THURSDAY, SEPTEMBER 22, 1910.

ANIMALS OF THE ANCIENTS.

Die Antike Tierwelt. By Otto Keller. Erster Band, Säugetiere. Pp. xii+434. (Leipzig: W. Engelmann, 1909.) Price 10 marks.

FOR many years past the author of this interesting volume has been engaged in investigating the records relating to animals known to the ancients, with the object of identifying the various species described or depicted, and working out their past history and distribution, special attention, in the case of mammals, being directed to the larger and more interesting forms, and those which have been domesticated by man. The results of this protracted study are incorporated in the work, of which the first volume is now before me, and in many respects Dr. Keller is to be congratulated on the outcome of his labours, especially in regard to his treatment of the various species of the Primates and Carnivora, although even among these he does not appear to have made himself acquainted with all the recent literature on the subject, and notably the work of Dr. Lortet on the mummified animals of Egypt, now in course of publication in the Archives of the Lyons Museum.

Even in the case of the Carnivora, I cannot, however, agree with all the author's conclusions, as, for instance, the statement on p. 72 that domesticated cats owe their origin in part to the jungle-cat (*Felis chaus*). Indeed, it is difficult to believe that he is fully acquainted with the characteristics of that species, or he would have hesitated in identifying with it the cat depicted in a fresco from Pompeii, which is reproduced on p. 72, the tail being much too long, and the ears showing no trace of the distinctive tufts.

Leaving the Carnivora with this brief mention, I pass on to the Ungulata, where there is much more room for criticism, more especially in regard to the author's identification of animals represented in the ancient sculptures and cylinders of Syria and adjacent parts of Asia Minor with species indigenous to Central Asia and other distant regions. Nor is this all, for when Dr. Keller attempts to identify animals represented in the frescoes of ancient Egypt with species inhabiting northern Africa, he is, in many cases, to say the least, far from happy in his conclusions. In the upper figure on p. 295 we find, for instance, an antelope identified as a hartebeest (Butalis), although it is much more probably a lesser kudu (*Strepsiceros imberbis*), and is identical with the fresco from the Ptahhetep Chapel, reproduced in Fig. 3 of the present writer's paper on "Some Ancient Animal Portraits" (NATURE, vol. lxx., pp. 207–209, 1904), and provisionally identified with that species. Again, the animals in the lower figure (99) on the page cited are likewise termed Bubalis, although two species are clearly portrayed, one being the presumed lesser kudu, while the other is, I think, the brindled gnu (*Connochaetes taurinus*). Further, on p. 291, Fig. 94, we find a fresco identified with the addra gazelle (*Gazella dama ruficollis*),[1] although it clearly represents *G. soemmerringi*, as does Fig. 2 in my above-cited article. The white oryx (*Oryx leucoryx*), Fig. 95, the addax (*Addax nasomaculatus*), Fig. 97, and the Nubian ibex (*Capra nubiana*), Fig. 101, are, on the other hand, correctly identified.

Leaving animals indigenous to Egypt and the neighbouring countries, attention may be directed to Fig. 93A, which is the one reproduced in NATURE for September 2, 1909, in a review of Countess Cesaresco's "Man and Animals in Human Thought." In that work the animals shown in this Assyrian relief are described as goats, but it was pointed out in the review that they are much more probably gazelles, although I was wrong in suggesting the addra, in which the females are horned. Dr. Keller is likewise of opinion that they are gazelles, but identifies them with the Tibetan goa (*G. picticaudata*), a species with which the ancient Assyrians cannot, I conceive, have been acquainted. Such an identification is, moreover, perfectly unnecessary, seeing that in the goitred or Persian *Gazella subgutturosa* we have a practically local species which agrees in all respects—notably the hornless females—with the relief.

Having shown that the animals in this sculpture are of a local type, attention may be directed to Fig. 102, p. 301, which reproduces the figures on part of a cylinder brought by Sir H. Layard from Constantinople. One of the ruminants on this is identified by Dr. Keller with the Himalayan markhor (*Capra falconeri*), and the other with the Central Asian argali sheep (*Ovis ammon*). Both species, be it noted, are represented as being in captivity, under the charge of apparently Syrian attendants, and the female of the supposed markhor carries horns as long as those of the male, and has a kid. This renders it, I think, clear that both kinds were seen by the artist in the living condition, and if this be so, it is perfectly evident that they were not, respectively, markhor and argali; animals, the very existence of which could not, I submit, have been even known to the ancient Assyrians. It is no argument to state, as the author does on another page, that the Assyrians were in the habit of bringing two-humped Bactrian camels from Afghanistan, seeing that these animals now come as far south as the Crimea and the Caucasus. Moreover, the long horns of the female are fatal to the markhor theory. In my opinion there is every reason to regard the supposed markhor as Circassian domesticated goats, in which both sexes carry long spiral horns.

