THURSDAY, AUGUST 22, 1912.

NATURAL HISTORY AND TRAVEL.

(1) *The Horse and its Relatives.* By R. Lydekker, F.R.S. Pp. xii + 286. (London: George Allen and Co., Ltd., 1912.) Price 10*s.* 6*d.* net.

(2) *Das Tierreich.* Im Auftrage der Königl. Preuss. Akademie der Wissenschaften zu Berlin. Herausgegeben von F. E. Schulze. 28 Lieferung. Hymenoptera. Apidæ I.; Megachilinæ. Bearbeitet von Dr. H. Friese. Pp. xxvi + 440. Price 32 marks. 30 Lieferung. Hymenoptera. Ichneumonidea: Evaniidae. Bearbeitet von Prof. J. J. Kieffer. Pp. xix + 431. Price 31 marks. 32 Lieferung. Tunicata. Salpae I.: Desmomyaria. Bearbeitet von Dr. J. E. W. Ihle. Pp. xi + 67. Price 6 marks. (Berlin: R. Friedländer & Sohn, 1911 and 1912.)

(3) *Aus Indiens Dschungeln.* Erlebnisse und Forschungen von Oscar Kauffmann. Vol. i. Pp. v + 192 + plates + map. Vol. ii. Pp. 192–352 + plates + map. Leipzig: Klinkhardt and Biermann, 1911.) Price 20 marks two vols.

(4) *Zoology.* By Prof. J. Graham Kerr, F.R.S. (Dent's Scientific Primers.) Pp. vii + 99. (London: J. M. Dent and Sons, Ltd., n.d.) Price 1*s.* net.

(5) *A Catalogue of the Vertebrate Fauna of Dumfriesshire.* By Hugh S. Gladstone. Pp. xiv + 80 + map. (Dumfries: J. Maxwell and Son, 1912.)

(6) *A Revision of the Ichneumonidae.* Based on the Collection in the British Museum (Natural History). With descriptions of New Genera and Species. Part i. Tribes Ophionides and Metopiides. By Claude Morley. Pp. xi + 88 + map. (London: Printed by order of the Trustees of the British Museum, and sold by Longmans and Co., B. Quaritch, Dulau and Co., Ltd., and at the British Museum (Natural History), Cromwell Road, S.W., 1912.) Price 4*s.*

(1) SO many years have elapsed since the publication of the late Sir William Flower's little work on the horse that the public will welcome Mr. Lydekker's new book on the same subject. There is no other animal which has within the past few years attracted more attention and been the subject of more study, and Mr. Lydekker's book, being not only a popular but a scientifically accurate account of the natural history of the more important representatives of the horse family, ought to fulfil its author's expectation that it will appeal to a large circle of readers. Only the natural aspect of the subject is dealt with, such side issues as the legendary history of the horse, horse-sacrifice, the acquisition and development of the arts of riding and driving, and the training and management of horses, being left untouched. Two interesting conclusions of the author are that the much-discussed "chestnuts" of the legs of the Equidæ are decadent glandular structures, and that the wild Mongolian horse may safely be regarded as the ancestor of many of the domesticated European breeds, though probably not of the Arab. We have not space to follow the author further, but commend his book to the student of a fascinating subject. It is well printed, easy to read, free from misprints (note, however, "haunted" for "hunted" on p. 73), and very usefully illustrated by twenty-four plates and eleven text figures.

(2) The two parts of "Das Tierreich" devoted to sections of the Hymenoptera and one to the Tunicata are admittedly for the use of specialists and of little interest to the general public. In No. 28 Dr. H. Friese treats of the Apidæ, the whole volume being devoted to the sub-family Megachilinæ. No. 30 is from the pen of Prof. J. J. Kieffer, and deals with a single family of Hymenopterous insects, the Evaniidæ. In No. 32 Dr. J. E. W. Ihle treats of the Desmomyaria, a section of the Tunicates. The plan of all three is similar, and the work equally well done, so that they may fitly receive a similar commendation.

(3) In two volumes of, in all, 352 pages, Herr Oscar Kauffmann treats of his experiences during a decade spent in India, including Kashmir, Cochin, and Burmah. The volumes are richly illustrated with a number of excellent photographs. But the fact that they are written in the German language is likely to militate against their popularity in Britain, while the absence of an index must act as a strong deterrent to the serious student who approaches them with a desire for information.

(4) In 99 pages, including the index, Prof. Graham Kerr has managed to give a very clear account of the science of zoology. His method is to take three types, Amœba, Hydra, and the Earthworm, and, after devoting a chapter to each, he passes to consider briefly the main groups of animals, from Protozoa to Vertebrates, the "Fact of Evolution" and the "Method of Evolution," to each of which headings he devotes a further chapter, concluding with the mechanism of "Heredity and Variation." The articles on the three types are clear and concise, and in each of them the author contrives to introduce his readers to certain conceptions or attributes of animals. Amœba, for instance, suggests the conception of the cell and of metabolism; the Hydra symbiosis and parasitism. There are thirteen diagrams and figures, a large proportion of which are used in illustrating the account of the earthworm.

(5) Mr. Gladstone has produced one of the best local faunas that we have seen, although it seems almost a pity that, in order to save space, the Latin technical names are omitted from the index, as are, for the same reason, almost all references to authorities. Another peculiarity of the index is that it includes local and Gaelic names which are not given in the body of the work. Thus the entry, "Briskie (Chaffinch), 20," represents the only appearance of the former word. It is interesting to find that, contrary to the predictions of objectors, writers of local faunas have not been slow to adopt the most recent advances in nomenclature. Thus Mr. Gladstone's list of Dumfriesshire birds includes several sub-species, whilst amongst his mammals are found many of the most newly unearthed genera (such as Nyctalus for the Noctule), for which we are indebted to the laws of priority. He has not, however, ventured into sub-species of mammals, and, indeed, it is difficult to see how a local writer can do so until an authoritative text-book has been issued. It is most useful to find the mammals extinct within prehistoric or historic times included, such as the urus, elk, reindeer, wolf, and brown bear; but by a curious mistake the wild boar is sandwiched between the mountain hare and rabbit. Space does not permit allusions to the amphibia, fishes, and reptiles.

(6) Mr. Claude Morley's small volume on two tribes of Ichneumonidæ is the first of a series, for which, as we are informed by Dr. Harmer, we are indebted to Mr. Morley's having undertaken to bring a very large accumulation of unsorted specimens at the British Museum into order, these, as it appears, not having been arranged since Frederick Smith left them in 1860. The two tribes included in the "Revision" have been selected on account of considerations of an entirely practical nature, and not because their close association is indicated by a study of their respective systematic positions. It is not surprising to find that the author brings forward a somewhat large proportion of apparently new species, with a few additional genera, on the possession of all the types of which the national collections may be congratulated. Many of these have long been awaiting description, Mr. H. W. Bate's rich South American collection made during 1848–1859 affording a particular instance. The book includes one coloured plate by Mr. Rupert Stanton of a British example of the widespread *Ophion luteus*. The descriptions and notes on geographical distribution appear to have been very carefully drawn up, and the author states that he has been able to consult practically all the literature. The volume will be most valuable to students.

CONCERNING HEAT.

(1) *Heat Engines.* By H. A. Garratt. Pp. xii+332. (London: Edward Arnold, n.d.) Price 6*s*.

(2) *Modern Destructor Practice.* By W. F. Goodrich. Pp. xvi+278. (London: C. Griffin and Co., Ltd., 1912.) Price 15*s*. net.

(3) *Barker on Heating: the Theory and Practice of Heating and Ventilation.* By A. H. Barker. Pp. xvi+640+lxxvi. (London: J. F. Phillips and Son, Ltd., 1912.) Price 25*s*. net.

(1) IN this volume Mr. Garratt follows along the paths trodden by most writers of elementary text-books on heat engines, but with considerable discrimination and judgment, which has resulted in a very concise and readable work for the technical student. The difficulties of presenting even elementary thermodynamics to students imperfectly equipped with mathematics are well known to every teacher, and various expedients have to be devised to bridge the gaps left by mathematical shortcomings. The author skips from one equation to another when the connecting link involves a knowledge of the calculus, as, for instance, when deriving the work done by a gas expanding adiabatically. Such omissions are quite justifiable, for the earnest student can make good the hiatus either concurrently or afterwards.

With some exceptions of this kind, the thermodynamic part of the book is very straightforward, and especially the method of dealing with that fugitive quantity "entropy," in which the author steers clear of the hopeless redundancy and mysticism which various writers bring to bear with the worthy object of making things clear. Probably there is no part of the subject of thermodynamics which is at the same time the object of so much pedagogic endeavour and resists the attacks so well. We are glad to find a well-written chapter on the mechanism of reciprocating engines, for a thorough understanding of the fundamental principles of slide valves and motions is the best equipment for the mechanical engineer. The steam turbine is given a chapter to itself, in which the various forms of turbine combining different degrees of the "reaction" and "impulse" types are described with their mechanical details.

The introduction to the theory of the steam turbine through that of the water turbine is not happy, and the student of steam turbines will find it convenient to forget Bernouilli's equation when dealing with an expanding gas. Though the author alludes to the difference, the analogy is so far from complete that it would be better to treat the steam turbine as arising directly from the flow of an expanding gas. The author is well up to

date in his chapter devoted to the internal combustion engine, for he describes that latest, most ingenious, and economical pump due to Mr. Humphrey. This volume should prove very welcome to engineering students. The illustrations are excellent, and numerical exercises with their answers bear upon the principles discussed in each chapter.

(2) Many of those who have not given attention to the subject are still under one of two false impressions concerning destructors and the disposal of city waste. Either it is supposed that a destructor has no other utility than getting rid of the leavings of our streets and houses, or else that the calorific value of refuse is so low that to make electricity out of it would be impossible, or, in fact, to use the heat generated for any other useful purpose. The book before us will tend to dispel such impressions, and the reader will be grateful to Mr. Goodrich for putting together much information concerning the construction, working, and economy of destructors in Great Britain, the Continent, and America. It will be gratifying to English engineers to learn that the author is "able to place on record the proved superiority of the British destructor in many countries." He shows how, one by one, city authorities are abandoning the methods of land and sea dumping, and are adopting some kind of incineration as the best means for disposing of waste. In connection with sewage works, it has been found that, unless the lift is very high, the refuse burnt in a destructor will maintain steam for pumping, and Epsom is cited as a case in point where not only is the sewage of the town dealt with, but that of several large institutions of the London County Council. The tables of costs in connection with electricity works are especially instructive as showing what may be done towards reducing the coal bill by burning refuse. It would perhaps have been better if the analysis of refuse from American cities had been compared with that from English cities, and some deductions drawn therefrom. The descriptions of actual destructors, which occupy the greater part of the volume, show what strides have been made in recent years.

(3) This bulky volume on heating and ventilation should possess some interest to others than those connected with the heating and ventilating trades, but it is so loaded down with empirical formulæ that it requires a nice discrimination on the part of the reader to separate the chaff from the wheat. It might, indeed, be regarded as a treatise on the physics of the subject, though much of the subject-matter, especially the elementary matter at the beginning, might safely be omitted. It is generally superficial, though the author may be excused from this charge on the ground that he has to crowd in such a mass of material. A work of this description should prove advantageous, as so much of our heating and ventilation is done in a haphazard and unscientific manner.

PSYCHOLOGY IN BUSINESS.

Increasing Human Efficiency in Business. A Contribution to the Psychology of Business. By Prof. W. D. Scott. Pp. v+339. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1911.) Price 5*s.* 6*d.* net.

THIS work is a genuine attempt to develop the application of reasoned methods to the organisation of the human element in industry and commerce. The opening chapter, on "The Possibility of Increasing Human Efficiency," sets out with the proposition that the output of work, whether of brain or muscles, by the average individual is very far below the maximum possible; that in most cases the individual would gain in health and happiness if his efficiency were judiciously developed, and that the general gain to the community through this development would be correspondingly great. In the concluding paragraph of this chapter the author says: "In the succeeding chapters will be described specific methods, many of which are employed by individual firms, but which could be used by other business men, to ensure their own efficiency and that of their employees. The experiences of many successful houses will be linked to the laws of psychology to point to the way that will bring about greater results from men." In the eight chapters which follow, "Imitation," "Competition," "Loyalty," "Concentration," "Wages," "Pleasure," "The Love of the Game," and "Relaxation" are treated of as means of increasing human efficiency. The final chapters deal with "The Rate of Improvement of Efficiency," "Practice plus Theory," "Judgment Formation," and "Habit Formation."

The author makes no attempt to define the sense in which he uses the term efficiency. For the most part it appears that he is considering efficiency from the point of view of the business organiser or from that of the type of manufacturer "whose razors *may* be made to shave, but certainly *must* be made to sell." But that other criteria of efficiency are not absent from the author's mind is evident from the outset, for in the first chapter the illustrations of efficiency are often culled from regions of human activity very far removed from commerce and industry. For example, on p. 13 the walk of Mr. Weston, aged 70 years, from New York to San Francisco, at

an average rate of fifty miles a day, is described, while on p. 22 there is a quotation from Charles Darwin, in which he gives a very modest estimate of his own intellectual powers and endowments. Commenting on this estimate the author says:—

"This is presumably an honest statement of fact, and, in addition, it should be remembered that Darwin was always physically weak, that for forty years he was practically an invalid and able to work for only about three hours per day. In these hours he was able to accomplish more, however, than other men of apparently superior ability who were able to work long hours daily for many years. Darwin made the most of his ability and increased his efficiency to its maximum."

The honesty of the author's appreciation of Charles Darwin is transparent, but its intellectual discrimination is not quite so clear.

To experienced leaders, whether in commerce or industry, there may not be much that is new in the ideas which are developed by the author, but there is much that is shrewd and stimulating. As a professor and teacher he has no doubt found that his methods make a useful appeal to the students with whom he has to deal. It will be interesting to see how far these methods will appeal to British teachers and students, and it is to be hoped that this work will be read by many of these.

OUR BOOKSHELF.

The Teaching of Physics for Purposes of General Education. By Prof. C. Riborg Mann. Pp. xxv+304. (New York: The Macmillan Company; London: Macmillan & Co., Ltd., 1912.) 5*s.* 6*d.* net.

THIS book may be described as a skilful compilation of quotations. The first four chapters, which are well written and interesting, trace the rise of the teaching of physics in American high schools to its present unsatisfactory condition, when, if we may trust the author, "all teachers are constantly amazed at the inability of the pupils to apply their pure physics even to the physical problems of their daily life, to say nothing of their inability to think scientifically on any problems outside of physics."

It is maintained, probably correctly, that the more descriptive and objective introductory teaching prescribed thirty years ago was better suited to the purposes of a general education than the methods of premature generalisation into which it seems to have drifted in American schools.

The second part of the book is an irrelevant and almost grotesque attempt to distort history to suit a mistaken and misleading view of the influence of Greek thought on physical science, and is not worth serious attention.

In the third part, under "Hints at Practical Applications," we find Prof. Mann deprecating the use of test-questions that call for an accurate knowledge of the use of scientific terms and definitions, and advocating instead what he calls "vital problems" such as "Why are there door-knobs on doors?" "Why has no one ever found the pot of gold that lies buried at the end of the rainbow?"—"When you come down stairs, do you get back the work done going up? How?" We can scarcely imagine worse advice.

A. M. W.

The Beyond that is Within, and Other Addresses. By Prof. Émile Boutroux. Translated by Jonathan Nield. Pp. xvi+138. (London: Duckworth and Co., 1912.) Price 3*s.* 6*d.* net.

IN the first address, which supplies a title for the book, the author discusses the general question of psychical research "proof," and admirably makes clear that no fact, however strange, can prove the existence of a veritable Beyond; though he admits that there is evidence which seems to imply "a life beyond this life." By "a veritable Beyond" he means a state which has no analogies with our present existence. On the whole he is inclined to rely on intuition—the feeling of the "Inner Beyond"—which the modern doctrine of the subliminal self has again made respectable and reasonable. "The subliminal self may put us in communication, not only with beings like or inferior to ourselves, but with superior existences. . . ."

In the next address, "Morality and Religion," M. Boutroux looks forward to a reconciliation of these combatants. Morality is practical, but Religion supplies the impetus from the feeling-side, and both are necessary.

The last is a short address on the relation of philosophy to the sciences. The author pleads for a philosophy which shall reason on knowledge and on life, without laying down any closed system in the way of science.

A Guide to the Dissection of the Dog. By Dr. O. C. Bradley. Pp. viii+241. (London: Longmans, Green and Co., 1912.) Price 10*s.* 6*d.* net.

