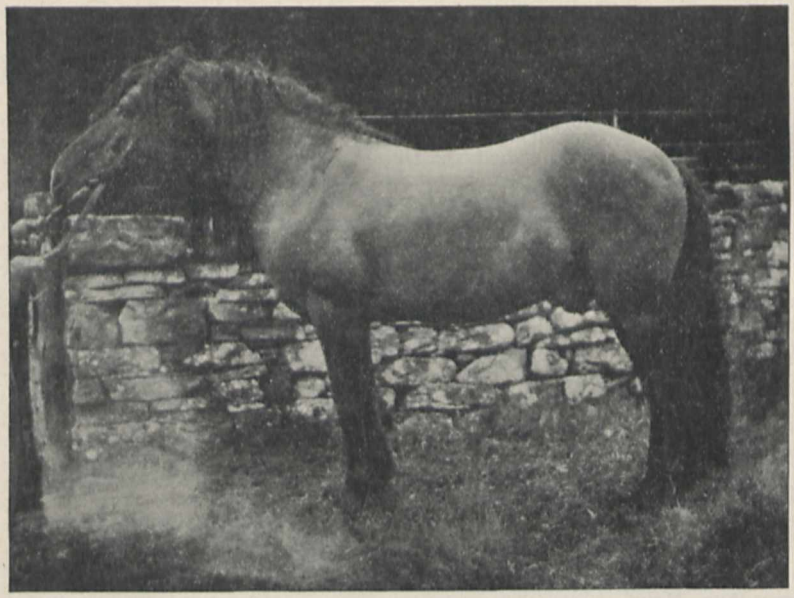
[1] That the Celtic pony is akin to the smaller high-caste Arabs has already been hinted. The only fundamental difference, apart from the coat, mane, and tail, between many small Arabs and a Celtic pony is in the ears: in the Arab they are long and often incurved at the points. The long ears of the Arab may either be due to Eastern blood of the Kattiawar kind or to long ears being an advantage to the wild ancestors that frequented the great Libyan plateau, as long ears are of advantage to the mountain zebra, and to the kangaroo of the Australian bush. About the origin of the large varieties of Arabs provided with ergots, with hind chestnuts like those of Prjevalsky's horse, a somewhat long head, a tendency to a Roman nose, large joints, and a circumference of 7½ to 8 inches below the knee, I am unable to offer an opinion.

eyes to meet under the forelock, differs greatly from the "bumpy" forehead of Prjevalsky's horse and the flat forehead of the Celtic pony. The space between the orbit and the nostril is relatively longer than in the Celtic pony, but shorter than in Prjevalsky's horse. The eyes project beyond the level of the forehead. In the Celtic pony the eyes are large and adapted for a wide range, in the wild horse they are some distance from the front of the head, in the Norse horse they are small and look downwards rather than forwards. The outline of the face becomes convex above the muzzle, and ends in a somewhat long upper lip, adapted, like the upper lip in the giraffe, for feeding on leaves and twigs. In the neck and shoulders, trunk and limbs, the Norse variety may be said to resemble a small cart-horse of the Suffolk type.

Compared with the wild horse, the withers are lower and the hind-quarters more rounded, and the tail springs more abruptly and at a lower level, and hence fails to convey the impression that it is a direct continuation of the trunk. The dock is relatively longer than in the Celtic pony, but shorter than in the wild horse. The limbs are short, but the joints are large and the hoofs fairly broad, hence in a side view of the foreleg a considerable increase is noticed as the thick fetlock joint is reached.

It will be evident from what has been said that the Norse horse differs chiefly from the wild Gobi horse in being of a darker dun colour, in being far more richly striped, in the shape of the head, size of the ears, position of the eyes, and also in the muzzle, mane, tail, hind-quarters, joints, and hoofs. From the Celtic pony the Norse horse also differs in the colour and markings; but it especially differs in the tail and in the greater proportional length of the distance between the eye and the nostril, and in having a complete set of ergots and chestnuts. It is inconceivable that the Norse variety could revert to the Prjevalsky horse type, or be regarded as an offshoot from the Celtic pony.

The question may now be asked, Is there any evidence that the Palæoliths of the south of Europe were familiar with horses of the Norse type? Fig. 7 gives an imperfect idea of a specimen of the Norse race from the west of Ross-shire. If this figure of a horse still living is compared with Fig. 2, which faithfully reproduces an engraving made thousands of years ago in the Combarelles cave by one of the artist-hunters of the Early Stone age, it will, I think, be admitted the Norse horse probably belongs to a very ancient race.