As to the supposed argali, I am less confident but unless they be domesticated sheep, it may be suggested that they are Pallas's tur (*Capra cylindricornis*), of the eastern Caucasus, and in any case there can be little or no hesitation in regarding them as representing a more or less strictly local species. In connection with sheep, it must suffice to mention that there is great doubt as to the identification of those in the Negadah plate, B.C. 6000–5000 (Fig. 106, p. 310), with the domesticated Hausa sheep of Nigeria, as they appear to represent the wild udad, or Barbary sheep (*Ovis lervia*, or *tragelaphus*), of North Africa generally.

[1] *Antilope damma* of the author.

In place, therefore, of foreign species, with which it seems impossible for the ancient Egyptians and Assyrians to have been acquainted, it seems to me that all the ruminants referred to by Dr. Keller are local forms, well known to the artists and sculptors by whom they were painted or chiselled. The same remark will, I believe, apply to the representations of the Indian elephant, like the one on the obelisk of Salmanassar II. (Fig. 130, p. 375), although the author regards these animals as of foreign origin. He appears, however, to be unacquainted with the definite record that at an early date the Assyrian kings hunted the Indian elephant in the Euphrates valley, this record being confirmed by the occurrence of fossilised remains of the so-called *Elephas armeniacus,* which may have been merely a local race of the former species, in Armenia.

The Indian elephant being thus shown to have been a local, instead of an imported, species in ancient Assyria, it may be suggested that if the unicorn animal on the obelisk of Salmanassar ii. be, as Dr. Keller suggests (p. 386, Fig. 133), the Indian *Rhinoceros unicornis*, which is known to have had formerly a much wider distribution than at the present day, that species may likewise have ranged in Assyrian times into Mesopotamia; and, if this be the case, it will be practically certain that all the animals represented by the artists of ancient Egypt and Assyria were more or less local species.

More criticism of much the same nature might be added, but sufficient has been stated to show that while the volume under review contains a very large amount of valuable information concerning the early history of well-known animals, at least the portion relating to ungulates stands in need of revision by a writer with a fuller knowledge of that group than the author appears to possess. R. L.

THE DESIGN OF REINFORCED CONCRETE STRUCTURE.

(1) *A Concise Treatise on Reinforced Concrete.* By C. F. Marsh. Pp. viii+225. (London: Constable and Co., Ltd., 1909.) Price 7s. 6d. net.

(2) *Concrete-Steel Construction.* By Prof. Emil Mörsch. Authorised translation from the third (1908) German edition, revised and enlarged by E. P. Goodrich. Pp. ix+368. (New York: The *Engineering News* Publishing Co.; London: Messrs. Constable and Co., Ltd., 1909.) Price 21s. net.

(3) *Il Cemento Armato e la sua applicazione practica.* By Cesare Presenti. Pp. 141. (Milan: Ulrico Hoepli, 1910.)

(4) *Le prove dei materiali da costruzione e le costruzioni in Cemento Armato.* By Giulio Revere. Pp. xii+541. (Milan: Ulrico Hoepli, 1910.) Price 11 lire.

THE employment of reinforced concrete in connection with engineering and architectural structures has now become so general that a text-book on somewhat simpler and more condensed lines than those of Mr. Marsh's well-known treatise on "Reinforced Concrete" will be gladly welcomed by many engineers and architects. The present volume (1) has been, to a certain extent, based upon a series of lectures delivered by the author in the winter of 1908–9 at the Central Technical College, London; hence, in all cases the derivation of important formulæ has been fully dealt with, but lengthy and detailed descriptions of the various systems of construction have been omitted; this latter portion of the subject was fully dealt with in the author's manual.

The first two chapters deal respectively with the properties and the behaviour under bending of reinforced concrete, the important question as to the value of the modulus of elasticity (E_c) for the concrete which should be adopted in the calculations required in connection with the design of struts and beams is very fully discussed, and Mr. Marsh shows that we may safely assume it to be 2,000,000 pounds per square inch when the concrete is two or three months old, or, in other words, that the ratio of E_s/E_c may be taken as 15. In the third chapter the various assumptions which have to be made for purposes of calculation are briefly explained, and their validity discussed; it is shown that, when calculations are based on the safe working stress for concrete, it is sufficiently accurate for all purposes to assume a straight line stress-strain relation for the concrete as well as for the steel.