CREDIT is due both to the author and the publishers of this work for having removed a serious obstacle to the proper study of the anatomy of the dog. Hitherto in this country veterinary students and others who wished to dissect the dog could find no better guide than the somewhat meagre descriptions contained in the systematic text-books on veterinary anatomy, mainly devoted to the anatomy of the horse. In this respect German students have been more favourably placed since the publication in 1891 of Ellenberger's systematic treatise on the anatomy of the dog, but even that work, excellent as it is, is of little value as a dissection guide. One cannot pay Dr. Bradley's work a higher compliment than to say that it forms a worthy companion to the text-book of Ellenberger. The order in which the different parts of the body are dealt with appears to be convenient, and the text is concise and clear. The illustrations, sixty-nine in number, are good, although many of them are semi-diagrammatic.

Photographic Copyright. By G. E. Brown and A. Mackie. Pp. 89. (London: Henry Greenwood and Co., 1912.) Price 1*s.* net.

ACTS of Parliament are not always intelligible to even the legal mind, and the ordinary person, whose privileges and duties are therein defined, is often much troubled to know what the law really is. Therefore, everyone who makes or has to do with photographs is much indebted to the authors for clearly stating how the matter of copyright stands. They first give on a small page the shortest possible statement of the new Copyright Act, pointing out those parts wherein the new Act differs from the one that preceded it. They then take up just those points upon which anyone reading the Act would like a little more information, and make them clear, often quoting judicial decisions where the interpretation of the Act would otherwise be doubtful. The volume closes with a tabular statement of the copyright laws of other countries, the text of the 1911 Act, the 1862 Act so far as it is not repealed, an excellent index, and a list of the most important copyright cases that have been decided in the Courts.

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.]*

Artificial Daylight.

MAY I supplement the interesting article on the above subject which appeared in NATURE of August 15 by a short note on some work carried out about twelve years ago by Mr. Arthur Dufton and myself? The work had for its primary object the removal of the great difficulty experienced by dyers and other workers in colour, under the extremely variable conditions of illumination which naturally prevail. These conditions are such that during the winter months a few hours only per day are available for the accurate matching of colours, and even in the most favourable circumstances the colour-quality of daylight is continually varying. A standard light, which would render dyers and others independent of atmospheric conditions, was therefore much needed, and the "Dalite" lamp, which was the ultimate outcome of our work, solved the problem in such a satisfactory way that many hundreds are in use in dye-houses, colour-printing works, schools of art, drapery establishments, &c., both in this country and abroad.

For accurate colour work it is, of course, not necessarily sufficient to have available a "white" light. In addition to being devoid of colour, the light must obviously contain all the vibrations of the visible spectrum in properly balanced proportions. The correction of a single radiant which does not yield a complete and continuous spectrum is impossible.

Our work, therefore, consisted in the examination of all available illuminants, the selection of the most suitable, and the elimination from the selected light of those rays which were found to be present in excess.

Some account of the work has been given in papers read before the British Association (Bradford meeting, 1900), the Society of Chemical Industry, and the Society of Dyers and Colourists.

We found that an arc lamp of the enclosed type, burning pure carbons, gave the nearest approximation to the light favoured by colourists, *i.e.* that diffused from a cloudy north sky. An enclosed arc lamp yields light from two sources—the glowing carbons and the arc itself—and by adjusting the length of arc, diameter of carbons, &c., and thoroughly mixing by diffusion the light from these, we arrived at our "raw" light.

This was found to contain an excess of red and violet rays, and a long investigation was then undertaken to find the best means of cutting out this excess. Reflection of the light from white or tinted surfaces was a practical failure on account of the enormous loss in intensity, and eventually direct absorption by suitably tinted screens was adopted. The whole range of coal-tar green and blue colouring matters were examined in the form of dyed gelatine films, and the curious fact emerged that with one exception—naphthol green—all were fairly transparent to red light, and therefore unsuitable for the purpose of absorbing the red, though the absorption of the excess of violet presented no difficulties.

With a suitably adjusted lamp, a solution of sulphate of copper was found to give the necessary absorption in the red, and after numberless expensive failures, a suitable blue copper glass was produced.

In its final form the "Dalite" lamp consists of a carefully adjusted enclosed arc lamp surmounted by a lantern fitted with white diffusion and blue absorption glasses. Provision is not usually made for the absorption of the excess of violet since this is not found to interfere with the accurate matching of hues,[1] but by the introduction of a third glass this is readily provided for.

The Moore light referred to by your contributor, in which the gas in a partially evacuated CO_2 tube is rendered incandescent by an alternating current, emits light containing an excess of green rays, which renders it inaccurate for many hues, *e.g.* pale pinks and blues, but otherwise it is a most suitable illuminant for colour work. WALTER M. GARDNER.

Technical College, Bradford, August 16.

Experimental Illustration of the Reversal of Bright Line Spectra.

THE following way of showing the reversal of the bright line spectrum of metals may be of some interest to lecturers. I have not, so far, seen the method described.

Having scraped a hollow in the lower carbon of an arc lantern (which should be non-automatic), fuse a little iron wire (for example) in the flame, keeping the carbons as far apart as possible. If the usual spectroscopic arrangement is placed in front of the lantern a bright line spectrum of course appears on the screen or in the field of the telescope.

Now by the hand adjustment reduce the distance between the carbons until the point of the upper carbon is practically within the crater. Suddenly the bright lines on the screen "reverse," becoming bright once more as the poles are again separated.

The production of reversal is evidently due to an envelope of relatively cool gases round a *small* arc, the envelope consisting of the outside layers of the gases in the original and much larger arc.

[1] The reasons for this have been thoroughly worked out, but are immaterial to the present purpose.

We have found in this laboratory that a large direct-vision spectroscope is most satisfactory for projection.

When salts are placed in the crater the effect is just as striking as with iron, but naturally more transitory. E. P. HARRISON.

Physical Laboratory, Presidency College, Calcutta, July 18.

Strepsiptera in India.

IN a notice on Dr. W. W. Fowler's recent volume on Coleoptera (Fauna of British India Series), the reviewer makes a statement (*vide* NATURE, May 16, 1912, p. 267) to the effect that "the abnormal Coleoptera, Strepsiptera or Stylopidæ, . . . are not yet proved to be Indian." If, as I gather from the context, by "Indian" is meant "represented in the Indian region," this statement is incorrect. So long ago as 1858 Westwood described *Myrmecolax nietneri*, obtained from a species of ant in Ceylon. W. Dwight Pierce refers to this record in his "Monographic Revision of the Insects comprising the Order Strepsiptera" (Smithsonian Institution, Bulletin 66, p. 88, 1909), and in the same author's "Notes on Insects of the Order Strepsiptera" (Proc. U.S. Nat. Mus., vol. xl., p. 490, 1911) he refers to the same species an insect that I captured at light in the Yatiyantota district of Ceylon. In the same paper (p. 505) he describes a new species—*Pentazoe peradeniyae*—bred by me from the Homopteron—*Thompsoniella arcuata*—at Peradeniya.

Another species, as yet undetermined, is a common parasite of the allied Jassid—*Tettigoniella spectra*. Again, in his useful work, "Indian Insect Life," Lefroy records the occurrence of a species of Xenos in the bodies of the wasp *Polistes hebraeus* in India. I think that these references are sufficient to prove the existence of Strepsiptera in the Indian region.

E. ERNEST GREEN,
Entomologist to the Ceylon Government.
Royal Botanic Gardens, Peradeniya, Ceylon, July 5.

IN reference to Mr. Green's letter, I should perhaps have verified the statement to which he takes exception, but will now merely quote a passage from Dr. Fowler's work concerning the Strepsiptera:—

"They have been found in Europe, North America, Brazil, Africa, and Mauritius, and stylopized bees have been observed in Tasmania and other countries; most probably they are represented in the Indian region." THE REVIEWER.

The Occultation of a Star by Jupiter.

IN reference to the occultation of the star ω Ophiuchi by the planet Jupiter on September 15, I should like to direct attention to the possibility that one or other of the satellites may make a close approach to the star, so that it would be worth while to observe the planet for several hours before and after the occultation itself. Satellite I. will be nearest to the star about 6 p.m. on that date, at which time Jupiter will be favourably situated for observation in Europe and Africa. The second satellite will be in conjunction with the star about 6 a.m. on September 16, and satellite III. about midnight on September 15. The latter is in transit on the evening of that day, and emerges from the disc shortly after the commencement of the occultation. The conjunction of this satellite with the star will therefore be visible in America. Satellite IV. is at this time well to the east of the planet, and its nearest approach to the star, which takes place in the early afternoon of September 15, may therefore be witnessed in India and China.

It is unfortunate that the occultation of this fairly bright star (mag. 4·5) will not be visible in this country. The star disappears behind the planet between 9h. 20m. and 9h. 30m., the time varying slightly in different localities owing to the effect of parallax. Reappearance takes place between 10h. 45m. and 11h. 0m. ARTHUR BURNET.

52 Prospect Terrace, Hunslet Moor, Leeds. August 15.

Boulder Clay in Essex.

WITH your kind permission I should like to supplement the letter which you were good enough to print in NATURE for June 20, 1912.

(1) To the geological formations recognised in the erratics must now be added varieties of Millstone-grit (rather frequent), Marl-slate (as seen at the base of the Magnesian Limestone in Notts), and a highly weathered, roughly cleaved slate, reminding one of the Swithland quarries (Charnwood). A slab of Millstone-grit (32 in. × 28 in. × 8 in.) is the largest erratic observed. A very coarse-grained Oolite (unfossiliferous) has also turned up.

(2) Two miles south of Harlow the limit of the Boulder Clay is reached, and we come upon the London Clay, with frequent Septaria. This occurs at first underlying the "till," and from that point southwards nothing but London Clay is met with.

(3) Several fragments of crystalline rock have now been found, but these have not yet been accurately determined or identified as to their original home.

(4) Mindful of recent speculations as to the antiquity of the Hominid in relation to the great Chalky Boulder Clay of southern England, a keen but futile search has been made for anything of the nature of a human artefact. A. IRVING.

Bishop's Stortford, August 17.

The Prairie Wolf and Antarctic Dog.

IN my book on the distribution and origin of life in America, I stated that an intimate relationship existed between the prairie wolf of North America and the Falkland Island wolf. The reviewer of my book, however, remarks (NATURE, July 25) that this is a complete fallacy. Might I ask whether your reviewer would be good enough to mention the grounds on which he bases his assertion?

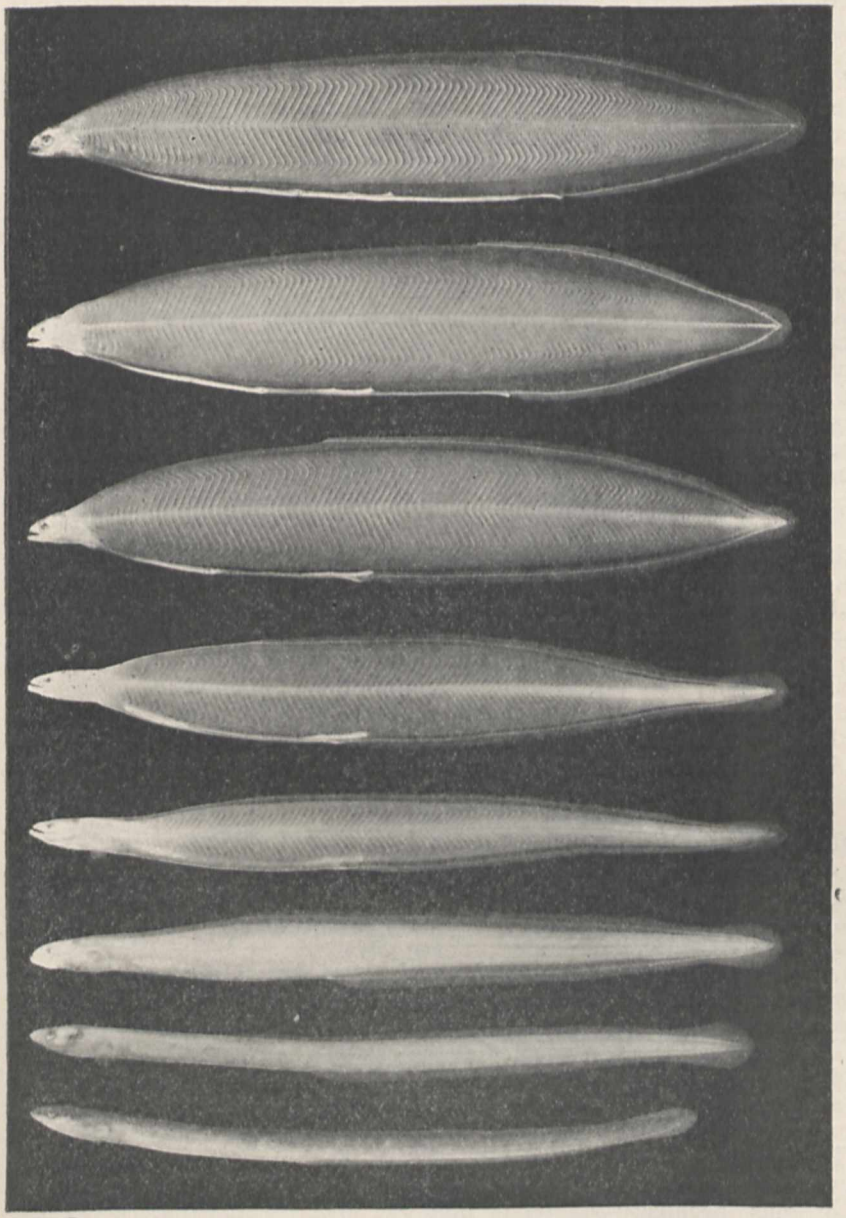
R. F. SCHARFF.

National Museum of Ireland, Kildare Street, Dublin, August 2.

MY reason for speaking as I did about the alleged relationship between the prairie wolf and the Antarctic dog was to prevent the mistake being passed any further into zoological literature, and my assertion that the two species are not closely allied was based partly upon some external features, but mainly upon the characters of the skulls, which show clearly that *C. antarcticus* must be affiliated with some of the Neotropical Canidæ, and *C. latrans* with the wolves and jackals of the northern hemisphere. I will justify this opinion more fully elsewhere. R. I. P.

THE REPRODUCTION AND SPAWNING-PLACES OF THE FRESH-WATER EEL (ANGUILLA VULGARIS).

AMONG the apodal fishes of the British Museum described by Kaup in 1856 was a transparent, tape-like fish of about 8 cm. in length, similar to the uppermost specimen in Fig. 1 here reproduced. This received the name *Leptocephalus brevirostris*, and came from the Straits of Messina, practically the only place in Europe from which Leptocephali were known. Without knowing it, Kaup had given the first contribution to the question of the reproduction of the eel.



[FIG. 1.—Larvæ of the eel (*Leptocephalus brevirostris*) and their metamorphosis to elvers. All figures slightly enlarged.—Johs. Schmidt (1909).

About forty years later we learnt from Grassi and Calandruccio that Kaup's *Lept. brevirostris* was no other than the larval form of the common eel living in the Mediterranean countries, a species supposed by some to be identical with the North European eel. These investigations were carried out at Messina, and left no doubt that the identification was correct. The mysterious problem of the reproduction of the eel was thus, about 1895, for the first time opened up to scientific investigation.

The Italian authors, however, did not stop at the facts observed; they *a* put forward a number of suppositions regarding the reproduction of the eel, occurrence of the eggs, mode of life of the larvæ, etc. Egg "No. 10" of Raffaele, found in the Mediterranean, was supposed to *b* belong to the common eel, the larvæ were imagined to be demersal, deep-water fishes, and Grassi's publication in the Proceedings of the Royal Society of London in 1896 led every- *c* one to believe, as the one thing quite certain in the matter, that the spawning places of the eel are in the depths of the Mediterranean. Recent investiga- *d* tions have not altered the fact that *L. brevirostris* is the larval form of *Anguilla vulgaris*; but the biological conclusions have not proved to be correct.

In 1904 a new light was *e* thrown upon the matter, when the *Thor* obtained a specimen of *Lept. brevi-* *f* *rostris*, 7½ cm. in length, in the surface waters of the Atlantic west of the Faeroes. In the same year *g* a second specimen was taken west of Ireland by the *Helga*. The year 1904 *h* thus marked the beginning of the second stage in the solution of the eel problem; previously no *Lept. brevirostris* had been taken outside the Mediterranean. As Denmark is the country in which the eel fisheries are of the greatest importance, it seemed fitting that the Danish Commission should carry the investigations further, and for this purpose we had the advantage, not only of a sea-going steamer, but also of the most modern apparatus—thanks to the experience and ability of the Director of the Danish Biological

Station, Dr. C. G. Joh. Petersen. How necessary both are can be judged from the sequel.