Photograph by G. A. Ewart.

FIG. 7.—A richly striped dark yellow-dun horse of the Norse type, which has a general resemblance to the Combarelles horse reproduced in Fig. 2.

I need only add that I regard the Norse race as the foundation of what in the Highlands are known as garrons. Horses of this type may very well have been originally obtained by blending the old indigenous yellow-dun striped race with Flemish and French breeds imported direct from the Continent or introduced from England during the middle ages. Further, it is extremely probable that the Norse race took part in forming the small active Clydesdales of a former generation.

OTHER OCCIDENTAL HORSES.

In addition to oriental and African varieties, which doubtless include several wild species amongst their ancestors, there are two or more occidental varieties which in various ways differ from the Norse and Celtic races and from Prjevalsky's horse.

One of the latter races include long, low, heavily built animals with unusually long heads, another consists of short-bodied animals with a large head and a pronounced Roman nose.

The long-headed variety which occurs in the Hebrides and the Central Highlands reminds one of the horses engraved during the Stone age on a piece of reindeer horn. In one specimen of this variety met with in Perthshire the profile is straight and the distance from the orbit to the nostril is 13 inches, *i.e.* 2 inches more than in a member of the Norse breed of a like size, and 4 inches longer than in a 14 hands Connemara pony allied to the Celtic race. Some of these long-headed forms with a straight profile and a well moulded muzzle resemble the horses of the Parthenon.

Horses with a pronounced Roman nose also occur in the western islands and Highlands of Scotland, and in Ireland, Austria, America, and other parts of the world into which breeds were introduced from Spain. One of this Roman-nosed type, of a yellow-dun colour, met with in the Outer Hebrides was especially interesting. It very decidedly differed from members of the Norse race in the same district, but, on the other hand, it agreed in the outline of the head with some of the engravings in the Dordogne caves. It is hence conceivable that the Roman-nosed variety (from which the modern Shire breed may be an offshoot) is a very old one—a variety which was firmly established centuries before domesticated breeds first made their appearance in Europe.

SUMMARY.

I have endeavoured to indicate that in post-Glacial as in pre-Glacial times there were several distinct species of horses, and that it is extremely probable some of the prehistoric species and varieties have persisted almost unaltered to the present day. I have shortly described three distinct kinds of living horses, viz. the wild horse of the Gobi desert (*E. c. prjevalskii*); the Celtic pony, which though no longer wild, may be known as the *E. c. celticus*; and the Norse horse, which may very well stand as the type of one of the large occidental breeds, and be known as *E. c. typicus*. I have also pointed out that in addition to these three very distinct types—two at least of which have taken part in forming quite a number of our British breeds—we have a long-headed, heavily built variety with a straight profile, and a long-headed, heavily built variety with a more or less pronounced Roman nose. I have also indicated that in addition to several occidental varieties there are several African and oriental varieties, and I might have added that, in so far as the English thoroughbred is a mixture of African and oriental varieties and of occidental light and heavy varieties, it might be cited as an excellent example of a breed which includes amongst its ancestors several wild species—a breed which has had a multiple origin.

ATMOSPHERIC TIDES.

AN article on atmospheric tides, by Mr. W. Krebs, who is a frequent contributor to the scientific literature of Germany, appears in *Das Weltall*, a Berlin journal of astronomy, of December, 1903. The author points out that the astronomer Mädler demonstrated in 1837 from the Berlin barometer observations the existence of an oscillation of air pressure in the course of a lunar day. The mean range exhibited a minimum pressure in the afternoon and a maximum in the forenoon of that period. This occurrence, which was found by Mädler for the years 1820–1835, was confirmed by Prof. Börnstein with reference to the years 1884–1888, and was also shown to obtain at other German stations. But neither of these physicists ventured to affirm the existence of a tidal movement of the atmosphere in the oscillation which they had discovered.

The hitherto purely statical conception of the oscillations of air-pressure was an obstacle to such a theory. This conception supposed a maximum of pressure to be simply the result of an elevation, and a minimum to be the result of a depression of the barometric column. According to this still prevalent idea, a maximum of pressure must be expected at the time of the upper culmination, and a minimum at the time of the lower culmination of the moon. The former was, however, found to occur at Berlin almost exactly five lunar hours after the upper culmination, and the latter about the same time after the lower culmination. For these reasons Mädler thought it possible "that there was a third way in which the celestial bodies acted upon each other, which was still unknown to us," that is to say, other than by radiation and gravitation.