The rest of the book is devoted to methods of calculation; after a short discussion of the bending moments of beams and slabs partially built in at the supports, direct compression is taken up, and then the longitudinal, bond, and shearing stresses in rectangular section and T section beams with single or double reinforcement; pipes and similar structures subjected to either internal or external pressure are then dealt with; a very thorough and complete investigation is next given of the calculations which are necessary in the design of small, and large, span arches, and other pieces which are subjected to both direct stresses and to bending stresses. The design of reinforced concrete arches is always admittedly a difficult piece of work, and there is no doubt that the treatment which Mr. Marsh gives of this branch of reinforced concrete work will prove of great service to those who only occasionally have to deal with such structures, as the methods explained and discussed are simple and direct.

In the last chapter a brief description is given of the general methods of reinforcement which should be adopted in structural work.

Mr. Marsh, by his well-known treatise, established his position as a trustworthy guide in this important field of engineering and architectural design, and the present volume is quite worthy of the reputation thus acquired.

(2) Prof. Mörsch, in his capacity as director of the technical bureau of the well-known firm of Wayss and Freytag, has been responsible for the design and erection of the reinforced structures built by this firm during the past fifteen years; he has, therefore, in

part ii. of this book, which deals with the applications of reinforced concrete, confined himself entirely to work done by Messrs. Wayss and Freytag, and there is justification in regard to this choice, since the whole of the examples described have been designed in accordance with the rules and formulæ given by Prof. Mörsch in the first half of the book, and many of them, in accordance with the recommendations for the design and construction of reinforced concrete structures, issued by the Verbands Deutscher Architekten und Ingenieur Vereine, and the Deutscher Beton Verein in 1904.

The theory of reinforced concrete is fully and thoroughly discussed in part i. of this book, and it is this section which will be of great service to English and American designers, because it includes a mass of experimental data not hitherto readily accessible to those who wished to make use of these results in connection with any new piece of design work.

In an investigation as to the flexure of reinforced columns, Prof. Mörsch shows that a special calculation of their safety against rupture by flexure will only be required in exceptional cases; for the strength of reinforced columns with spiral reinorcement, the author accepts the conclusions of Considère, who showed that the carrying capacity would be 2·4 times as great with such a system as when the same amount of reinforcement was employed in the shape of longitudinal rods.

For calculations connected with simple bending, Prof. Mörsch adopts the usual hypothesis that the tensile strength of the concrete should be ignored; the gradual shifting upwards of the position of the neutral axis as the loading is increased is clearly shown by the plotted results of a series of careful tests made at the testing laboratory at Stuttgart. A valuable chapter is that devoted to the calculations necessary when bending is combined with axial forces; circular and annular sections are discussed, as well as those of rectangular form.

In rectangular metal beams the shearing stresses are unimportant, and may usually be neglected, but in reinforced concrete they are of great importance in considering the arrangement of the reinforcement, and Prof. Mörsch devotes several chapters to the consideration of this branch of the subject, which is often inadequately treated in works on reinforced concrete design; after a mathematical investigation, he deals fully with the results obtained in numerous experimental investigations, which he has himself carried out on T beams, both when simply supported and when continuous; the results obtained from the latter tests are exceedingly interesting and of great importance to designers of structures in which such continuous members are largely used.

In part ii. there are excellent illustrations of the use of reinforced concrete, examples having been selected from all the various types of buildings or structures for which this material has up to the present time been employed.

The recommendations of the German societies, already referred to, and the regulations of the Royal Prussian Ministry of Public Works, for the construction of reinforced concrete buildings, are printed as an appendix.

The translator, Mr. Goodrich, and the publishers are to be congratulated on the result of their labours. The illustrations, on the whole, are satisfactory, in spite of the difficulties connected with their reproduction, referred to in the publishers' note.

(3) The author adopts the usual hypotheses in order to obtain fairly simple formulæ for the design of beams, both smple and continuous; he takes E_s/E_c as equal to 15, and deals fully with both simple rectangular cross sections and T sections. The various formulæ are illustrated by numerous fully worked out examples.

In the second part of the work is given a number of graphical and numerical tables for facilitating the rapid calculation of the dimensions of beams of various classes for certain lengths of span under known loads, and examples are given to show how much labour is saved by the use of such tables; the maximum stresses permitted are those usually adopted in practice.