In 1905 we continued our work in the Atlantic between Iceland and Brittany. The larvæ of the eel were found in quantities, as many as seventy in a single haul, from the Hebrides southwards, but not to the north and not to the east of the 1000 m. line—thus not in the North Sea or Norwegian Sea. I drew the conclusion from this (1906), that *all the eels which occur in the North European countries must come from the Atlantic.* A comparison of all the available data for the time of appearance of the elvers in the rivers of West and North Europe confirmed me in this conclusion.

In 1906, May-June and August-September were devoted to an investigation of the waters between North Spain and South-West Ireland. No younger stages than those of 1905 were found, but it proved that the larvæ were not restricted to the belt between 1000 and 2000 m., where we had found them in 1905. They were taken out over 5000 m., the greatest depths investigated. More than 500 specimens were taken, and a curious thing was that the spring specimens were not yet metamorphosed, whilst those taken in autumn were for the most part in process of transformation. It proved, further, that the youngest specimens (not metamorphosed) occurred furthest out to sea, the oldest metamorphosing nearer the coasts (see Fig. 1).

It was thus perfectly clear that the larvæ of the eel are not demersal fishes, as Grassi and Calandruccio had supposed, but belong to the surface waters, even out over the greatest depths. Nevertheless, we had not yet found the early stages, and I was now (1909) inclined to the belief that the larvæ must be hatched out over great depths, far from the coasts and away from the bottom of the sea. This may be said to mark the end of the second stage in our investigation of the eel problem.

A study of the distribution of the adult eel in the countries bordering on the Atlantic afforded an instructive commentary on our deep-sea investigations. As is shown in Fig. 2, the eel is quite wanting along the coasts of the South Atlantic, and does not even reach down to the equator, whereas it occurs on all the islands of the temperate North Atlantic. From an investigation of a large number of specimens, I found that the European eel (*A. vulgaris*) could always be distinguished from the American eel (*A. rostrata*), from the fact that it has on an average seven more vertebræ than the latter. The eels living on the Azores, for example, were found to be typical *A. vulgaris*. The explanation of this peculiar occurrence seemed to lie in the distribution of temperatures and salinities in the deeper layers of the Atlantic. In the Northern, temperate Atlantic and in the Mediterranean, thus, where the larvæ occur, these have higher values than in the Southern Atlantic. On the supposition, therefore, that the eel requires a high temperature and salinity for spawning purposes, we can explain the absence of eels on the coasts of the South Atlantic; further, the direction of the currents there is such that the larvæ cannot be carried to the South Atlantic coasts (Fig. 2).

The third stage in the solution of the eel problem began with our 1908 investigations in the Mediterranean and adjacent parts of the Atlantic. These investigations extended over both winter (1908–09) and summer (1910), so that all seasons of the year have been considered. The result has been a great surprise to me. Instead of finding here the youngest developmental stages of the eel—and Grassi's publication in the Royal Society's Proceedings of 1896 was certainly responsible for the general belief that the spawning places would be found there—I have been obliged to come to the conclusion that *the eel does not spawn in the Mediterranean at all.* The Mediterranean owes its stock of eels, like the North Sea and Baltic, to the Atlantic. On the other hand, I have found the early developmental stages (eggs or early larvæ) of fourteen other species of eels in the Mediterranean, which means that they must spawn there. This is in so far a distinct advance, for the eggs and early larvæ of these forms could not previously be identified with certainty in any single case.

With regard to the common eel, it is naturally more difficult to prove a negative result, *e.g.* that it does not spawn in the Mediterranean, than a positive one, *e.g.* that *Muraena helena* spawns there. It has been necessary, therefore, to take a number of conditions into consideration, of which the following are the most important. (1) *Large quantities of eel larvae are carried by currents into the Mediterranean from the Atlantic.* This has been proved by investigations on both sides of the Straits of Gibraltar, and I have been able to follow their drift further east. The hydrographical investigations of Dr. J. N. Nielsen from the *Thor* show that the surface waters, in which the eel larvæ live, are moving eastwards from the Straits of Gibraltar the whole year round. The current bottles I have had put out in the neighbourhood of the Straits further show that the rate of flow is at least twelve to eighteen miles in the twenty-four hours, as far east as ca. 11° E.L. at any rate. *These observations prove incontestably that a portion at least of the eel stock of the Mediterranean must come from the Atlantic.*

The same lines of reasoning, by which I showed, in 1906, that the eels of the North Sea and Baltic must come from the Atlantic—and the reasoning and facts have not been controverted—can also be applied to the Mediterranean. The larvæ of the eel were found by the *Thor* over the whole of the western basin (west of Italy), but increasing greatly in numbers towards Gibraltar, where the quantities were greatest. In the eastern basin (east of Italy) no larvæ of the eel were found—compare Italy with the 1000 m. line west of South Ireland. The eel larvæ taken nearest Gibraltar were on an average smaller than those found further east, both by the *Thor* and in the collections I have had made for me at Messina during fourteen months (see Table). Further, at Messina, most larvæ were taken in spring and summer, fewest in winter, and this agrees with the fact

that at Gibraltar most larvæ were taken in winter. With an average rapidity of twelve miles in the day, the currents will carry the larvæ from Gibraltar to Messina in the course of three months.

Larvae of the Eel (Lept. brevirostris). *Distribution compared with Age (from Investigations with the* Thor *and other Danish Vessels).*

Region	Percentage of specimens smaller than 70 m.m.
Atlantic S. of ca. 45° N. and W. of ca. 20° W. ...	100
,, N. of ca. 45° N. and E. of ca. 15° W. ...	ca. 5
Mediterranean W. of 3° W and Straits of Gibraltar	,, 60
,, E. of 3° W.	,, 5
Messina (collections between March 1911–May 1912)	,, 3

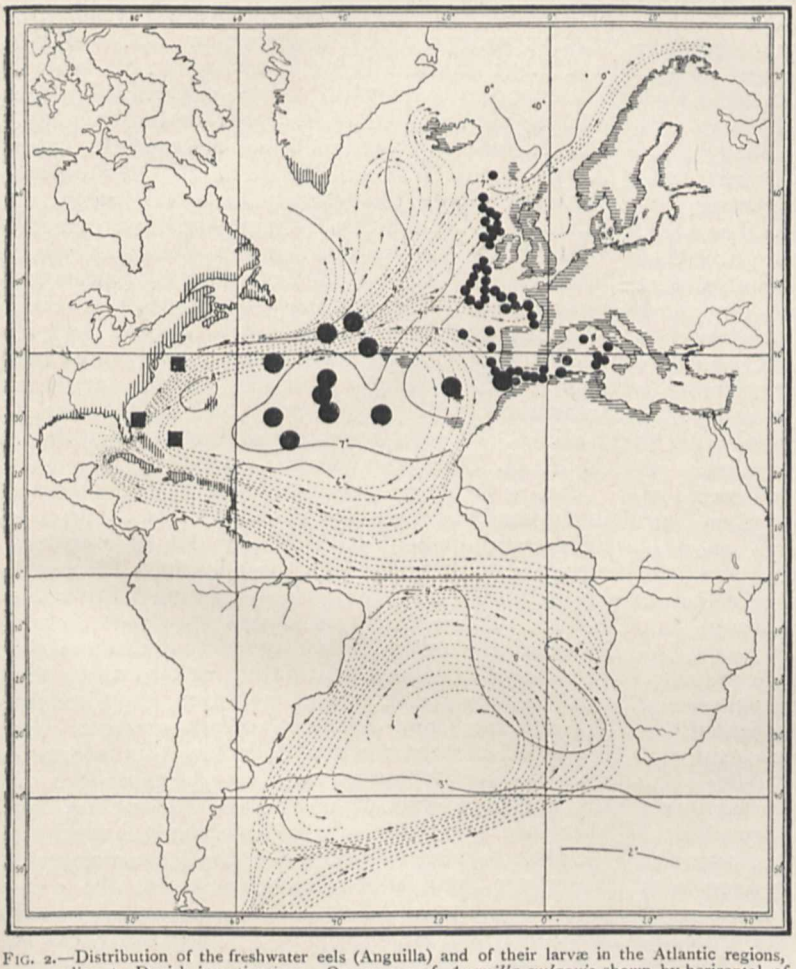


FIG. 2.—Distribution of the freshwater eels (Anguilla) and of their larvæ in the Atlantic regions, according to Danish investigations. Occurrence of *Anguilla vulgaris* shown by horizontal, of *Anguilla rostrata* by vertical, shading of the coasts. ● Younger (3½–6 cm.) and ● older (>6 cm.) larvæ of *Anguilla vulgaris*, ■ larvæ of *Anguilla rostrata* recorded. The unbroken lines indicate the temperature at 1000 m. depth.—Johs. Schmidt (1909 and 1912).

(2) The elver fishing, such as we know in the rivers of West Europe, is in the Mediterranean only carried on in the western basin (West Italy), not further to the east. Just as in North Europe this indicates that the elvers decrease in quantity from west to east, and in the same way we may compare the scarcity or absence of eels in the Black Sea region with the similar condition in the inner Baltic or northernmost Norway. (3) A very extensive investigation has given the result that the North European, South European, and Atlantic eels all belong to the same species. Further, Cand. Strubberg has counted the vertebræ in 2000 specimens from the Atlantic and 1000 from the Mediterranean, and found as average number for the former 114·731, for the latter 114·736, thus complete agreement, and there is nothing to oppose the view that the Mediterranean eels come from the Atlantic. (4) The eel larvæ which I have taken in the Mediterranean measure 60–85 mm., those of Grassi were 60–77 mm. This good agreement, based on a large number of specimens taken throughout the year, shows that the Mediterranean larvæ are older, almost or quite full-grown specimens—a condition very different from what we find far out in the Atlantic, where *all* the larvæ obtained are less than 60 mm. (see Table and Fig. 2).

This positive evidence that the eel larvæ are carried into the Mediterranean from the Atlantic may be supplemented by the negative. In spite of our excellent apparatus and numerous stations at all times of the year, we have never found larvæ or eggs of the eel in the Mediterranean. Nor have other investigators found them; the eggs and larvæ which Grassi (latest in 1910) referred with much doubt to the eel belong to other species, as I have been able to show in my detailed work which has just been published.

Altogether, the result is that *the stock of eels in the Mediterranean comes from the Atlantic.* Just as from the North Sea, Baltic, and northern Norway, the maturing eels must migrate out of the Mediterranean—even from its most eastern parts—to spawn in the Atlantic, and thereafter probably die. We cannot say as yet where exactly the spawning takes place, and but little more than that *the spawning places must lie in the Atlantic beyond the Continental Slope, and that they must be in the Northern Atlantic.*

Confirmation of this conclusion has been obtained from two different sides. On a cruise over the Atlantic in 1910 with the *Michael Sars,* Dr. Hjort has taken twenty-one eel larvæ south of the Azores, the majority of which were 1, a few even 2 cm. smaller than the smallest I had found west of Europe in 1905–6. This was a most important discovery. Further, surface collections made by Danish vessels crossing the Atlantic, both fifty years ago and recently, have yielded a large material of these young larvæ. Our captures are shown on the chart, Fig. 2, from which it will be seen that *larvae of the genus Anguilla occur across the*

whole of the North Atlantic between ca. 25° and ca. 45° N.L. Of these the specimens from west of ca. 20° W. were the smallest in size, namely, 3½–6 cm.

To make quite certain of the forms we were dealing with, it has been necessary to examine thousands of eels, not only from the continents, but also from all the Atlantic islands where the eel occurs (Iceland, Faeroes, Madeira, Canaries, Azores, Bermudas, and the West Indies). The result is also shown on Fig. 2. There are *only two species of eel in the North Atlantic region,* an eastern (*A. vulgaris*), which has its western limit at the Azores, and a western (*A. rostrata*). A further result has been that the stocks are practically unmixed, each being restricted to its own region. On counting the vertebræ (myomeres) in our larvæ from the Atlantic, we were now able to prove that only the larvæ taken west of the Bermudas belonged to *A. rostrata,* whilst larvæ of *A. vulgaris* were found in large quantities as far west as 53° W.L.—though, as mentioned, the western limit of the adult is at the Azores, ca. 30° W. The larvæ may even occur further west.

The question is, now, whether we can prove that the smaller larvæ (3½–6 cm.) from the central part of the Atlantic are the product of the main stock of *A. vulgaris,* which lives on the European continent. It might be thought, for example, that the larvæ found near the Azores come from the stock living on those islands; but, fortunately, we have now obtained from the Gulf Stream south of Newfoundland, 53° W., such a large number of half-grown larvæ that the quantity alone seems to exclude the possibility that they can spring from the inconsiderable stocks on the Azores or other Atlantic islands. The distance from Europe of the place in the Gulf Stream where they were found, is ca. 2000 miles, but there can be no doubt that they traverse this distance with the currents, for we have found the intermediate stages on the way, and another species, *Synaphobranchus pinnatus,* whose full-grown larvæ are found in quantities west of Europe in company with those of the eel, has the same distribution.

We see from the Chart and Table how the larvæ of *A. vulgaris* are distributed in a very characteristic manner according to age or size, over the whole of an enormous area, by comparison with which the distances in the Mediterranean seem small. We have not yet attained to the full solution of the exceedingly difficult eel problem, but the steady progress of the last twenty years is full of promise for the future. We cannot say exactly where the eel spawns, though the Sargasso Sea is perhaps a principal spawning region, but continued collections and investigation of the currents will assuredly lead to the discovery of the eggs and earliest larvæ, perhaps not in deep water, as Grassi imagined, but nearer to the surface. There is even perhaps reason to believe that the eel spawns in the intermediate layers and not on the bottom. Altogether, the whole story of the eel and its spawning has come to read almost like a romance, wherein reality has far exceeded the dreams of phantasy. JOHS. SCHMIDT.

THE FIFTH INTERNATIONAL CONGRESS OF MATHEMATICIANS.

THE International Congress of Mathematicians, which meets in Cambridge on August 22, is the fifth of a series inaugurated at Zürich in 1897 and continued in Paris, 1900, Heidelberg, 1904, and Rome, 1908. The inviting body is the Cambridge Philosophical Society, and the project of receiving the fifth Congress at Cambridge has been well supported, not only by Cambridge men, resident and non-resident, but also by others, in Oxford and in the country generally, who are interested in the progress of mathematics.

The congress is organised in four sections, devoted respectively to analysis, geometry, applied mathematics, and philosophical, historical, and didactical questions. The Section of Applied Mathematics is divided into two departments, one dealing with mathematical physics and astronomy, and the other with economics and statistics. Each section appoints its own chairman from day to day, the chairman for the first day being chosen by an international committee from among those persons who, in the preparation for the congress, have been charged with the duty of collecting papers for the sections. The sections also appoint their own secretaries. The work of preparation has been in the hands of an organising committee, presided over by Sir George Darwin, and having as treasurer Sir Joseph Larmor, and as secretaries Prof. E. W. Hobson, of Cambridge, and Prof. A. E. H. Love, of Oxford.

Owing to the great interest which is now taken in the study of improved methods of teaching, the department dealing with didactical questions has attracted to the congress many adherents interested in questions concerning the teaching of mathematics. Associated with this department is an international commission appointed at Rome four years ago to collect information in regard to the methods pursued in various countries, and to study the directions and effects of recent changes. In Great Britain the work of collecting this information has been done by an advisory committee of the Board of Education, and the information has been incorporated in a series of reports issued by the Board and now collected in two large volumes. These are intended for presentation to the congress, and similar reports have been compiled with the same view in Germany and the other countries.

In addition to the sectional meetings of the congress, there will be plenary sessions, at which lectures will be delivered, as follows:—"Boundary problems in one dimension," by Prof. M. Bôcher, of Harvard; "Définition et domaine d'existence des fonctions monogènes uniformes," by Prof. E. Borel, of Paris; "Periodicity in the solar system," by Prof. E. W. Brown, of Yale; "Il significato della critica dei principii nello sviluppo delle matematiche," by Prof. F. Enriques, of Bologna; "The principles of instrumental seismology," by Prince B. Galitzin, of St. Petersburg; "Gelöste und ungelöste Probleme aus der Theorie der Primzahlverteilung und der Riemannschen Zeta-

funktion," by Prof. E. Landau, of Göttingen; "The dynamics of radiation," by Sir J. Larmor; "The place of mathematics in engineering practice," by Sir W. H. White. The formal opening meeting is to take place this morning, and the formal concluding meeting on the evening of August 27.