But the atmospheric oscillation in the course of a lunar day, first discovered by Mädler, appears to be nothing more than a wave caused by gravitation, when it is considered as a transverse oscillation and explained dynamically. The greatest rarefaction of the air occurs about half-way after the lower culmination, corresponding to the greatest uprising movement of the medium. The greatest compression of the air occurs about half-way after the upper culmination, corresponding to the greatest downward movement of the medium. In both cases an attraction of the moon on the lower atmosphere of the earth is presupposed. The third kind of mutual action between the celestial bodies assumed by Mädler accordingly reveals itself, in the case in question, as simply gravitation, when its effect is only considered from the standpoint of the wave theory. When applied to the solar day, the author considers that this view of the matter completes a missing link in the explanation of the double atmospheric oscillation according to Kelvin and Hann.

ON LEAD POISONING AND WATER SUPPLIES.

THE second volume on the above subject has recently been issued by the medical officer of the Local Government Board. The former volume contained information concerning Dr. Houston's study of waters derived from moorland gathering grounds in Lancashire and Yorkshire; the present volume gives details of an extensive series of laboratory experiments bearing on the general subject and conducted by Dr. Houston. They have been published in order to facilitate the interpretation of the results obtained when studying the solvent or erosive power of a water on lead pipes, with the view of counteracting these dangerous qualities. Particular attention is directed to observations on "standards" (p. 443) in this volume, where methods of measuring the solvent and erosive powers of a water upon lead are given enabling an opinion to be formed as to the degree of risk arising from the contact of such water with lead surfaces.

The report is illustrated with drawings of the apparatus employed in the investigations, and photographs have been reproduced to show the actual amount of deposit remaining in the tubes in which the erosion of lead by water had been allowed to take place.

From the nature of this report it will be understood that the substance of it consists of the tabulated results, together with brief descriptions of the experimental methods adopted. The main conclusions arrived at were stated in the previous volume, but a general summary of all conclusions is also given in Section iv. of this volume. A reference to this summary will be found useful to those who are concerned with the consideration of dangers of lead poisoning arising from water supplies.

The summary starts with an explanation of the meaning of the term "erosion," and proceeds to state that bright lead is rapidly eroded by rain and by snow water, as well as by distilled water; then follow the names of substances which do not influence the erosive power of water when introduced into it, as well as of substances which delay and inhibit the action. Moorland waters are next considered in regard to their erosive property, and the conditions which increase, diminish, or prevent their erosion are stated. Then follow waters which do not fall under the above classification, together with remedial measures which may be adopted to avoid danger. A similar classification and consideration of waters as regards plumbo-solvency is then shortly entered into, and, finally, the conclusions arrived at from chemical and bacteriological experiments as to the cause of acidity in moorland water are given. The summary terminates with a selection of conclusions which have already appeared in the former volume. F. C.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. H. H. DIXON has been elected professor of botany at Trinity College, Dublin, in succession to Dr. E. Percival Wright, who has resigned.

THE Princess of Wales opened the new buildings of the St. Paul's Girls' School at Brook Green, London, W., on April 15. Accommodation is provided for a museum, chemical laboratory, and practical physics.

AT the request of the Board of Treasury the following gentlemen have consented to act as a committee to consider the allocation of the proposed increased grant to the university colleges giving education of a university standard in arts and science, viz. the Right Hon. R. B. Haldane, M.P. (chairman), Sir F. Mowatt, G.C.B., I.S.O., Mr. C. A. Cripps, K.C., M.P., the Rev. Dr. Woods, late president of Trinity College, Oxford. Mr. Henry Higgs, of the Treasury, will act as secretary.

AN annual commemoration day was inaugurated at the University of Glasgow on Tuesday. Sir William Ramsay gave a discourse on Joseph Black's life and scientific work; and after the oration several honorary degrees were conferred. At the commemoration banquet on Tuesday evening Mr. Choate, the United States Ambassador, remarked in the course of a speech that the universities had to do their best for the guidance of the councils of the nations to which they belonged.

THE council for the extension of higher education in North Staffordshire has issued its report for 1903. The objects of the council are to stimulate interest in higher education throughout the district, to assist in coordinating institutions and classes for higher and technical instruction, to aid existing institutions by the provision of supplementary and advanced courses of instruction, and to take steps for the establishment of a suitable institution in which to conduct a scheme of higher education for the benefit of the whole district. The report gives, among other information, reasons for the establishment as soon as possible of the proposed North Staffordshire University College, and urges the members of the council to join in the promotion of the scheme.