Besides the lectures and sectional meetings there will be many opportunities for social intercourse afforded by evening receptions, afternoon parties, and excursions. On the evening of Wednesday, August 21, the members of the congress were received in the Combination Room and Hall of St. John's College by Sir George Darwin, President of the Cambridge Philosophical Society, and Mr. R. F. Scott, Vice-Chancellor of the University. On the evening of Friday, August 23, they will be received at the Fitzwilliam Museum by Lord Rayleigh, the Chancellor of the University. On Sunday afternoon, August 25, the organising committee will receive the members in the gardens of Christ's College, and in the evening an organ recital will be given in King's College Chapel; also on Monday evening, August 26, there will be a reception in Trinity College by the master and fellows. Facilities will be given for visits to the works of the Cambridge Scientific Instrument-making Company, visitors to which will be entertained by Mrs. Horace Darwin, and to the University Observatory, visitors to which will be entertained by Mrs. Newall. An excursion has been organised to Ely on the Monday afternoon, and for the day after the concluding meeting visits are arranged to Oxford and Hatfield. A committee of ladies, under the presidency of Lady Darwin, has issued a very complete and varied programme of visits to objects of interest in Cambridge for those ladies who accompany members of the congress and may not wish to attend the sectional meetings.

A large concourse is expected, more than 600 persons having already joined or indicated their intention of joining. There are large representations from practically all the countries of Europe, the United States, the British Dominions beyond the seas, Japan, Mexico, and various States of South America. The assembly will thus be truly cosmopolitan, and it is to be hoped that it may prove not less fruitful than the previous assemblies in other countries.

ILLUSTRATIONS OF BRITISH BIRDS.

THE first part of Mr. Stonham's beautiful work on British Birds [1] was noticed in these pages on its appearance, and the book has now been completed in twenty parts, forming five handsome volumes printed on pure rag paper, which is not liable to decay or to become discoloured. The beautiful drawings, remarkable for their softness and delicacy, go a long way, at all events, to justify the publishers' claim in the prospectus of the work that they are far superior to anything of the kind yet produced in this country. As a rule, the adult male only of each species is figured, but when the sexes differ in any appreciable degree separate drawings are given. Further, there are additional plates of those nestlings and young birds (as, for example, some waders and gulls) the appearance and plumage of which call for especial illustration, and some winter plumages are given.

The same plan is followed in regard to any particular points of plumage, such as the outspread wing or tail, which the ordinary drawing does not show. Black and white illustration naturally lends itself with most success to those species which have sharply contrasted colours, but it is only in the case of some of those birds which have a large amount of bright chestnut or rufous in their plumage that we have noticed a failure to represent the colour effect adequately. For instance, the knot in summer (Pl. 253) is surely much too light-coloured, and gives little indication of the deep reddish chestnut underparts. The same may be said of the bar-tailed godwit in summer dress. Representing the partridge with the crown of its head of a plain pale colour may have been due possibly to some similar cause. One might, of course, criticise in some other cases minor items from the point of view of the scientific ornithologist, but on the whole there is nothing but high praise for the drawings, and they will entirely satisfy those to whom the work will mainly appeal, viz. the lover of birds, to whom, as to the author himself, they have long afforded so much pleasure and recreation.

It would be invidious to point to any plates especially remarkable for their beauty, but all bird-lovers, according to their individual taste, will surely, as we have done, find some which will be to them a joy for ever. But there are some of especial interest and value. Among these may be mentioned that of five ruffs in their varied liveries, and the remarkable attitudes assumed by them when on the "hill," and the downy nestling of the bar-tailed godwit, drawn from the specimen obtained by Mr. Popham on the Yenesei. Moreover, visitors to the Zoological Gardens in London in 1907 will be deeply grateful to the artist for preserving the pretty and interesting scene of the avocet nestling her young one in her own peculiar manner.

Though the letterpress is necessarily largely a compilation, the author has had very considerable experience as a field observer, and his personal observations will be read with great interest, not the less because the personal experiences of one field ornithologist so often differ a little from those of another; we cannot have too many of these original remarks, for herein lies much of the charm of the study. Here, for instance—to refer to one little thing only—we find that the clutch of eggs of the corn and yellow buntings is said to number from four to six; yet other observers (whose experience was perhaps gained in a different part of the country) we know would put the usual number at three or four only. The descriptions of the

[1] "The Birds of the British Islands." By Charles Stonham, C.M.G. With illustrations by Lilian M. Medland. In 20 parts. (London: Grant Richards, Ltd., Carlton Street, 1906–1911). Price 7s. 6d. net each part.

plumage, although short, have been carefully drawn up and are clearly expressed, but it is not correct to say that in young greater spotted woodpeckers the "entire head is crimson," though the entire crown of the head is so. Possibly it was a slip of the pen that produced Royston's instead of Royston crow.

An important feature of the book is the bibliography—a list of books relating to British birds, brought down to 1900. This valuable piece of work has been compiled by Mr. W. H. Mullens for the use of those who may desire to gain some general knowledge of the work which has been done in British ornithology in the past. The final parts contain a full addenda and corrigenda to the account of rare and accidental visitors given at the end of each family, bringing the records up to date; a glossary of synonyms and provincial names of British birds, scientific and English indices, a short preface to the final volume, and the list of subscribers.

DR. H. O. JONES, F.R.S.

ON Thursday, August 15, Mr. Humphrey Owen Jones, F.R.S., with his wife and a guide, met with a tragic death in an accident on the Alps, in the neighbourhood of Courmayeur, where Mr. and Mrs. Jones were spending part of their honeymoon. They were ascending the western face of the Mont Rouge de Peuteret, and were struck by a falling rock, which had become dislodged. They fell about a thousand feet to the Fresnay Glacier. It was in an attempt to make the first ascent of a peak in the same range, the Aiguille Blanche de Peuteret, that Prof. F. M. Balfour was killed in 1882.

Mr. Jones was born on February 20, 1878, and was educated at the University College, Aberystwyth, and at Clare College, Cambridge. He was one of the first graduates in science of the University of Wales. He graduated at Cambridge in 1900, obtaining the rare distinction of a "star" in chemistry in part ii. of the natural science tripos. He was admitted to the D.Sc. of the University of London in 1904. In 1902 he was appointed Jacksonian Demonstrator, a post which he held to the present time, and subsequently he became a fellow and lecturer of Clare College, Cambridge. In the present year, at the early age of thirty-four, he was elected a fellow of the Royal Society.

Mr. Jones was a man of remarkable energy and a born teacher. A peculiar quickness of perception enabled him immediately to understand and meet the difficulties of students. His lectures and his laboratory teaching, both to undergraduates and to postgraduates, were a feature of the university chemical laboratory. He was greatly interested in estimating the abilities and particular facilities of students. This characteristic made him an excellent examiner, an office which he was frequently called upon to fill, both in his own university and elsewhere. His original investigations and contributions to knowledge were numerous and many-sided. As early as 1904 he was recognised as an authority on the stereochemistry of nitrogen, on which subject he wrote a detailed critical report for the British Association, and subsequently the chapter in the annual reports of the Chemical Society. With Sir James Dewar, he investigated metallic carbonyls, and discovered carbon monosulphide. More recently he had been engaged on researches on thiooxalates, and on the intricate problem of the constitution of aldol bases.

Mr. Jones also took a very active part in affairs not purely professional. He was a co-opted member of the Cambridge Appointments Board, where his power of discriminating between candidates was of particular value, and, with others, he directed the building of the recent extension to the chemical laboratory at Cambridge. His appointment to the Royal Commission to report on the use of oil fuel in the Navy, which is just announced, would have given scope to his ability in practical problems.

It is perhaps as a mountaineer that Mr. Jones will be best known to a wide circle of friends. Finding out almost accidentally, during a visit to North Wales seven years ago, his exceptional facilities as a rock climber, he set himself to learn, with characteristic energy and directness, the highest practice of the art from the best exponents. He rapidly acquired a minute knowledge of the Italian side of Mont Blanc, and was the originator of several new routes. Soon becoming recognised as a skilful cragsman and experienced mountaineer, he was elected a member of the Alpine Club in 1909, and was a member of the committee of the Climbers' Club.

He married, on August 1, Muriel Gwendolen Edwards, the second daughter of the Rev. William Edwards, of Bangor, a member of the Edwards family to which the Bishop of St. Asaph and the late Dean of Bangor belong. Mrs. Jones was also a chemist; she was a member of Newnham College, Cambridge, and was the first woman to be elected a fellow of the University of Wales.

K. J. P. O.

PROF. F. A. FOREL.

M. FRANÇOIS ALPHONSE FOREL, of Morges, honorary professor of the University of Lausanne, who died on August 7 at seventy-one years of age, was born at Morges, on the shores of Lake Geneva, and devoted his life to the study of the lake, fostered in his studies by his father, Président François Forel, of Morges. "Pour nous, ses riverains," he writes, "le Léman est le roi des lacs; nous l'aimons avec enthousiasme, avec passion"; and from 1868 onwards there flowed from his pen memoir after memoir dealing with "le Léman" in all its varying aspects. There is no department of limnology that he did not enrich by his researches, and he may fairly be considered the founder and chief exponent of the scientific study of lakes.

Forel's activity as an author was great. In

the bibliography of limnography, published in the Scottish Lake Survey Reports, about four pages are taken up by references to his work, and his output is more than double that of any other writer. His work was always marked with a clearness of thought and insight, while a love of his subject glowed in every page.

Forel's monograph on "le Léman," which appeared in three volumes from 1892 to 1904, is a model for all limnologists to follow in whatever branch of their science they are concerned, be it as physicist, chemist, zoologist, botanist, archæologist, historian, or economist, while his small "Handbuch der Seenkunde" (1900), which is an admirable introduction to the study of lakes, shows that, in spite of the minuteness of his study of Lake Geneva, he maintained a clear idea of the fundamental points of his subject.

The late Prof. Chrystal called Forel "the Faraday of seiches," and while he ranged over so many sciences, his chief claim to be remembered is that he was the first to explain the nature of seiches or the oscillatory movements which occur in all lakes. He first of all established, by means of portable limnographs, the fact that when the water was rising in level at one end of the lake, it was usually falling at the other, and only two years later, in 1875, he published his theory that the seiches were really standing waves. Considering the data at his disposal, the formulation of his theory was a brilliant piece of work. He himself was content that his reputation should rest on this. He narrates how, in 1875, as he sat for hours motionless at the side of the lake at Romanshorn, watching one of his instruments, he was accosted by a schoolmaster, to whom he endeavoured to explain his theories, but only at the end to be met with the question, so often asked, "Zu was nützt das?" Forel adds with pride :—

Il est vrai que j'ai consacré à ces recherches bien des heures, bien des journées, bien des années de ma vie. Mais j'avoue que, dans mon for intérieur, je ne me suis jamais senti humilié d'avoir dépensé autant de cette denrée précieuse entre toutes, le temps qui s'écoule et ne revient pas, à un thème sans utilité immédiate et pratique. . . . Quand nous aurons trouvé une confirmation de quelques données de la théorie pure par l'observation directe d'oscillations qui mettent en mouvement de balancement aussi bien la masse énorme des 89 milliards de mètres du Léman, que les quelques litres d'eau de nos auges d'expérimentation, n'aurons-nous pas là une vérification précieuse. . . . Mon cher inconnu de Romanshorn, à ta question : "Wozu nützt es?" je réponds : "Es nützt doch etwas."

When the investigations of the Scottish Lake Survey extended his theory to temperature seiches, no one was more interested in the results than Forel, and he endeavoured to make observations himself to corroborate the Scottish work, but the attempt brought back some trouble in his hands which had caused him to give up actual observational work twenty years earlier.

In 1910 Forel was elected an honorary fellow of the Royal Society of Edinburgh, and when attending the International Seismological Congress at Manchester last year, he delivered an address at Edinburgh on refractions at the surface of a lake, mirages, and Fata morgana. He was unable, owing to ill-health, to accept a former invitation to this country, and it is a satisfaction to his friends here, who were attracted as much by his charming amiable manner and his great courtesy as by his work, that he should have made that visit before the end came.

NOTES.

We regret to announce the death, on August 15, of Dr. John Wade from injuries received in a motor-cycling accident on July 28. Dr. Wade, who was only forty-eight years of age, was lecturer on chemistry at the Guy's Hospital Medical School, and in that post he was very successful, both in his teaching and organising capacities. He had only recently occupied the new chemical laboratories in that school, the design of which had given him much pleasure. Dr. Wade possessed an original and energetic personality, which found expression in his lectures, his text-book on organic chemistry, and his contributions to the Transactions of the Chemical Society. As a graduate and member of Senate of the University of London Dr. Wade held strong views on the necessity for an external side to the university, and maintained his convictions with great ability and energy. In the field of pure chemistry his most important work was on the constitution of the metallic cyanides, the formation of esters, and studies in fractional distillation under varying pressures. In connection with the latter, he showed, in 1905, that the physiological differences known to exist between chloroform prepared from acetone and from ethyl alcohol were accompanied by chemical differences, ethyl chloride being absent in the former and present in the latter. In applied chemistry he carried out, at the request of the Local Government Board (partly in collaboration with Dr. Haldane and partly alone), a lengthy series of experiments on the disinfection of ships, and these reports form the basis of the current practice of port authorities in Great Britain and elsewhere. He was engaged at the time of his death upon another investigation for the Local Government Board upon the products of combustion of coal gas in rooms.

Mr. John Franklin-Adams, whose death on August 13 we greatly regret to record, was an enthusiastic worker for astronomical science. He began photographic delineation of the Milky Way about 1898, at Machrihanish, Argyllshire, and this developed into the more ambitious scheme of charting the whole heavens, northern and southern. His celebrated Photographic Chart of the Heavens was commenced (with a 10-in. Cooke lens) at the Cape of Good Hope in 1903, for the southern stars; and completed, for the northern stars, at Mervel Hill, Surrey, between 1904 and 1909. It was found necessary to give an exposure of 2h. 20m. in this climate, to equal 2h. in the clear skies of South Africa. Each plate was 15 in. square, and covered $15° \times 15°$, the entire heavens, down to stars of 15th magnitude, being included in 206 plates. Owing to great improvements

in plate manufacture, it was decided to repeat the southern stars. This was done in 1910 at Johannesburg, the instrument being afterwards presented to the Transvaal Government Observatory. Besides this, there was another equatorial, carrying an 8-in. Wray O.G., and a 6-in. Cooke triplet, with which some fine solar pictures were taken. In his earlier years Mr. Franklin-Adams had taken part in several eclipse expeditions, and secured some good corona photographs. He was elected a fellow of the Royal Astronomical Society in 1897. Owing to protracted illness, he felt unable to carry out his intention of publishing his chart plates, and these were transferred to Greenwich Observatory in July, 1911.

THE death is reported, in his seventy-fifth year, of Prof. Eugene Lamb Richards, professor emeritus of mathematics at Yale. His whole academic career had been spent at that university. Having graduated there in 1860, he was appointed a tutor in 1868, and was promoted to an assistant professorship in 1871, and to a full professorship in 1891. He resigned his chair in 1906. His best-known books were his "Plane and Spherical Trigonometry" and his "Elementary Navigation and Nautical Astronomy."

THE twenty-third annual general meeting of the members of the Institution of Mining Engineers will be held at Birmingham, on Wednesday, September 11, in the Lecture Theatre of the University of Birmingham, Edmund Street, Birmingham. The members will be welcomed to the city by the Lord Mayor of Birmingham (Alderman W. H. Bowater). A reception of the members and their lady friends by the Lord Mayor of Birmingham and Mrs. Bowater will be held at the Council House, Birmingham, on the evening of Wednesday, September 11.

IN May of last year the Home Office announced a competition for a prize of 1000*l.* for the best electric lamp suitable for miners. The prize money was provided by a colliery owner, and the competition was open to persons of any nationality, conditions being laid down that the lamp must be safe, efficient, convenient, and durable, as well as economical in first cost and in use. The first prize has now been awarded to the C.E.A.G. lamp sent in by Mr. F. Farber, Beurhausstrasse 3, Dortmund, Germany, who will receive 600*l.*; and sums of 50*l.* each have been apportioned to eight other competitors, whose lamps were found by the judges to "possess considerable merits."

THE Geologists' Association has made arrangements for a long excursion to the east coast of Scotland from September 12 to September 19. The directors on this occasion will be Mr. G. Barrow, Dr. R. Campbell, and Dr. G. Hickling. The excursion secretary is Miss G. M. Bauer, 16 Selborne Road, Handsworth Wood, Birmingham. Members of the British Association, which meets at Dundee on September 4–11, are invited to take part in the excursion. The programme issued gives particulars of special railway and boat arrangements for travelling from London to Aberdeen, which will be the headquarters of the party. During the excursion an opportunity will be given of seeing the interesting coast section near Aberdeen.

TOWARDS the end of July the crater of Etna showed signs of renewed activity. On July 30 a column of vapour, with ashes and lapilli, rose from the new mouth formed on the north-east side of the central crater on May 28, 1911. This was followed by another outburst on August 3 at 6 p.m., and by a still more pronounced eruption on the following day. At 10.46 a.m. on August 4 a great column of vapour rose from the same vent to a height of 10 km., and then drifted off to the south-east, covering the south-east flank of the volcano with ashes as far as Canizzaro. Shortly before this, from July 28 to 31, increased activity also prevailed in Stromboli, where there were strong shocks, loud rumbling noises, and considerable eruptions of vapour and incandescent material.

THE summary of the weather for the week ending August 17 issued by the Meteorological Office shows that the temperature was again below the mean over the entire kingdom. The greatest deficiency was 6·0° in the south-east of England, while it was almost equally as large in several other districts, amounting to 5·7° in the Midland counties, 5·4° in the south-west of England, 5·0° in the Channel Islands, and 4·7° in the east of England. The north-east of England was the only district in which the thermometer rose to 70°, the highest temperature in the south-east of England being 66°. In the corresponding week last year the thermometer registered 91° at Greenwich, and it rose to 90° or above in all the English districts. The rainfall varied considerably in different parts of the kingdom, and it was below the average in several districts; as much as 2·2 in. fell at Jersey on August 12, and 1·1 in. at Plymouth and Salcombe on August 17. The bright sunshine was again much below the average. In most districts the mean daily duration was less than 2½ hours, and in the Midland counties, the south-east of England, and in the north and east of Scotland it was less than 2 hours. The mean temperature of the sea is in some districts as much as 6° colder than last year.

IN *The National Geographic Magazine* for February, Miss E. R. Scidmore, under the title of "Adam's Second Eden," supplies a valuable account of Ceylon, illustrated with perhaps the finest collection of photographs of the people, monuments, scenery, and productions which has ever been brought together. This is followed by an elaborate account of the pearl industry, prepared by Mr. H. M. Smith, United States Deputy Commissioner of Fisheries. The great bulk of the pearls, he states, is the result of the entry of animal parasites which normally pass a part of their life-cycle within the oyster. The minute spherical larvæ of various marine worms, particularly cestodes, enter the shell and become more or less embedded in the soft tissues. As a result of the irritation thus caused, the oyster forms a protective epithelial sac round the intruder, and when the latter dies its mass is gradually converted into carbonate of lime, pearly nacre is secreted by the contiguous epithelium, and the growth of the pearly mass proceeds with the growth of the shell, which is formed in the same way.

MR. W. BURTON contributes to the Journal of the Royal Society of Arts for May a paper on ancient Egyptian ceramics, which supplies a new theory of the formation of this class of ware. Too much attention, he believes, has been devoted to the ordinary unglazed pottery prepared for domestic use, which differs in no degree from the common domestic pottery. The case, however, of the ancient glazed ware dating from early dynastic or pre-dynastic times, with its brilliant turquoise colours of green or blue, is quite different. From an analysis of the material, he arrives at the startling conclusion that it corresponds roughly with the analyses of many ordinary sandstone and quartzite rocks. He dismisses the supposition that the glazed objects could be made by mixing a small amount of clay with a large percentage of sand. These blue or green glazes first appear on objects carved from actual stones, and he suggests that the ancient Egyptians used some natural sandstone from which they carved these glazed vessels. He supports this novel theory by the reproduction of photographs of slices from vessels and rocks tested by the well-known methods of microscopic examination with polarised light, &c. Sir C. Read, who presided, had some hesitation in accepting what he termed "a thoroughly revolutionary theory," such as that advanced by Mr. Burton, and suggested the necessity for further tests, particularly of mediæval Persian ware.

To the third part of *The Austral Avian Record*, the editor, Mr. G. M. Mathews, contributes a note on the colouring of the neck of the Australian cassowary, and also descriptions of various new subspecies of Australian birds.

No. 2 of vol. xlviii. of the Proceedings of the American Academy of Arts and Sciences is devoted to an appreciative biography, by Prof. H. P. Walcott, of Alexander Agassiz, in which special attention is directed to his pioneer work in oceanography and to his labours in connection with the Agassiz Museum.

IN order to save them from the torment of flies, a writer in the July number of *The Animals' Friend* suggests that when horses are "summered" in pastures they should be turned out only at night, and kept in their stables during the daytime, or at any rate during the hottest hours.

THE New York Zoological Society's Bulletin for July contains an illustrated account, by Major Schomburgh, of the living specimens of the pigmy West African hippopotamus, to which reference was recently made in our columns. The author confirms previous accounts as to the great difference in habits between the pigmy species and its giant cousin, the former frequenting the depths of the forests or the bush on the margin of small streams, and not resorting to the rivers and lakes.

THE latest addition to the list of birds observed in the British Islands is the Terek sandpiper (*Terekia cinerea*), of which four examples were killed in Romney Marsh, Kent, last May, as recorded in Witherby's *British Birds* for August. The species breeds in north-eastern Europe and northern Siberia from western Finland to the Kolyma Valley, and normally passes through eastern Europe and Asia on migration to winter in Australia, Malaya, and other parts of Asia, or north-eastern, and even southern, Africa.

MR. J. H. ORTON gives an account (Journ. Marine Biol. Assoc., vol. ix., No. 3, June, 1912) of the natural history and mode of feeding of the "slipper limpet" (*Crepidula fornicata*), which was introduced into this country, along with American oysters, about 1880, and has spread rapidly, especially in certain areas, *e.g.* on the Essex coast, where it is over-running the oyster-beds. As it takes the same food—microscopic organisms, chiefly diatoms—as oysters, it seriously depletes the food-supply of the latter. Each Crepidula is at first male, but later becomes female, and produces in its later life at least 13,000 eggs per year, which are carefully protected beneath the shell of the parent until they are hatched. The larvæ are free-swimming for about a fortnight, during which period they may be borne, by currents, to considerable distances.

MR. G. E. BULLEN contributes to the Journal of the Marine Biological Association (June, 1912) notes on the feeding habits of mackerel in the English Channel, and points out that the fish possesses a capability for selective feeding which may be extended to comparatively minute organisms, when these are present in sufficient numbers. This faculty causes the fish to seek in greatest numbers water supporting the most suitable type of food. The extent of inshore migration, and consequently a profitable or unprofitable fishery, is therefore dependent largely on the planktonic condition of the coastal waters. Mr. G. H. Drew describes several cases of new growths in fish; for instance, fibro-sarcomata in skate and plaice, and an endothelioma of an eel, which was similar in the structure, growth, and arrangement of its cells to the endotheliomata occurring in man.

IN the Clare Island Survey, part 16 (Proc. Royal Irish Acad., vol. xxxi.), Mr. W. West deals with the fresh-water algæ and the marine diatoms. The district is extremely rich in algæ; of fresh-water algæ there have been collected 769 species, 230 varieties, and 40 forms, and of marine diatoms 118 species, 24 varieties, and 6 forms. The recent investigation has resulted in extending the known distribution of a large number of species, in adding 157 species to the number already known for Ireland, 19 species to those known for the British Isles, and in the discovery of 6 new species, 27 new varieties, and 7 new forms. One of the most remarkable results was the discovery of an interesting species of blue-green algæ, *Eucapsis alpina*; this monotypic genus was previously known only from one locality in Colorado, and affords a striking instance of extension of range. Some interesting associations of algæ are enumerated, the most notable feature of which is the fact that "the lists of species vary considerably, though obtained from similar pools with similar surrounding influences."

DR. MARIE C. STOPES has published a remarkably interesting paper (Phil. Trans. Roy. Soc., Series B, vol. cciii.) on petrifactions of the earliest European

Angiosperms, in which she describes and figures three new species of fossil Angiosperms, founded on specimens of petrified wood from the English Lower Greensand. The author shows commendable caution in giving these specimens non-committal generic names, as well as in her admirable discussion of the possible affinities of each genus. The histology of these beautifully preserved specimens suggests comparison with a number of recent genera of Dicotyledons, but only in one case is the resemblance really close—the fossil *Woburnia porosa* agrees closely with the wood of some members of the recent family Dipterocarpaceæ. However, the important fact established by Dr. Stopes is the existence of Angiosperms in England at a period (Aptian) when they were supposed not to exist in northern Europe, the three genera she describes being, moreover, the oldest Angiosperms of which the anatomy is preserved. This important paper is of special interest, since, as the author justly remarks, "except the origin of Man himself there are probably no problems in palæontology of greater interest and importance, and of which less is known, than those which centre round the origin of Angiosperms, and the early history of that group."

THE half-yearly reviews of mining operations in South Australia, Nos. 14 and 15, describe the mineral developments of that State during the year 1911. They report the retirement of Mr. H. Y. L. Brown from the post of Government geologist, which he has held for more than thirty years. Mr. Brown's journeys in Central Australia during that time have not been equalled in extent by those of any other Australian traveller. Mr. Brown's intimate knowledge of the country will remain at its disposal, as he has accepted the post of honorary consulting geologist for the State. Mr. L. K. Ward, late of the Mines Department of Tasmania, has been appointed as Mr. Brown's successor, and Mr. R. L. Jack, son of Dr. Logan Jack, as senior assistant. The mining operations during the past year include the further development of the Radium Hill mines and the raising of a considerable quantity of ore, from which the radium is to be extracted at new works at Bairnsdale, in Victoria. Other radio-active deposits have been found near Mount Painter, and five tons of the ore have been sent to Europe for examination. An additional boring has been made in the Leigh Creek coalfield; it passed through the whole of the coal-bearing deposits, and reached bed rock at a depth of 1079 ft. Mr. Brown reports the progress of the attempt to drain an area known as the "Dismal Swamp" by boring holes through the floor of the swamp into the porous beds beneath; and though the bores that have been put down are small, and it has been found difficult to keep them clear of sand, Mr. Brown is of the opinion that the progress made shows that the swamps may be reclaimed by this ingenious application of percolation wells.

THE twentieth volume of the German oversea meteorological observations has been issued by the Deutsche Seewarte, with the aid of the Imperial Colonial Office. This useful publication (for the year 1910) is divided into three parts:—(1) Monthly and yearly means of observations made at certain hours at stations maintained by the Seewarte in various parts of the world, but not necessarily in countries or localities under the control of Germany. (2) Actual observations and means at certain hours from selected stations, with five-day and ten-day means at all stations in the colony of Togo. At these stations the wet-bulb thermometers are provided with an Assmann aspirator. (3) Similar observations and means, with additional data, for stations in German and one in Portuguese East Africa. Summaries of observations under (2) and (3) are also prepared for publication in the colonial *Mitteilungen aus den deutschen Schutzgebieten*.

FROM the *Annuario* of the Messina Observatory for 1909 we are glad to learn that meteorological observations were recommenced on March 1 of that year. Since the most disastrous earthquake of December 28, 1908, the conditions under which the work has been carried on have been, and are still, very difficult. Owing to the general ruin, everything had to be done again, and access to the instrumental rooms could only be obtained after removal of large masses of débris which choked the passages leading to them. Some of the instruments and the books were eventually removed to vaults which had escaped injury, but after a time they had to be transferred to an adjacent building, owing to the injurious effects of dampness. A classified list of earthquake shocks is given for the whole year; these number no fewer than 1083. Shocks have continued down to the present time, but with decreasing intensity and frequency.

IN the *Atti dei Lincei*, xxi. (1), 10, Dr. Giovanni Giorgi discusses the conditions under which, in a finite field, the limit of an integral of a function, taken between fixed limits, is equal to the integral of the limit of the function, when the parameter of the function becomes infinite.

A BACTERIAL disease has been found to infect the leaves of the well-known *Aster chinensis* of our gardens, and a short description of this disease is given by Dr. G. L. Pavarino in the *Atti dei Lincei*, xxi. (1), 8. The infection appears at first in the form of small spots on the underside of the leaves, and these spread rapidly, causing the leaves to wither and dry up. From the diseased leaves, the author has succeeded in making cultures in the usual media, and has thus isolated a micro-organism which he now describes as a new species under the name of *Bacillus asteracearum*.

IN the *Müller Breslau Festschrift* for 1912 Dr. H. Reissner contributes a paper on stresses in spherical shells, with special reference to domes and similar structures loaded symmetrically or unsymmetrically. Several cases are considered, namely that of a dome in which the potential energy of bending is negligible compared with that of stretching, that in which the resistance to bending is important and the edges are free, and that in which the edges of the dome are fixed. These are all applications of well-known analytical formulæ, but the cases in question do not appear hitherto to have received much attention.

Two patterns of conveniently mounted lenses have been put on the market by the Third Hand Patents, Ltd., of 361 and 363, City Road, London, E.C. Each consists of a lens mounted on a clip for clasping the left thumb, and so leaving the hands free to manipulate specimens under examination. Lenses of almost any power required in a simple magnifier can be provided. A high-power lens with German silver fittings and universal joint costs 6*s*., and a low-power lens with imitation tortoiseshell rim may be purchased for 2*s*. These simple microscopes may be recommended to teachers of nature-study for the use of their pupils when examining natural objects.

THE *Journal de Physique* for July contains an article by MM. Reboul and Grégoire de Bollemont on the distintegration of metals at high temperatures, in which a theory of the process is suggested which seems to cover the known facts satisfactorily. Their own experiments were made in an electric furnace which could be heated to 1200° C. A thin sheet of copper or silver in the form of a cross was attached to a sheet of platinum, the two sheets being parallel and about a millimetre apart. Without opening the furnace, the two could be moved from the cold to the hot part of the furnace, remain there a known time, and be again brought to the cold part. If certain conditions were satisfied, on subsequent examination the platinum sheet was found to have on it a thin film of copper or silver in the form of a cross. The authors ascribe the effect to the direct projection of metallic particles from one sheet to the other, owing to the explosion of minute pockets of occluded gases in the copper or silver sheets near their surfaces. They have already suggested an explanation of the emission of positive charges of electricity by heated metals based on the same theory.

COMMENTING on the Charlestown curve derailment which occurred on June 21, *The Engineer* for August 16 finds itself unable to agree with Colonel Druitt's conclusion that radial tank engines are unsuitable, and quotes the case of the Lancashire and Yorkshire Railway, which has at present 330 of these locomotives in service. The reputation of these locomotives is that they are extremely easy on the road, and consequently on themselves, the flanges of the wheels keeping wonderfully round after running thousands of miles. Our contemporary has no hesitation in accepting Colonel Druitt's recommendations as to speed restrictions, also regarding the difficulty which drivers experience in judging speeds when running on good roads and down steep gradients. The use of speed recorders is suggested in the report, and to this no objection can possibly be taken. Seeing the very extensive use made of such instruments on the Continental railways, it is somewhat surprising that these are not more employed in this country.

THE last of a series of articles descriptive of the Fried. Krupp establishments at Essen appears in *Engineering* for August 16. It is of special interest to note the admirable equipment for works tests. Each department has its own "private" testing plant in order to enable the engineers and metallurgists in charge to ascertain at any moment, for their own private guidance, the way in which the various processes are being carried out. Our contemporary states that the chemical and physical laboratory has not its equal in any part of the world. This is a five-storey building covering an area of 39,000 sq. ft. The chemical laboratories are most completely equipped for the analysis of steel, other metals and alloys, ores, gases, water and so forth, for testing oils, gunpowders, and all products made and used throughout the establishments. The physical research department is admirably equipped for metallographical research work and all classes of physical tests. A number of rooms on the lower floor are set apart for manufacturing all the different glass bottles, tubes, and connections used in the chemical laboratory for analytical purposes, the plant containing the necessary compressed-air piping and the glass-annealing stoves.

A VERY useful little handbook for students who wish to use the reading-room at the British Museum has been written by Mr. R. A. Peddie, and published by Messrs. Grafton and Co., 69 Great Russell Street, London, at the price of 1*s*. net. The book gives full information as to the conditions of admission to the reading-room, the various catalogues, and so on.

OUR ASTRONOMICAL COLUMN.

COLOUR PHOTOGRAPHY OF THE MOON.—Another of Prof. Wood's interesting papers on the photography of the lunar surface, using different selected portions of the spectrum, appears in No. 1, vol. xxxvi., of *The Astrophysical Journal*.

With a nickel-coated mirror of 16 in. aperture, prepared as described in his previous paper, Prof. Wood secured three photographs, one using the visual region of the spectrum, one the violet, and the third the ultra-violet, and on these the different features of the lunar surface show very marked differences of brightness. For example, a patch just above the crater Aristarchus is as bright as the surrounding surface when the "visual" region is employed, comes out rather darker on the "violet" image, and is quite dark when photographed in the "ultra-violet" light. On the other hand, many of the *maria* come out relatively darker in the violet picture, and appear to be differentiated *inter se* by this selective process.

Prof. Wood makes the interesting suggestion that, could pictures be taken over a greater range of different wave-lengths, it would become possible to take up the subject of lunar petrography. For example, a series of experiments led him to the conclusion that the dark patch near Aristarchus is covered by a form of sulphur or some sulphur compound. If it were possible to extend the range of the photographs to, say, 8μ, where the silicates begin to show anomalies in reflecting power, one might be able to map out, petrographically, the lunar surface.