THE United States consul at Leipzig has, says *Science*, compiled a table of the number of students attending twenty-one German universities during the winter 1903–4. The total number of matriculated students at these universities is 37,854, of whom 3093 are foreigners, the largest number ever recorded. The number of foreign students is equivalent to 8·2 per cent. of the total number. Of other students attending lectures in these universities there are 7874 men and 1313 women, so that the total number of students is 47,041. Noteworthy among other things in the

table is the numerical preeminence of attendance at Berlin, where the total exceeds that of Munich, Leipzig, Bonn and Breslau combined. But 42 per cent. of Berlin's attendance is made up of non-matriculated students, representing a floating element to a considerable extent. Elsewhere in Germany this feature is a minor one in university attendance.

In his presidential address at the annual conference of the National Association of Manual Training Teachers, held at Hastings on April 5, Sir John Cockburn dealt with the psychological importance of manual training. It is now recognised, said Sir John Cockburn, that the hand is one of the best channels to the intelligence, and that in training the hand we minister most effectually to the requirements of intellectual, moral, and physical development. Time in giving intellectual studies would be saved if half the school hours were spent in the workshop. Pupils detect their errors in actual work more readily than in abstract processes, and learn to despise inaccuracy and slovenliness. Nothing so clearly demonstrates the difference between right and wrong as manual training. A lie in wood stands self-exposed. The constructive imagination is strengthened, and invention is stimulated by manual work. Psychologists are agreed that in developing the mind manual training must rank as an indispensable element in all primary and secondary schools.

To celebrate the seventieth birthday of President Eliot, president of Harvard University, the graduates and students of the university have subscribed a thousand pounds for a portrait or bust to be placed in the Union. A very eulogistic letter with ten thousand signatures was presented to President Eliot on his birthday. After enumerating the distinguishing characteristics of his thirty-five years of presidency, the letter continues:—"Through you the American people have begun to see that a university is not a cloister for the recluse, but an expression of all that is best in the nation's thought and character. From Harvard University men go into every part of our national life. To Harvard University come from the common schools, through paths that have been broadened by your work, the youth who have the capacity and the will to profit by her teaching. Your influence is felt in the councils of the teachers and in the education of the youngest child. . . . Fearless, just, and wise, of deep and simple faith, serene in affliction, self-restrained in success, unsuspected by any man of self interest, you command the admiration of all men and the gratitude and loyalty of the sons of Harvard." British men of science will join in the congratulations to President Eliot that he has passed the age of seventy with undiminished power.

At the ordinary meeting of the Society of Arts on April 13, Mr. J. C. Medd read a paper on agricultural education. He said it has now been realised that success in farming demands extensive scientific knowledge quite as much as thorough practical training. The development in the facilities for instruction since 1888 has been remarkable. Figures were quoted to show there had been a total outlay by the Government and by local authorities of nearly 100,000*l.* per annum. Mr. Medd thinks that it is to the evening school that the authorities must look for the improvement of the labourer and the recovery of the skilled or "handy" man. The paper concluded with a scheme to coordinate and place upon a satisfactory basis the rural and agricultural education of every county. Small village schools should be closed and their children conveyed daily to some central school. Better buildings and equipment, more regular attendance, and a more efficient staff would thus be ensured. A few favourably situated schools should be developed upon the model of the *écoles primaires supérieures*. A continuation school should be organised in every village. Winter schools of agriculture and horticulture should be established in selected districts according to the particular requirements and characteristics of each county, and the services of their directors should be made available for all farmers and gardeners during the summer. Demonstration plots should be placed in the charge of men who combined scientific accuracy with some actual knowledge of practical farming, and were in touch with the farmers of the district.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 17.—"Physical Constants at Low Temperatures. (1) The Densities of Solid Oxygen, Nitrogen, Hydrogen, &c." By Prof. James **Dewar**, M.A., LL.D., D.Sc., F.R.S.

The observed densities of solid oxygen and nitrogen, taken at the boiling point of hydrogen, are 1·425 and 1·026 respectively. Similarly the density of solid hydrogen between 13° and 14° absolute was found to be 0·076. From the observations given in the paper, the "Matthias Diameter Line" is deduced in each case, and from these the critical density and molecular volume at the zero of temperature follow. The molecular volume at zero of oxygen is 21·2, of nitrogen 25·5, and of hydrogen 24·2. From these results it follows that if solid water could result from a combination of solid hydrogen and oxygen taking place at the zero of temperature the reaction would involve a volume contraction of 45 per cent. A discussion follows of the critical constants of hydrogen in which the want of agreement between theory and experiment is pointed out. The conclusion reached is that in the case of the constants of hydrogen a marked variation from what in the case of other substances may be regarded as fairly general results must be anticipated, and that further experiments are required to clear up the difficulties.