A three-colour lantern slide, made by Mr. Ives from the three negatives, showed the general surface of the moon to be olive-green, but certain spots came out with an orange tone, while others were decidedly purple. The spot near Aristarchus appeared of a deep-blue colour, as was to be expected.

The subject is obviously one of great importance and capable of considerable extension in celestial photography, and Prof. Wood's detailed description of his numerous experiments, colour-filters, and photographs will be found of immense assistance by others who may take up the work. Moreover, he offers to render any help he can and to lend his silvered plates of uviol glass, which he uses as screens, to any observatory ready to use them.

EPHEMERIDES FOR HOLMES'S COMET.—Dr. Zwiers continues his ephemerides for Holmes's comet in No. 4594 of the *Astronomische Nachrichten*. The comet is still too far south (declination -41° 42′) to be observed in these latitudes, and its computed brightness progressively decreases until the end of the year, where the ephemeris now given concludes.

OBSERVATIONS OF MERCURY.—During the latter part of March a number of observations of Mercury were made at the observatory of the Astronomical Society of France, by MM. Camus, Danjon, Prud'homme, and Rougier, and are recorded in the August number of *L'Astronomie*. On six nights the planet was seen by the naked eye, and always appeared brighter than Mars, which was nearer the zenith; it was also less ruddy than Mars.

Telescopic observations revealed certain markings, of which the two principal ones were recorded by different observers, working quite independently, in corresponding positions. The markings are said to be of the same order as those on Mars, when observed under the best conditions and with a sufficiently good instrument, and the regular observation of Mercury is to be carried out at the society's observatory. The colour of the planet, observed telescopically, was seen to be as white as, and very similar to, that of the moon.

HALLEY'S COMET.—The astrophysical observations of Halley's comet made at the Catania Observatory are brought together by Prof. Riccò in No. 7, vol i. (2nd series), of the *Memorie della Società degli Spettroscopisti Italiani*.

Visual observations revealed changes in the structure of the head, while the photographs taken showed that important modifications occurred in the coma and the tail. The spectroscopic observations, both visual and photographic, showed that substances emitting certain radiations were distinctly stronger in some parts of the comet than in others, a typical example being the restriction of the "cyanogen" band at $\lambda 388$ to the head. On several of the direct photographs, some of which are reproduced to accompany the paper, the tail extends for some 30° from the head.

THE NEW ZEALAND INSTITUTE.[1]

THE Transactions of the New Zealand Institute, the federation of scientific societies of New Zealand, for 1910 include fifty-seven papers, dealing with chemistry, physics, botany, geology, zoology, anthropology, and mathematics. The majority of the papers are contributions to the natural science of New Zealand and the adjacent regions.

One of the most important papers in the volume is the account of the physiography and plant ecology of the Mt. Arrowsmith district, one of the highest areas in the Southern Alps, by Messrs. Speight, Cockayne, and Laing. Dr. Cockayne gives a most interesting account of the flora of the district, and holds that if the ice had as great an extension as is believed by some New Zealand geologists, the present distribution of the plants is inexplicable. Mr. Speight refers to the well-shown facetting of the valley spurs by the glaciers; he attributes the corries to glacial action, and many mountain passes to their enlargement.

Prof. Marshall, Dr. Speight, and Mr. Cotton have collaborated in a statement as to the correlation of the younger rocks of New Zealand, which confirms the view that the supposed Cretaceo-Tertiary fauna of New Zealand has no existence. They accept the Oamaru beds as of early Oligocene age. Mr. Chapman's report on this question was apparently issued too late for consideration.

The artesian wells of Canterbury are described in a valuable paper by Mr. Speight. The water flows from inter-stratified sands and clays. Some of the wells are more than 500 ft. deep. Owing to the great irregularity of these deposits, the wells vary greatly in yield and character. There is no doubt that the water is of meteoric origin, for the discharge falls off during dry weather and immediately recovers after rain. According to Mr. Speight, much of the water is derived from percolation from the rivers on the Canterbury Plains. Interesting tidal wells occur along the coast, and their water is salt. Mr. Speight refers to a tidal well in Japan in which the oscillation is due to the varying load of the tidal water on the rocks above the water-bearing layer—an interesting case of flow due to rock pressure.

Some of this artesian water when fresh from the wells has a fatal effect on young trout. Dr. Coleridge Farr and Mr. D. B. Macleod attribute this effect either to a deficiency of oxygen or to a radio-active emanation.

Mr. R. H. Worth describes a series of rocks collected in South Victoria Land by Mr. T. V. Hodgson. The results agree with those of Dr. Prior. Mr. Hodgson adds an interesting note on the glacial problems of South Victoria Land, and throws doubt on the supposed great recession of the glaciers. He thinks that the normal variations between different seasons are sufficient to account for the known variations in the Antarctic ice fronts, if aided by occasional earthquakes, an agency which has been previously invoked to explain some changes in Arctic glaciers.

Dr. Henderson has an interesting paper on the physiography of the West Nelson district, and directs attention to the dominant influence of the earth movements and rift valleys in that area. He also describes the coalfields of the same district, and accepts the view that, excluding cannel coal, all coals have been formed from vegetable matter of initially similar composition—a conclusion not so widely accepted as formerly. Oil occurs in association with these coals, but the author does not expect it to prove of economic importance.

Among the contributions to New Zealand zoology are descriptions by Mr. E. Meyrick of thirty-six new species of Lepidoptera and a classification of the New Zealand Tortrices, a revision by Prof. Chilton of the New Zealand Stomatopods, which are a few widespread species, and a memoir by Major Broun on beetles from the Chatham Islands. The last author founds twenty-seven new species and two new genera, records thirty-four species which also live in New Zealand, and remarks that the fauna has no special relation to that of the sub-Antarctic region.

[1] Transactions and Proceedings of the New Zealand Institute, 1910. Vol. xliii. (New Issue). Pp. vi+680+128. (Wellington: John Mackay, Government Printer; London: W. Wesley & Son, 1911.)

A LOST TRIBE AMONG THE ESKIMO.

THE Canadian correspondent of *The Times* reports (August 13) that Prof. James Mavor, of the University of Toronto, has received a letter from Mr. Vilhjalmur Stefansson, one of the leaders of the Anglo-American expedition to the Arctic seas, in which he claims to have discovered a long-lost European tribe in far-northern Canada. In south-western Victoria Land they met a race strikingly non-Eskimo in type, and looking like North Europeans. The most distinctive group is that of the Haneragmiut, opposite Cape Bixley, and in Herschel Island they found an Eskimo tribe consisting of white half-bloods, but none with fair hair or blue eyes. Unfortunately, owing to

well-known superstitious reasons, it was found impossible to procure specimens of the head and beard hair of the Haneragmiut. We must, therefore, await the return of the expedition to examine any photographs or other anthropological material which they may have collected.

Writing from Shingle Point, Arctic Ocean (approximate lat. 69° N., long. 137° W.), Mr. Stefansson gives some interesting notes on the marriage rites, wife-lending, communism in the matter of food, and treatment of the sick by magical songs, dances, and sleight-of-hand tricks. Many of these people have attained a fairly high culture, using clocks, watches, magazine rifles, and American stoves.

Until further information is forthcoming it is impossible to discuss the supposed European strain among these people. As in the Vinland Saga, there is good evidence of early Norse communications with Greenland. Mr. Stefansson discards the theory that the European strain may have come from survivors of the Franklin expedition, some of whom are believed to have survived among the Eskimo in Victoria Land. He seems to connect it with the so-called "lost colonies" from Denmark or Norway. But so many expeditions have failed to trace any survivals of them that for the present it will be wise to suspend judgment in the matter.

LANCASHIRE SEA-FISHERIES.

THE twentieth report (for 1911) on the Lancashire Sea-Fisheries Laboratory at the University of Liverpool and the hatchery at Piel provides ample evidence of the continuance of their sound scientific work. As in previous years, classes for fishermen have been held at Piel. Altogether fifty-seven fishermen attended the four classes, and received instruction in marine biology. Two of the classes were restricted to deep-sea trawl fishermen, who were preparing for the Board of Trade examination for certificates as second hands or skippers of fishing vessels. The men received each morning a lesson in marine biology suitable for deep-sea fishermen, and each afternoon a lesson in navigation and seamanship. These well-planned and efficiently taught classes stimulate the interest of the fishermen-students, and enable them to appreciate the problems associated with the development of fisheries, and to realise the value of the regulations which have been put in force for the benefit of fishermen and the fishing industry.

Mr. Johnstone reports on measurements of plaice and on a number of interesting diseases of fishes, especially noteworthy being several forms of malignant growths—melanotic sarcomata in skate, a fibro-sarcoma in a cod, and a lympho-sarcoma in a flounder. Mr. Riddell and Dr. D. M. Alexander contribute a note on an ulcerative disease which has occurred in the plaice in the spawning ponds at Port Erin. The disease is apparently a septicæmia, probably connected with one of three bacilli which the authors describe.

Prof. Herdman gives a summary of the work of the last twenty years on shellfish, and their contamination by means of sewage. He directs attention to recent experiments which have shown that a very considerable degree of cleansing—the loss of about 93 per cent. of the *coli* organisms—occurs when badly polluted mussels are relaid for four days in unpolluted water. A recommendation was made to apply this method of cleansing to mussels taken in the estuary of the Conway, but was met with such uncompromising hostility from the fishermen concerned that the project had to be abandoned. Unless regulation of the mussel fishery in this estuary is established, it is probable that the industry will still further decline, as the mussels are under grave suspicion. In view of the increasing pollution of the estuary, the mussels may become a dangerous source of epidemic disease. An account, by Mr. Johnstone, follows, on the examination of the mussel-beds in the estuary of the Wyre, in which the pollution does not appear to reach a dangerous amount.

Prof. Herdman gives details of a further series of studies, by himself and Mr. Scott, on the plankton around the south end of the Isle of Man. He concludes that, although there is a natural sequence in the distribution of the plankton throughout the year, and a certain constancy in the maxima and minima for particular groups, and even species, the sequence is liable to disturbance, and the maxima are affected, both in time and in amount, by surrounding conditions; hence the variations which have been recorded from year to year. Continued work on the plankton of the west coast of Scotland supports the suggestion, put forward in last year's report, that the most probable explanation of the presence of huge masses of diatoms in the Scottish seas in summer (when the plankton at Port Erin is composed almost entirely of animal organisms, especially copepods) is that the phytoplankton remains longer and passes off more slowly as one goes further north. Appended to the report is a useful memoir (115 pp., with eight plates) on the whelk, by Dr. W. J. Dakin.

SIR WILLIAM HERSCHEL.[1]

THE only general test of the relative nearness or farness of the stars is their brightness, because the faint stars must, on the average, be more distant than the bright ones. Herschel proposed to penetrate into space by means of a celestial census of the distribution and of the brightness of the stars. With this object he carried out four complete reviews of the heavens, so far as they may be seen from our latitude, passing successively to the fainter and fainter objects by means of the increased size of his telescope.

He divided the heavens into sweeps 2° 15′ of breadth in declination, and each zone was examined throughout by the process which he called star-gauging. His census was made with the 20-ft. reflector, with which instrument the field of view was about one-quarter of the size of the full moon. It needs more than 300,000 of such fields of view to cover the whole of the hemisphere of space, and Herschel surveyed the whole northern hemisphere, and as much of the southern one as he could.

Von Magellan in a letter to Bode describes the method of observation as follows: "He has his 20-ft. Newtonian telescope in the open air. . . . It is moved by an assistant who stands below it . . . near the instrument is a clock . . . in the room near it sits Herschel's sister, and she has Flamsteed's Atlas open before her. As he gives her the word, she writes down the declination and right ascension. . . . In this way Herschel examines the whole sky. . . he is sure that after four or five years (from 1788) he will have passed in review every object above our horizon. . . . Each sweep covers 2° 15′ in declination, and he lets each star pass at least three times through the field of the telescope, so that it is impossible that anything can escape him. . . . Herschel observes the whole night through . . . for some years he has observed . . . every hour when the weather is clear, and this always in the open air."

Herschel points out that by this survey he was not only looking into the most distant space, but also into the remotest past, for the light of many of the stars

[1] A discourse delivered at the Royal Institution on April 26 by Sir George H. Darwin, K.C.B., F.R.S. Continued from p. 623.

must have started on its journey towards us thousands or even millions of years ago. The celestial museum therefore exhibits to us the remotest past alongside with the present, and we have in this way the means of reconstructing to some extent the processes of evolution in the heavens. In photography the modern astronomer possesses an enormous advantage, but Herschel laid the foundation of this branch of astronomy without it.

The most conspicuous and the most wonderful object in the heavens is the Milky Way. It runs all round the skies in a great band, with a conspicuous rent in it forming a streamer which runs through many degrees. To the naked eye it shines with a milky light, but Herschel was able to show that it consists of countless stars in which there lie embedded many fleecy nebulæ. There is good reason to believe that the Milky Way on the whole consists of stars which are younger than those in the other parts of space, for the stars in it are whiter and hotter, and the nebulæ are mostly fleecy clouds. On the other hand, the spiral and planetary nebulæ are more frequent away from the Milky Way, and these are presumably older than the cloudy and flocculent nebulæ. The shape of the Milky Way seems to resemble a huge millstone or disk of stars, and since it forms a complete circuit in the heavens the sun must lie somewhere towards its middle. It is probable that we look much further out into space along this tract than elsewhere, although it happens that by far the nearest of all the stars—namely, α Centauri—lies in the line of the Milky Way.

This great congregation of stars is far from uniform in density, for there are places in it where there are but few stars or none at all. Caroline Herschel, writing to Sir John Herschel at the Cape of Good Hope, in 1833, mentions that her brother, when examining the constellation of the Scorpion (which lies at best low down on our horizon), had exclaimed, "after a long awful silence, 'Hier ist wahrhaftig ein Loch im Himmel.'" And her nephew, as he said, rummaged Scorpio with the telescope and found many blank spaces without the smallest star.

It will explain some of the deductions which Herschel drew from his star-gauges, and will at the same time furnish a good example of his style, if I read a passage from a paper of his written in 1789.[2] He points out that the sun is merely a star, and, referring to the stars, he continues thus:—

"These suns, every one of which is probably as of much consequence to a system of planets, satellites, and comets as our own sun, are now to be considered, in their turn, as the minute parts of a proportionally greater whole. I need not repeat that by my analysis it appears that the heavens consist of regions where suns are gathered into separate systems, and that the catalogues I have given comprehend a list of such systems; but may we not hope that our knowledge will not stop short at the bare enumeration of phenomena capable of giving us so much instruction? Why should we be less inquisitive than the natural philosopher, who sometimes, even from an inconsiderable number of specimens of a plant, or an animal, is enabled to present us with the history of its rise, progress, and decay? Let us then compare together, and class some of these numerous sidereal groups, that we may trace the operations of natural causes so far as we can perceive their agency. The most simple form, in which we can view a sidereal system, is that of being globular. This also, very favourably to our design, is that which has presented itself most frequently, and of which I have given the greatest collection.

"But, first of all, it will be necessary to explain what is our idea of a cluster of stars, and by what means we have obtained it. For an instance I shall take the phenomenon which presents itself in many clusters. It is that of a number of lucid spots, of equal lustre, scattered over a circular space, in such a manner as to appear gradually more compressed towards the middle, and which compression, in the clusters to which I allude, is generally carried so far, as, by imperceptible degrees, to end in a luminous centre of an irresolvable blaze of light. To solve this appearance it may be conjectured that stars of any given very unequal magnitudes may easily be so arranged, in scattered, much extended, irregular rows, as to produce the above described picture; or, that stars, scattered about almost promiscuously within the frustum of a given cone, may be assigned of such properly diversified magnitudes as also to form the same picture. But who, that is acquainted with the doctrine of chances, can seriously maintain such improbable conjectures?"

Later in the same paper he continues:—

"Since then almost all the nebulæ and clusters of stars I have seen, the number of which is not less than three and twenty hundred, are more condensed and brighter in the middle; and since, from every form, it is now equally apparent that the central accumulation or brightness must be the result of central powers, we may venture to affirm that this theory is no longer an unfounded hypothesis, but is fully established on grounds which cannot be overturned.

"Let us endeavour to make some use of this important view of the constructing cause, which can thus model sidereal systems. Perhaps, by placing before us the very extensive and varied collection of clusters and nebulæ furnished by my catalogues, we may be able to trace the progress of its operation in the great laboratory of the universe.