Linnean Society, April 7.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. E. P. **Stebbing** exhibited lantern-slides of the metamorphoses of *Clania Crameri*, a Psychid moth from the Madras Presidency, showing its use of its food-plant, *Casuarina equisetifolia*, in the making of its protective case.—Mr. F. **Enock** displayed a series of more than fifty slides of natural colour photography of living insects and flowers by the Sanger-Shepherd three-colour process, the president adding a few remarks on the results.—Mr. C. E. **Jones** then gave an abstract of his paper, the morphology and anatomy of the stem of the genus Lycopodium.

Faraday Society, April 13.—Mr. J. Swinburne, vice-president, in the chair.—Alloys of copper and arsenic: Arthur J. **Hiorns**. The object of the author's investigations was to ascertain the exact relation between copper and arsenic in binary alloys, and the limit of proportion of arsenic that can be retained in copper in the cold solid state. The addition of arsenic lowers the melting point of copper uniformly down to about 14 per cent., when a steep fall in the freezing point curve occurs, reaching its lowest point at 685° C. This alloy contains 19·2 per cent. of arsenic, which corresponds to the formula Cu_5As_2. The alloy with 22 per cent. of arsenic freezes at 708°, and the temperature gradually rises until the alloy with 28·34 is reached at 747°. This is the compound Cu_3As. At 810° another chemical compound freezes, having the chemical formula Cu_5As_2; it contains 32·2 per cent. of arsenic. Beyond this point the temperature gradually falls again to a minimum at the alloy with about 35 per cent. of arsenic. The curve then rises to another summit at 740°, forming the compound Cu_2As, with 37·24 per cent. of arsenic. From this position the curve descends to 702° with the alloy containing 41 per cent. of arsenic; this is nearly the practical limit of the direct combination of copper and arsenic.—Experiments with a new primary cell: E. G. P. **Bousfield**. The cell consists of an inner porous pot containing nitric acid and a carbon pole, and an outer vessel containing sodium hydrate solution and a metal pole, preferably zinc, *i.e.* with a solution of from 12 per cent. to 15 per cent.; using solutions of maximum conductivity with zinc and carbon poles on open circuit, an E.M.F. of 2·6 volts may be obtained. Not only does the cell possess this comparatively high E.M.F., but it may be short-circuited far longer than most cells before it runs down. A cell short-circuited through a total resistance of 0·61 ohm gave a current of 4·18 amperes, which fell to 2·61 in an hour, 2·38 in 2¼ hours, and 1·75 in 6 hours. A smaller cell gave a fairly constant current of about 0·8 ampere for 20 or 25 hours. Discharge curves are given in the paper.—Mr. **Bousfield** also contributed a note on determining accurately the percentage of ozone in gases not dissociated by moderate heat.

Mathematical Society, April 14.—Dr. E. W. Hobson, vice-president, in the chair.—Mr. G. B. Mathews communicated a paper by Prof. F. **Morley** on a plane quintic curve. The curve is the locus of the points of contact of tangents from a fixed point to a pencil of cubics. It is of maximum genus (deficiency), viz. 6, and the 45 tangents at points of inflexion pass by nines through 5 points.—Mr. H. M. **Macdonald** gave an account of his recent researches concerning the singularities of functions determined by Taylor's series. Unless special relations hold among the coefficients of the series every point on the circle of convergence is a singularity, and attention has been directed to the problem of determining the coefficients in order that the function may have singularities at prescribed points on the circle only.—The following papers also were communicated:—Note on a system of linear congruences: Rev. J. **Cullen.**—The tile theorem: Dr. W. H. **Young.**—Note in addition to a former paper on conditionally convergent multiple series: G. H. **Hardy.**—On functions generated by linear difference equations of the first order: Rev. E. W. **Barnes.** The simplest solutions of linear difference equations with meromorphic functional coefficients are one-valued functions with sequences of poles tending to infinity. When the coefficients are one-valued functions with essential singularities the solutions generally have sequences of such singularities. These functions cannot in general arise as the integrals of differential equations of any finite order and dimensions with coefficients which are not derived from the function itself. Thus linear difference equations give rise to classes of transcendental functions which cannot be generated by differential equations.—Mathematical analysis of wave-propagation in isotropic space of p dimensions: T. H. **Havelock.** In the case of three dimensions certain methods of integration of the equation of wave-propagation were found by Poisson and Kirchhoff. These are connected with the analytic expression of Huygens's principle. In two dimensions the corresponding integrals are more complicated, and the interpretation of them shows that in general the waves generated at a temporary source have no definite rear surface, but leave a trail behind. Corresponding integrals are obtained in the paper in the case of any number of dimensions, and it is shown that this distinction of properties extends to all cases of uneven and even numbers of dimensions.—On spherical curves, part ii.: H. **Hilton.**—Perpetuant syzygies of degree four: P. W. **Wood.**—Extension of Sylow's theorem: Prof. G. A. **Miller.**—(1) Transformation of the function $F([\alpha][\beta][\gamma]x)$; (2) The extension of Neumann's addition theorem for Bessel functions: Rev. F. H. **Jackson.**—The following informal communications were made:—Behaviour of a power series near a point on the circle of convergence at which the series diverges: Dr. H. F. **Baker.**—Transvectant operators in connection with binary forms: R. J. **Dallas.**—Factorisation of $13^{39}-1$: Lieut.-Colonel A. **Cunningham.** The factors are 4.3; 3.61; 1803647; 53.264031; 577451246626681*; 79.1003.4603.21841, where the semicolons separate the algebraic factors and the colons separate the Aurifeuillian factors. The factor marked with an asterisk has not been resolved.

MANCHESTER.

Literary and Philosophical Society, January 5.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—Note on a method of preparing hydrobromic acid: R. L. **Taylor.**

January 19.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—The specific heats and specific volumes of certain alloys: H. E. **Schmitz.** The calculated and observed values in the cases examined agreed very closely.—On phenomena due to repetitions of stress, and on a new testing machine: F. **Foster.** When a metal is strained by a steady stress, the crystals of which it is composed undergo no change until the elastic limit is passed, but then an internal slipping takes place, which is permanent. The same slipping takes place if a stress much less than the elastic limit is applied and removed repeatedly, and is due probably to hysteresis in the extension of the metal. In order further to study these phenomena, the author has designed a new testing machine capable of subjecting the metal under test to a great variety of conditions.

February 2.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—A diagnostic key for the genera of recent dibranchiate Cephalopoda: Dr. **Hoyle.**

February 16.—Mr. Charles Bailey in the chair.—On a suitable arrangement for determining the capacities of condensers by the successive discharge method: H. **Morris-Airey** and E. D. **Spencer.** The rotating commutator generally employed in this method was replaced by an electrically excited tuning fork, the prongs of which carried aluminium riders making contact in mercury cups. By this means it was possible to obtain perfectly regular discharges at a much bigger rate than is usually possible with rotating commutators.—Note on the spectrum of the glow discharge at atmospheric pressure: Dr. G. A. **Hemsalech.** With an alternating discharge the spark spectrum between metallic terminals is affected by heating them, the glow then being obtainable at either pole.

Special Meeting, February 23.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—The Wilde lecture, on the evolution of matter as revealed by the radio-active elements, was delivered by Mr. F. Soddy (see p. 418).

March 1.—Prof. H. B. Dixon, F.R.S., in the chair.—The ionisation of air: Prof. A. **Schuster,** F.R.S. The author described a method of observation which allowed him to determine the number of ions which are constantly being formed in the atmosphere. All experiments which have hitherto been made only determined the total number of ions present, but not the rate at which they re-combined or formed. Some experiments made in a field near Rochdale on February 28 gave 2400 for the number of ions in each cubic centimetre of air, and a formation of 18 new ones in each second, while on the roof of the physical laboratory at the Owens College on February 29 the numbers were 3600, with a formation of 38 fresh ones each second.

March 15.—Prof. W. Boyd Dawkins, F.R.S., president, in the chair.—The Falkland Islands revisited: Rupert **Vallentin.** The principal zoological, botanical and geological features of the district were described.—Mendel's principles of heredity: A. D. **Darbishire.**—On photochemically active chlorine: D. L. **Chapman.**

PARIS.