"If these clusters and nebulæ were all of the same shape, and had the same gradual condensation, we should make but little progress in this inquiry; but as we find so great a variety in their appearances, we shall be much sooner at a loss how to account for such various phenomena, than be in want of materials upon which to exercise our inquisitive endeavours.

. . . . . .

"Let us, then, continue to turn our view to the power which is moulding the different assortments of stars into spherical clusters. Any force, that acts uninterruptedly, must produce effects proportional to the time of its action. Now, as it has been shown that the spherical figure of a cluster of stars is owing to central powers, it follows that those clusters which, *ceteris paribus*, are the most complete in this figure, must have been the longest exposed to the action of these causes. This will admit of various points of view. Suppose, for instance, that 5000 stars had been once in a certain scattered situation, and that other 5000 equal stars had been in the same situation, then that of the two clusters which had been longest exposed to the action of the modelling power, we suppose would be most condensed, and more advanced to the maturity of its figure. An obvious consequence that may be drawn from this consideration is that we are enabled to judge of the relative age, maturity, or climax of a sidereal system, from the disposition of its component parts; and, making the degrees of brightness in nebulæ stand for the different accumulation of stars in clusters, the same conclusions will extend to them all. But we are not to conclude from what has been said that every spherical cluster is of an equal standing in regard to absolute duration,

[2] Phil. Trans., vol. lxxix., p. 212.

since one that is composed of a thousand stars only must certainly arrive to the perfection of its form sooner than another which takes in a range of a million. Youth and age are comparative expressions; and an oak of a certain age may be called very young, while a contemporary shrub is already on the verge of its decay. The method of judging with some assurance of the condition of any sidereal system may perhaps not improperly be drawn from the standard laid down earlier; so that, for instance, a cluster or nebula which is very gradually more compressed and bright towards the middle may be in the perfection of its growth, when another which approaches to the condition pointed out by a more equal compression, such as the nebulæ I have called *Planetary* seem to present us with, may be looked upon as very aged, and drawing on towards a period of change, or dissolution. This has been before surmised, when in a former paper I considered the uncommon degree of compression that must prevail in a nebula to give it a planetary aspect; but the argument, which is now drawn from the powers that have collected the formerly scattered stars to the form we find they have assumed, must greatly corroborate that sentiment.

"This method of viewing the heavens seems to throw them into a new kind of light. They now are seen to resemble a luxuriant garden, which contains the greatest variety of productions, in different flourishing beds; and one advantage we may at least reap from it is, that we can, as it were, extend the range of our experience to an immense duration. For, to continue the simile I have borrowed from the vegetable kingdom, is it not almost the same thing, whether we live successively to witness the germination, blooming, foliage, fecundity, fading, withering, and corruption of a plant, or whether a vast number of specimens, selected from every stage through which the plant passes in the course of its existence, be brought at once to our view?"

I now turn to another line of discovery of which I cannot show any pictures, but which, to me at any rate, is more interesting. Until 1838—that is to say, until sixteen years after Herschel's death—no one had succeeded in determining the distance of a single fixed star, but in that year Henderson and Bessel almost simultaneously attained success in the cases of the two stars α Centauri and 61 Cygni. The attempts at this measurement had already been numerous, and Herschel amongst others had failed, but his failure was a glorious one, for he made incidentally a discovery of another kind and of at least equal interest.

The earth moves round the sun at a distance of 93 million miles, so that in six months we shift our position by 186 million miles. If, then, there are two stars of which one is relatively near to and the other far from the sun, but so situated as to appear to us very close together, the near one ought to shift its position relatively to the distant one in the course of each six months. The amount of this change of position, called by astronomers annual parallax, should furnish the distance of the nearer of the pair, provided that the other is very far off. This idea is as old as the time of Galileo, but no one had been able to make successful use of it.

As I have already said, the only general test of the distance of a star is its brightness, and therefore Herschel chose pairs of stars of very different brilliancy. He thought, at least at first, that it was mere chance which brought the stars so near to one another, and there are undoubtedly such pairs now known as "optically double stars." But Herschel's mode of attack was bound to fail if the seemingly neighbouring stars were really so, and were linked together by their mutual gravitation. Already as early as 1707 Michel had suggested the existence of such true double stars, but it was Herschel who proved their existence. His first catalogues of double stars, published in 1782, contained 203 cases of such doublets, and he already suspected a community in their motions explicable only by their real association; but by 1802 he had become certain. In many cases the two components of a binary pair were found to be moving in nearly the same direction and at the same speed, but superposed on this motion of the system as a whole there was an orbital motion of one star round the other. Herschel even lived long enough to see some of his pairs of stars perform half a revolution about one another.

After his death Savary took the matter one stage further, and showed that the revolution was governed by the laws of gravity, and thereby confirmed the truth of Herschel's belief. Thus the failure to measure the distance of stars led to the proof that gravity reigns amongst the stars as in the solar system.

Arago thought that of all Herschel's discoveries this was the one that had the greatest future, and his prophecy has proved singularly correct. Every year adds to the number of double stars the orbits of which are now accurately determinable. These systems are found to be very unlike our own solar system, for the component stars are, in many cases, far larger than the sun, and revolve about one another in periods which, in various cases, may be either many years or only a few hours.

The spectroscope has, moreover, added enormously to our knowledge, for the speed of approach or recession of a star from the sun can now be determined as so many kilometres per second. Thus that component of the motion of a star which was concealed from Herschel is now known with the greater certainty. Moreover, being ignorant of the distance of the stars, he could only express the transverse component of motion in seconds of arc.

A wonderful corollary also results from the use of the spectroscope, namely the existence of many stars known as "spectroscopic binaries." As seen even with the most powerful telescope such a star is a single point of light, but if the spectral lines are duplicated we know that the source of light is double, and that one component is approaching us and the other receding from us. In this way the orbits and relative masses of these visually inseparable stars are determinable. The number of known double stars, including both visual and spectroscopic ones, is already large, and Campbell, of Lick Observatory, has expressed his opinion that one star in six is double. Some of them revolve so near to one another and in such a plane that they partially eclipse one another as they revolve, and thus produce a winking light like that of a lighthouse. It would seem that we can now even tell something of the shapes of a pair of stars visually inseparable from one another. But I must not go further into this subject, and will only repeat Arago's saying, that this discovery of Herschel's has "le plus d'avenir."

It is a figure of speech to refer to the stars as fixed, for a large number of them possess a measurable amount of "proper motion" relatively to their neighbours. The existence of double stars was discovered by the observation of their movements, and thus the study of proper motions is linked to the subject of which I have just been speaking. Some few proper motions had been observed by earlier astronomers, but when Herschel took up the subject proper motion had not been accurately measured in any case.

If a man is walking through a wood the trees in front of him seem to be opening out before him, whilst those behind seem to be closing together. In the

same way if our sun is moving relatively to the centre of gravity of all the stars, the stars must on the average seem to move away from the point towards which the sun is travelling, whilst they must close in towards the antipodes. These two points are called the apex and antapex of the sun's path.

Now Herschel concluded that there was something systematic in the proper motions of the stars, and that there was a point in the constellation of Hercules from which the stars were on an average receding, and that similarly they were closing in towards the antipodal point. The first of these is the sun's apex and the second the antapex. These conclusions were drawn from the motions of comparatively few stars, but the result has been confirmed subsequently from a large number. Moreover, we have now learned by means of the spectroscope that we are travelling towards Hercules at the rate of about sixteen miles a second.

During these last few years this grand discovery of Herschel's has gained a great extension at the hands of Kapteyn and of many others, and it has been proved that other systematic motions of the stars are discoverable. The time at my disposal will not permit me to pursue this subject further, but I may say that it now appears that if we could view the universe from the centre of gravity of the stars of the Milky Way, we should see a current of stars coming from a definite direction of space and penetrating our system.

What a vista of discoveries do these ideas open up to the astronomer! Some centuries hence the sun's apex may have shifted, and we may perhaps learn that the solar system is describing the arc of some colossal orbit. The drift or current of stars may also have begun to change its direction, and our descendants may have begun to make guesses as to its future course and as to its meaning. But whatever developments the future may have in store, we should never forget that the foundation of these grand conceptions of the universe was laid by Herschel. Holden ends his "Life of Herschel" with words which may also serve as a fitting end to my lecture: "As a practical astronomer he remains without an equal. In profound philosophy he has few superiors. By a kindly chance he can be claimed as the citizen of no one country. In very truth his is one of the few names which belong to all the world."

RECENT ADVANCES IN AGRICULTURAL SCIENCE—THE FERTILITY OF THE SOIL.[1]

FROM an ordinary common-sense point of view the fertility of the soil is best defined as that property for which a man pays rent—the property which causes some land to let for 2*l.* or 3*l.* an acre, whereas the adjoining land may be dear enough at 10*s.* With the causes of this fertility I do not propose to deal at any great length this evening more than to indicate that it is the outcome of a very complex series of factors, among which we can enumerate the actual supply of plant food in the soil, its mechanical texture as conditioning the movements of water, and the particular micro-fauna and flora inhabiting the soil, for upon these lower organisms depends the facility with which the material contained in the soil will become available for the nutrition of the plant. For the purpose of the present argument it will be sufficient to fix our attention upon the amount of nitrogen in the soil as the main factor determining fertility, because, in the first place, nitrogen is one of the necessary and most expensive elements in the nutrition of the plant, and, secondly, because its amount in the soil is subject to both gains and losses from causes which are more or less under the control of the farmer. The other essential elements which the plant has to draw from the soil—for example, phosphoric acid and potash—are only subject to slight losses by solution in the drainage water, and cannot be added to except deliberately by the action of the farmer; but in the case of nitrogen we have, in addition to the small stock of combined nitrogen in the soil, the vast store of free gaseous nitrogen with which both soil and plant are in contact. We may take it as settled nowadays that the plant itself can make no use of nitrogen gas, but must draw combined nitrogen in one of its simpler forms, such as nitrates or ammonia, from the soil. Among the bacteria of the soil, however, there are two great groups, one of which is capable of breaking up compounds of nitrogen and setting free the element as gas, whereas the other can take free gaseous nitrogen from the atmosphere and bring it into a combined form. Which of these two groups will be more active depends upon the conditions prevailing in the soil, and goes far to determine both its current fertility and the length of time during which it will be capable of bearing crops.

The question of the duration of the fertility of the land under continual cropping has excited much attention of late, chiefly because the United States has begun to take alarm about the reduced production of some of its most fertile lands, as, for instance, the old prairie lands of the middle West—a reduced production which, amongst other causes, has helped to set in motion a stream of migrants from the United States to the newer lands of the Canadian North-West. In the development of agriculture three distinct stages may be observed, In the first place, we may have a process of pure exploitation of the initial resources of the soil, when the farmer is to all intents and purposes mining in its fertility. This is the process which, in the main, has been going on in America, and, indeed, in all the newer countries which have been opened up to agriculture during the last two centuries. Not all virgin soils are rich, and the system of cropping alternately with wheat or maize which prevails over so much of North America has reduced great areas of the land in the eastern States to such a poverty-stricken condition that it has been allowed to go derelict. In the great plains, however, where the first settler found four or five feet of black soil, containing nearly half per cent. of nitrogen, the land has kept up its productivity almost unimpaired for nearly a century. If we suppose the black soil only extended to a depth of three feet, and contained three-tenths per cent. of nitrogen, both limited estimates, there would still be 30,000 lb. of nitrogen per acre—that is to say, nitrogen enough for five hundred crops larger than the American farmer has been accustomed to win from that land—and yet in less than a century such soils are beginning to show signs of exhaustion. The farming of the kind just described is destructive; but in the older lands of the west of Europe, which have been under cultivation for something like a century, a conservative system has been devised which is capable of keeping up the productive power of the soil, though not, perhaps, to a very high pitch. Perhaps the best example of this may be seen in the Norfolk four-course rotation prior to the introduction of artificial fertilisers. In this system a turnip crop, which was either consumed on the ground or converted into manure, and so returned to the soil, was followed by barley in which clover was sown, and the clover, which also got back to the soil, was followed by wheat. The farming covenants prevented the sale of anything more than barley and wheat grain, and the meat that was produced by the

[1] A discourse delivered at the Royal Institution on Friday, May 24, by A. D. Hall, F.R.S.

consumption of the turnips and hay. Thus but a small proportion of the nitrogen taken out of the soil by the crop left the farm; the rest was returned and used over again, although considerable losses of gaseous nitrogen occurred during the making of the dung. Both losses, however, were more than replaced by the nitrogen which the clover crop gathered from the atmosphere during its growth. At any rate, we find that under such a conservative system of farming the productivity of the land remained pretty constant at about a level of twenty bushels to the acre from the time of Queen Elizabeth down to the beginning of the nineteenth century. This conservative farming about 1840 began to give place to the third stage in the development—intensive farming, rendered possible by the discovery of artificial fertilisers and the cheap freights which brought foreign fertility in the shape of cheap feeding stuffs to the soil of this country. By these means the average production of the land of the British Isles has been raised from the twenty-bushel level to something over thirty bushels, and the most intensive farmers reach an average level at least 25 per cent. higher. In their case the soil has become practically a manufacturing medium transforming the nitrogen and other fertilising materials added to it into crops, giving nothing to those crops from its original stock, and indeed up to a certain point gaining rather than losing fertility with each year's cultivation. The inner history of these three stages in agriculture may be followed by a consideration of certain experimental plots at Rothamsted. We may begin with the experimental wheatfield which is now

EXPERIMENTS ON WHEAT, BROADBALK FIELD, ROTHAMSTED.

Average Produce of Grain, first 8 years (1844–51) and the successive 10-year periods 1852–1911.

Plot	Manure	Averages over							
		8 years, 1844–1851	10 years, 1852–1861	10 years, 1862–1871	10 years, 1872–1881	10 years, 1882–1891	10 years, 1892–1901	10 years, 1902–1911	60 years, 1852–1911
		Bush.	Bush	Bush.	Bush.	Bush.	Bush.	Bush.	Bush.
2	Farmyard manure	28·0	34·2	37·5	28·7	38·2	39·2	35·1	35·5
3	Unmanured	17·2	15·9	14·5	10·4	12·6	12·3	10·9	12·8

carrying its sixty-ninth successive crop of wheat. One of the plots has been without manure throughout the whole of that period. The production, which fell steadily for the first ten years, has since that time remained so constant that the slow falling off which we still believe to be taking place is disguised by the fluctuations due to season. The average yield is about twelve bushels to the acre, almost exactly the average yield of the wheat lands of the whole world. Unfortunately samples of soil were not taken at the very outset, but if we begin with the earliest analyses that were available in 1865 and draw up a balance-sheet for the nitrogen, we shall find that the removal in the crop is almost exactly balanced by the small amount that comes down in the rain and the decrease that has taken place in the amount of nitrogen in the soil. There are, however, other losses of nitrogen not brought into account; some is washed away by drainage water every year, and a further small unestimated amount gets removed as weeds. As these losses do not appear in the balance-sheet we must conclude that some recuperative action is at work keeping up the stock, though the process is not sufficient wholly to make up for the removals in the crop. The results of this plot show two principles at work—the tendency of the land under an unchanging system of farming to reach a position of equilibrium when the only variations in the crop are those brought about by seasons; and, secondly, that regeneration of the nitrogen stock in the soil is possible by natural causes alone.

We may now turn to one of the other plots which receives an excess of farmyard manure each year, the manure supplying about 200 lb. of nitrogen per acre, whereas the crop only takes away about 50 lb. Naturally the land in this case increased in fertility, but after twenty or thirty years another position of

BROADBALK WHEAT FIELD.

Nitrogen in Soil, lb. per acre.

In soil, 1865	In soil, 1904	Gain or loss in 39 years	Added in manure	Added in rain	Removed in crop	Unaccounted for
Plot 3.—Unmanured.						
2850	2290	−560	...	150	600	−110
Plot 2.—Farmyard Manure.						
4470	4970	+500	7800	150	1990	−5460

equilibrium was attained at a level of about 36 bushels per acre, after which, despite the continued additions of manure, the crop again did not vary except as the result of exceptionally favourable seasons. If we now consider a similar balance-sheet for this plot, we find that the additions of nitrogen are balanced neither by the removals in the crop nor by the accumulation of nitrogen in the soil; indeed half of the nitrogen applied is unaccounted for. The soil has been getting no richer for the last twenty or thirty years, and the greater part of the nitrogen is wasted, doubtless because bacterial action sets the nitrogen free as gas. Here, then, we see another principle illustrated, that in very rich land the wasteful agencies are so speeded up as to prevent any continued accumulation of fertility out of the unused residues of the manures put on. Higher fertility means a higher level of waste, and this explains the rapidity with which the very rich virgin soils lose their fertility when they are put under arable cultivation. In this Rothamsted plot, the soil of which still contains less nitrogen than the less rich virgin soils of the prairies, three times as much nitrogen are wasted every year as is converted into crop, and the same or an even greater rate of wastage must attend the conversion of the rich virgin soils into land growing a succession of cereal crops.