Academy of Sciences, April 11.—M. Mascart in the chair.—Theory of the quadrifilar azimuth balance: H. **Poincaré.** An investigation of the equations of sensibility and stability of the quadrifilar balance described by M. Crémieu.—Note on the graphical method applied to human pathology: M. **Lannelongue.** The graphical method, the use of which is described in detail in the paper, can be applied with advantage in a number of cases where photography or radiography would not give the same results.—A new general theorem in the theory of analytical functions: G. **Mittag-Leffler.**—Remarks on the communications of M. A. Charpentier, and the questions of priority to which they have given rise: M. **d'Arsonval.** The results of Charpentier are held to be new, since it is one of the characteristics of the radiations which he has discovered that they are without effect on a photographic plate, whilst the work of others claiming priority in this matter has been mostly carried out by means of photography.—On a particular class of persistent conjugate systems: D. Th. **Egorov.**—On groups of operations: G. A. **Miller.**—On the equations of geometry and the theory of substitutions: Ed. **Maillet.**—A quadrifilar azimuth balance: V. **Crémieu.** A description of an entirely new form of balance, in which the beam is supported by a plunger floating in mercury, and in which the pointer of the ordinary balance is replaced by a system supported by four wires in torsion attached to the beam. The theory of this balance is worked out by M. Poincaré in a previous paper. Instead of using a rider, differences below a centigram are measured by means of the electrodynamic repulsion produced between two bobbins, the current being adjusted by means of a resistance until the point of equilibrium is reached.—On the penetrating power of the n_1-rays emitted by certain sources, and their storage by different substances: Julien **Meyer.** The n_1-rays, discovered by Blondlot, the effects of which are the inverse of the n-rays, are given off by vacuous glass tubes, and possess a greater penetrating power than the similar rays given off by a Nernst lamp. Certain substances appear to possess the power of storing up these rays, aluminium being a notable example, and then emit them for as long as twenty-four hours afterwards.—On the earth-

quake in the Balkans, April 4: Th. **Moureaux.**—Electrical osmosis in methyl alcohol: A. **Baudouin.** The method adopted by M. Perrin in studying electrical osmosis in aqueous solutions has been applied by the author to solutions in methyl alcohol. The effects observed are similar to the case of water, but smaller in magnitude, so that higher differences of potential had to be employed. Osmosis is very sensitive to traces of dissolved materials provided that these are electrolytes. Non-electrolytes, even in comparatively large proportions, are without effect.—On the calculation of the heats of combustion of organic compounds containing nitrogen: P. **Lemoult.** A general formula for calculating the heat of combustion of any compound containing carbon, hydrogen, oxygen, and nitrogen is worked out, and numerous examples are given of the degree of approximation obtained.—On the application of the Blondlot rays to chemistry: Albert **Colson.** By means of the effects on a phosphorescent screen the author has been able to detect differences in the interaction of solutions of potash and zinc sulphate according to the order in which they are mixed, and these differences have been subsequently borne out by their chemical behaviour.—On a new mode of formation of calcium carbide: L. M. **Bullier.** Calcium carbide can be obtained by the electrolysis of a mixture of calcium chloride and lime, but the method has no commercial value.—The estimation of nitrogen: Léon **Débourdeaux.** Methods of estimating nitrogen based on the production of ammonia are all liable to be vitiated by the production of amines, notably methylamine. The method now described, which is based on the dry distillation of the nitrogen compound with a mixture of potassium monosulphide and potassium thiosulphate, gives ammonia free from amines. A list is given of the classes of compounds to which this method is applicable.—The influence of hydriodic acid on the oxidation of sulphurous acid: A. **Berg.** Hydriodic acid may either retard or accelerate the oxidation of sulphurous acid according to its concentration. For a given strength of sulphurous acid, there appears to exist a strength of hydriodic acid which is without influence on the rate of oxidation. Other substances besides hydriodic acid can affect the rate of oxidation.—The chlorination of phenyl carbonate in the presence of iodine: Et. **Barral.**—The action of oxidising agents on the purity of industrial fermentations: Henri **Alliot** and Gilbert **Gimel.** Various oxidising agents were tried with a view to see which exerted the greatest effect in reducing the production of butyric acid during an alcoholic fermentation. Manganese dioxide and bleaching powder gave the best results.—On *Randia Lujae*, a new myrmecophyte and acarophyte of the family Rubiaceæ: E. **de Wildeman.**—On the sense of rotation of water eddies in central Europe: Jean **Brunhes.** In more than 90 per cent. of the vortices observed in the small rapids of central Europe, the sense of rotation was always opposite to that of the hands of a watch.—New researches on the statical work of a muscle: Charles **Henry.**—The specific reinforcement of phosphorescence by extracts of organs in physiological exploration: Augustin **Charpentier.**—Biological observations made at Chamonix and on Mt. Blanc during August and September, 1903: Raoul **Bayeux.** The quantity of oxyhæmoglobin increases in normal blood with the altitude, but, on the contrary, the speed of reduction of the oxyhæmoglobin diminishes with increasing altitude.—The amounts of catalase in different animal tissues: F. **Battelli** and Mlle. L. **Stern.**—On the origin of lactose: Ch. **Porcher.**—The agglutination and hæmolysis of the blood corpuscles by chemical precipitates: M. **Gengou.**—On the yellow spot disease of the cork oak: F. **Bordas.**

DIARY OF SOCIETIES.

THURSDAY, APRIL 21.

ROYAL INSTITUTION, at 5.—Dissociation: Prof. Dewar, F.R.S.

LINNEAN SOCIETY, at 8.—On British Freshwater Rhizopoda: J. Cash.—*Exhibitions*: Drawings by Mrs. C. Reid of Fruits and Seeds of British pre-Glacial and inter-Glacial Plants. II. Calyciflorae: Clement Reid, F.R.S.—Holograph Letter of Linnæus to Haller, dated from Upsala, May 12, 1747: R. Morton Middleton.

INSTITUTION OF CIVIL ENGINEERS, at 8.—"James Forrest" Lecture: Internal Combustion Engines: Dugald Clerk.

INSTITUTION OF MINING AND METALLURGY, at 8.—Adjourned discussion on the Equipment of Laboratories for Advanced Teaching and Research in the Mineral Industries.

FRIDAY, APRIL 22.

ROYAL INSTITUTION, at 9.—Sleeping Sickness in Uganda: Colonel David Bruce, F.R.S.

PHYSICAL SOCIETY, at 5.—Calculation of Colours for Colour Sensetometers and the Illumination of "Three Colour" Photographic Transparencies by Spectrum Colours: Sir W. de W. Abney, F.R.S.—On Normal Pileing as connected with Osborne Reynolds's Theory of the Universe: Prof. J. D. Everett, F.R.S.—Note on the Diffraction Theory of the Microscope as applied to the Case when the Object is in Motion: Dr. R. T. Glazebrook, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—No. 2 River-pier of the Beckton Gasworks: A. Trewby.

MONDAY, APRIL 25.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The German Antarctic Expedition: Dr. Eric von Drygalski.

VICTORIA INSTITUTE, at 4.30.—Old Testament Chronology: F. G. Fleay.

INSTITUTE OF ACTUARIES, at 5.—On Life Premium Book-keeping: J. Chatham.

TUESDAY, APRIL 26.

ROYAL INSTITUTION, at 5.—The Transformation of Animals: Prof. L. C. Miall, F.R.S.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Origin of Jewellery: Prof. W. Ridgeway.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Annual General Meeting.

WEDNESDAY, APRIL 27.

SOCIETY OF ARTS, at 8.—The Need of Duty-Free Spirit: Thomas Tyrer.

GEOLOGICAL SOCIETY, at 8.—On a New Species of Eoscorpius from the Upper Carboniferous Rocks of Lancashire: W. Baldin and W. H. Sutcliffe.—The Genesis of the Gold-Deposits of Barkerville (British Columbia) and the Vicinity: A. J. R. Atkin.

THURSDAY, APRIL 28.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Further Experiments on the Production of Helium from Radium: Sir William Ramsay, K.C.B., F.R.S., and Frederick Soddy.—The Effects of Changes of Temperature on the Modulus of Torsional Rigidity of Metal Wires: Dr. F. Horton.—The Sparking Distance between Electrically Charged Surfaces. Preliminary Note: Dr. P. E. Shaw.—Studies on Enzyme Action. Part II. The Rate of Change Conditioned by Sucroclastic Enzymes, and its Bearing on the Law of Mass Action. Part III. The Influence of the Products of Change on the Rate of Change Conditioned by Sucroclastic Enzymes: Dr. E. F. Armstrong.—Part IV. The Sucroclastic Action of Acids as Contrasted with that of Enzymes: Dr. E. F. Armstrong and R. J. Caldwell.—Enzyme Action as bearing on the Validity of the Ionic-dissociation Hypothesis, and on the Phenomena of Vital Change: Prof. H. E. Armstrong, F.R.S.—On the Changes of Thermoelectric Power produced by Magnetisation, and their Relation to Magnetic Strains: Dr. Shelford Bidwell, F.R.S.—The Behaviour of the Short-period Atmospheric Pressure Variation over the Earth's Surface: Sir Norman Lockyer, K.C.B., F.R.S., and Dr. W. J. S. Lockyer.

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