We may now turn to another plot on the same field to illustrate the recuperative actions of which I have spoken. This is a part of the field that has been running wild since 1881, when the wheat it carried was not harvested but allowed to seed itself. A very few years sufficed to eliminate the wheat, which was unable to maintain itself against the competition of the weeds, and the land now carries a miscellaneous vegetation consisting mostly of grass. A soil sample was taken at starting, and when compared with another sample taken twenty-three years later showed that in the interval the land had gained nitrogen at the enormous rate of 92 lb. per acre per annum. Making every allowance for possible errors in sampling and analysis, the accumulation of nitrogen is in marked contrast to its steady depletion in the equally unmanured arable land alongside. Now, the difference between the two plots lies in the fact that on

the land running wild the vegetation is never removed, but allowed to die down naturally. Hence not only is the nitrogen taken out by the crop

BROADBALK FIELD, ROTHAMSTED.

Land allowed to run wild. Nitrogen in Soil, lb. per acre.

—	In soil to 27 in.		Added by rain	Gain in soil per annum
	1881	1904		
Broadbalk ...	5910	8110	90	92

returned to the soil, but also a large stock of carbonaceous matter assimilated from the atmosphere, and this carbonaceous matter furnishes a bacterium present in the soil, *Azotobacter chroococcum*, with the source of energy which will enable it to fix atmospheric nitrogen. Azotobacter is equally present in the soil of the unmanured wheat plot; but, as there the crop is removed and only a little root and stubble left behind, there is but little carbonaceous matter for the Azotobacter to work upon, and a correspondingly small fixation of nitrogen, sufficient only, as we have seen, to repair the casual losses by drainage and weeding. This plot gives us a clue to the source of the vast accumulations of nitrogen in the old prairie soils. Vegetation alone, however long continued, cannot increase the stock of nitrogen in the soil; there is only a circulation of the initial stock removed by the plants and then put back when the plant dies *in situ*. But if the conditions are also favourable to the development of Azotobacter, this organism derives from the carbonaceous part of the plant residues the energy it requires for the fixation of nitrogen, and a steady addition to the original stock goes on. We have found Azotobacter present in all these rich black soils, from both South and North America, the Russian Steppes, and similar virgin land in all parts of the world, and again we also find an abundance of lime, one of the other necessary factors for the growth of Azotobacter. Virgin soils are not necessarily rich; there are miserably poor ones, though they have equally carried some sort of vegetation for hundreds, indeed thousands, of years. They have remained poor because some of the other factors upon which depend the development of Azotobacter are lacking. With this far-reaching conclusion in sight, we have naturally tried at Rothamsted whether we could not bring about a similar heaping up of nitrogen in the soil by simply adding to it a carbohydrate containing no nitrogen, such as starch or sugar. In pots, the experiment is perfectly successful, and accordingly we

HOOSFIELD BARLEY.

Effects of Sugar (or Starch) on the Amount of Produce. Plot 4 O. Complete Minerals.

Year	Sugar (or starch) applied	Total produce of barley	
		Without sugar	With sugar
		lb.	lb.
1906	Spring	2485	[2]
1907 [3]	,,	3578	3249
1908	,,	1820	1404
1909	,,	2563	2261
1910	Autumn	2082	2502
1911	,,	1244	1915

[2] Very small crop, not weighed.
[3] Starch applied instead of sugar in 1907.

selected one of the plots in the barley field which was in a very nitrogen-starved condition, because it had been manured for fifty years only with mineral fertilisers containing no nitrogen, and treated half the plot with sugar at the rate of a ton to the acre, the other treatment of the two halves of the plot being alike. To our surprise, the half receiving sugar gave a miserable crop, much below the non-sugar half, for four years in succession, and a bacteriological examination of the soil showed that Azotobacter had not increased in response to the sugar, but that the number of merely putrefactive organisms had gone up greatly. These facts led Dr. Hutchinson to surmise that we had been putting on the sugar at the wrong time of year, in early spring or winter, some time before the barley was sown, when the soil is cold. Now Azotobacter is comparatively inactive at low temperatures, and the sugar was probably being wholly taken by the Streptothrix, &c., which are less affected by cold. As these organisms must also obtain nitrogen, they were robbing the barley of the small stock available in the soil, and so bringing about the observed reduction of crop. A change was accordingly made in the time of application of the sugar, which was put on as soon as the barley had been harvested, when the soil still retained its summer heat, and the change was immediately followed by an increase in the succeeding barley crops, as compared with the non-sugar plots, that was as marked as the deficiency had been previously. This illustrates the many pitfalls which attend investigations in agricultural science. Under laboratory conditions one can define the issue sharply, but as soon as the experiments are extended to the open ground and living plant, so many extraneous and unsuspected factors come into play that what is popularly called a conflict between theory and practice often becomes apparent.

We may now take a more complex example from the Rothamsted plots to illustrate what I have called the conservative systems of farming. One of the fields is farmed on a four-course rotation of turnips,

NITROGEN PER CENT. IN SOIL OF AGDELL FIELD, ROTHAMSTED.

The Plots receive Mineral Manures, but no Nitrogen.

	Fallow		Clover	
	Roots carted off, 13/14	Roots returned, 0/10	Roots carted off, 15/16	Roots returned, 11/12
1867	0·1224	0·1240	0·1327	0·1380
1874	0·1147	0·1238	0·1241	0·1321
1883	0·1161	0·1228	0·1329	0·1383
1909	0·1159	0·1195	0·1347	0·1498
1852–1903				
Wheat, average	31·2 bush.	32·2	32·2	35·1
Clover ,,	—	—	41·0 cwt.	47·7
Swedes ,,	151 0 cwt.	268·0	160·0	187·0
Barley ,,	22·1 bush.	28·7	24·5	34·5

barley, clover, wheat, but over half the field the clover is replaced by a year's bare fallow. Further, if we confine our attention to the one plot which never gets any nitrogen, but only mineral fertilisers, it is again divided at right angles into plots from which the turnip crop is wholly removed, and others on which it is returned, as so often occurs in practice when the turnips are eaten off *in situ* by sheep.

The above table shows the average yield on these

plots and also the changes in the nitrogen content of the soil at different dates.

There are two possible recuperative actions to make up for the crops removed—the Azotobacter working upon the carbonaceous matter returned in the turnip crop, and the growth of the clover, for that crop, as we know, gathers nitrogen from the atmosphere by means of the organisms living in the nodules upon its roots. When neither clover is grown nor are the roots put back the soil is slowly losing nitrogen; when either occurs singly a fair production is maintained without loss of soil nitrogen; when both take place during the rotation the average removals from the soil become as high as thirty-five bushels per acre of wheat, thirty-four of barley, and more than two tons of clover hay, yet the soil is, if anything, gaining rather than losing in fertility, though no extraneous nitrogen is being introduced.

Thus we see that we can maintain indefinitely a production of more than four quarters per acre of wheat, and their equivalent in other crops, by natural agencies alone without recourse to external supplies of nitrogen, provided we repair the small annual losses of phosphoric acid and potash, which, of course, cannot be regenerated from the atmosphere. But such a level of production, though equal to the average of the British Isles, is below that which a modern intensive farmer must attain, and the lesson that we have to bear in mind is that at a higher level, say that of five quarters of wheat, the wasteful actions of which we have spoken are increased out of all proportion. Hence we have to add as manurial nitrogen not merely the difference between that contained in the extra quarter of wheat, but four to five times that amount to repair the waste, and so on to an even greater extent if we still further raise the fertility and the production.

The essential wastefulness of highly intensive agriculture such as must be forced upon the race as the new countries fill up is a serious question, but the prospect of reducing the waste is not entirely hopeless. The losses, as we have seen, are due to bacteria, which attack the nitrogen compounds with liberation of nitrogen gas, the particular bacteria doing this being most active in soils rich in organic matter, until at Rothamsted we only recover in the wheat crop about one-quarter of the nitrogen applied in the heavy dressing of farmyard manure. The problem before us is to bring the soil bacteria under control, and we already begin to see in various ways that such control is not impossible. For example, the researches of Drs. Russell and Hutchinson at Rothamsted have already proved that in one simple way we can so rearrange the microfauna and flora of the soil as to obtain a much higher duty from the reserves of nitrogen therein contained.

It is too long a story to enter upon now. I can only briefly say that by putting the soil through various processes of partial sterilisation, such as heating or treatment with antiseptics, like chloroform or toluene, we can eliminate certain organisms which keep in check the useful bacteria in the soil—*i.e.* the bacteria which break down the nitrogen compounds to the state of ammonia, a form assimilable by plants. Heating the soil to the temperature of boiling water for two hours will double its productivity, and such a process has been found to be commercially profitable in the case of greenhouse soils. The market growers of cucumbers and tomatoes make up an exceptionally rich soil of virgin loam and stable manure, but in a few years such soil, while still enormously rich on analysis, becomes incapable of growing a profitable crop. The partial sterilisation processes of which I have been speaking restore and even enhance its fertility by eliminating the injurious organisms, and we learn from the detailed results that after such treatment a much larger percentage of the soil-nitrogen is recoverable in the crop than normally prevails in untreated soil. At present the processes have not been extended to the open field, but progress is being made in that direction, and gives some promise of a method by which ultimately the unseen fauna and flora of the soil will be domesticated, the useful races encouraged, and the noxious repressed, just as the larger flora and fauna have been reduced to our service since the days when primitive man first turned from hunting to agriculture.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A BEQUEST of the late Mr. J. E. Taylor of 20,000*l.* to the Victoria University, Manchester, has now become payable by the recent death of his widow.

IT is announced in *The Morning Post* that the foundation stone of the Agricultural College for Devonshire will be laid in October, probably by Mr. Runciman, President of the Board of Agriculture. The college is being provided as the result of a bequest by the late Mr. Charles Seale Hayne, M.P. for Mid Devon, who left nearly 100,000*l.* for the purpose. Of this 20,000*l.* will be spent on the buildings, and the balance will form a fund for administrative purposes. The site is the Howton estate, covering more than two hundred acres, near Newton Abbot.

THE Extension Section of the Manchester Microscopical Society will continue its useful activities during the coming session. We have received from the honorary secretary, Mr. R. Howarth, 90 George Street, Cheetham Hill, Manchester, the list of available lectures, for which the section is willing to make arrangements in and about Manchester. There are sixty-eight subjects to choose from, and nearly all the lectures are illustrated by means of the lantern. It will be remembered that the work of lecturing and demonstrating is entirely voluntary and gratuitous on the part of the members. The purpose of the section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees to professional lecturers. The cost of these lectures as a rule is limited to the out-of-pocket expenses of the lecturers, which in most cases do not exceed a few shillings. Secretaries of societies desirous of including nature-study lectures in their programmes should communicate with Mr. Howarth.

ON July 4 last, Mr. James Bryce, British Ambassador at Washington, visited the University of Sydney, where he was presented with an address, which was read by the Chancellor, Sir Normand MacLaurin. In replying, Mr. Bryce delivered an eloquent address, which was printed in *The Sydney Morning Herald*. Dealing with questions which are at present engaging the attention of university authorities throughout the Empire, Mr. Bryce remarked:—"How are the claims of theoretical science and applied science to be reconciled? How are the claims of languages, and geology, history, philosophy, and economics to be reconciled with the claims of physical science, and particularly the claims of applied science? At this moment science seems to have had all its own way. The development of scientific discovery has been such—so great and numerous have the applications of science to industry and commerce been, so far-reaching and potent in their results—that we have come to think of science as if it were the main object of human knowledge, and ought to take that primary place in

the scheme of human education formerly taken by languages and philosophy. I shall not—it would be presumptuous on my part to attempt to do so—say anything to disparage the claims of science. It is essential, not only to industry and commerce and progress of every material kind, but also indispensable as part of education itself, opening up to us the whole dealings of nature and God's dealings with men through nature, which it is essential that an educated man should possess. But any scheme of education is narrow and imperfect which does not reserve an important place for the human subject. A knowledge of men, their nature and literature, their history, their institutions, social and political, and their economic life—a knowledge of men and everything about men is at least as vital and essential to us as a knowledge of nature."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 12.—M. A. Gautier in the chair.—Lucien **Godeaux**: Rational transformations between two surfaces of genus one.—R. **Boulouch**: The properties of quasi-aplanatic surfaces in systems of spherical diopters.—Georges **Baume** and P. **Pamfil**: The fusibility curves of volatile systems. Mechanism of the formation of ethers. In studying the melting points of the system propionic acid, hydrochloric acid, and methyl alcohol, a clear maximum was obtained when these three substances were present in the proportion of one molecule of each. This combination constitutes the first step in the formation of methyl propionate.—G. **Timoféef**: The tempering and annealing of zinc. A reproduction of eight microphotographs showing the changes induced by tempering and the subsequent annealing of pure zinc.—B. **Longo**: *Ficus carica* in Italy.—P. **Mazé, Ruot,** and **Lemoigne**: Researches on chlorosis in plants induced by calcium carbonate. Calcium carbonate appears to cause chlorosis in plants by rendering the iron salts insoluble.—Em. **Bourquelot** and M. **Bridel**: New syntheses of glucosides of alcohols by the aid of emulsin. β-Butylglucoside, β-isobutylglucoside, and β-allylglucoside.

BOOKS RECEIVED.

Modern Road Construction. By Francis Wood. Pp. xi+137. (London: C. Griffin and Co., Ltd.) 4*s.* 6*d.* net.

The Technology of Iron Enamelling and Tinning: being Collected Papers by Julius Grünwald. Translated from the German by Dr. H. H. Hodgson. Pp. viii+139. (London: C. Griffin and Co., Ltd.) 6*s.* net.

Festschrift zur XLIII. allgemeinen Versammlung der Deutschen Anthropologischen Gesellschaft. Weimar, 4 bis 8 August 1912. Erstes Heft, Die steinzeitliche Technik und ihre Beziehungen zur Gegenwart. By Dr. L. Pfeiffer. Pp. vii+340. 13 marks. Zweites Heft, Das Aussterben diluvialer Säugetiere und die Jagd des diluvialen Menschen. By Dr. W. Soergel. Pp. v+81+3 plates. 5 marks. Drittes Heft, Der Derfflinger Hügel bei Kalbsrieth (Grossherzogtum Sachsen). By Armin Möller. Pp. iii+76+4 plates. 5.40 marks. (Jena: Gustav Fischer.)

Das Problem der Vererbung "erworbener Eigenschaften." By Richard Semon. Pp. viii+203. (Leipzig: W. Engelmann.) 3.20 marks.

Relative Bestimmungen der Intensität der Schwerkraft auf fünfundvierzig Stationen von Elsass und Lothringen. Bearbeitet von E. Becker. Pp. vi+150+map. (Karlsruhe: G. Braunschen.)

Structural and Field Geology. By Prof. J. Geikie. Third Edition, Revised. Pp. xxiv+452+plates. (Edinburgh: Oliver and Boyd; London: Gurney and Jackson.) 12*s.* 6*d.* net.

The Method of Archimedes, recently discovered by Heiberg. A Supplement to "The Works of Archimedes, 1897." Edited by Sir Thomas L. Heath. Pp. 51. (Cambridge: University Press.) 2*s.* 6*d.* net.

Das Problem der Funktionen des Nervensystems. By S. Baglioni. Pp. 50. (Jena: Gustav Fischer.) 1 mark.

Contribution à l'Étude des Courbes Convexes Fernicés et de certaines Courbes qui s'y rattachent. By Dr. C. Jordan and Dr. R. Fiedler. Pp. iii+73. (Paris: A. Hermann & Fils.) 3 francs.

The Collected Mathematical Papers of James Joseph Sylvester, F.R.S. Vol. iv. (1882–1897). Pp. xxxvii+756. (Cambridge: University Press.) 18*s.* net.

Per-acids and their Salts. By Dr. T. Slater Price. Pp. 123. (London: Longmans, Green and Co.) 3*s.* net. (Monographs on Inorganic and Physical Chemistry.)

Junior Magnetism and Electricity. By Dr. R. H. Jude and Dr. J. Satterly. Pp. vii+288. (London: W. B. Clive.) 2*s.* 6*d.*

Education: a First Book. By Prof. E. L. Thorndike. Pp. ix+292. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 6*s.* net.

The Teaching of Mathematics in Secondary Schools. By A. Schultze. Pp. xxi+370. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 5*s.* 6*d.* net.

College Zoology. By Prof. R. W. Hegner. Pp. xxv+733. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 11*s.* net.

Electric Lighting and Miscellaneous Applications of Electricity. By W. S. Franklin. Pp. viii+299. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10*s.* 6*d.* net.

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