(4) The first half of this book is devoted to the subject of the testing of the materials of construction—stone, wood, metals, cements, &c. There is nothing novel or exceptional in this section in the method of treatment of a subject to which so many text-books have now been devoted. A special chapter is given to the subject of the microscopical investigation of the structure of metals, and to the application of this method to commercial testing.

The standard conditions for carrying out commercial tests of materials, as approved by the Italian Government, are printed in the form of appendices to the appropriate chapters, and will prove of interest to engineers who may have to carry out contracts for the Italian Government, or for local authorities in that country.

The second half of the book treats of constructional work in reinforced concrete; here the usual order adopted in text-books is inverted; the first ninety pages of this section are occupied with illustrations and descriptions of works of all classes—buildings, bridges, silos, harbour works, &c.—which have been constructed in ferro-concrete, and then follow several chapters devoted to the theories underlying the design of such structures. Most of the works illustrated have been carried out in Italy, where ferro-concrete work has developed much more rapidly than in Great Britain, and this section of the book will prove useful to designers of similar works in this country, especially as many of the reproduced working drawings are fairly fully dimensioned.

The mathematical treatment adopted in the chapter devoted to the design of columns and beams of all classes is that which has now become more or less stereotyped in text-books dealing with reinforced concrete. There is only a brief treatment of the arch, but continuous beams are very fully discussed.

T. H. B.

TEXT-BOOKS OF CHEMISTRY.

(1) *Practical Chemistry.* By Dr. James Bruce and Harry Harper. Pp. viii+240. (London: Macmillan and Co., Ltd., 1910.) Price 2*s.* 6*d.*

(2) *Qualitative Analysis. Tables for Use at the Bench.* By E. J. Lewis. (Cambridge: University Press, 1910.) Price 2*s.* 6*d.* net.

(3) *Outlines of Organic Chemistry. A Book Designed especially for the General Student.* By Dr. F. J. Moore. Pp. x+315. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1910.) Price 6*s.* 6*d.* net.

(4) *The Calculations of General Chemistry, with Definitions, Explanations, and Problems.* Second edition. By Prof. William J. Hale. Pp. xii+175. (London: George Bell and Sons, 1910.) Price 4*s.* 6*d.*

(5) *A.B.C. Five Figure Logarithms and Tables for Chemists, including Electrochemical Equivalents, Analytical Factors, Gas Reduction Tables, and other Tables useful in Chemical Laboratories.* By C. J. Woodward. Pp. iv+70. (London: E. and F. N. Spon, Ltd.; Simpkin, Marshall and Co., Ltd.; New York: Spon and Chamberlain; Birmingham: Cornish Bros., 1910.) Price 2*s.* 6*d.* net.

(1) THE first of these books contains in the space of 240 pages an account of the manipulative methods of chemical experiment, a selection of inorganic and organic preparations, instructions for physical measurements, such as the densities of liquids and vapour densities, qualitative analysis of simple salts, and a selection of volumetric and gravimetric methods. In spite of the large amount of ground which is covered, the work is excellently done, and it is a great advantage to find in a single small volume nearly all that is needed in the way of text-book instruction for the practical work of a course passing well beyond the standard of an intermediate B.Sc. course, and almost up to the standard of the final examination. Such criticisms as may be made refer only to matters of detail, and are not intended to detract from the value of a book which is undoubtedly one of the best that has appeared. It may, however, be noted that the method of making ethylene by means of phosphoric acid, as described by Newth in the Journal of the Chemical Society, is much superior to the older method, in which sulphuric acid was used, and should be generally adopted. The gas-regulator shown on p. 5 is less efficient than those in which toluene is used, and the pyknometer (Fig. 42) shown on p. 98 has been improved by the use of two bulbs instead of one, as recently described by Mr. W. R. Bousfield. In the volumetric work it is to be regretted that only one method of preparing a standard solution (normal Na_2CO_3 from $NaHCO_3$) is given, as the checking of these methods against one another forms an excellent test of the accuracy of the work, and is of far greater value than the estimation of acids and alkalis in variable commercial samples; moreover, the estimation of acids is far more accurate if carried out with the help of a standard acid and intermediate alkali than when a standard alkali is used, as in the former case all the errors which arise from uncertainty as to "end-point," &c., are eliminated.

Amongst the omitted methods are the preparation of standard caustic soda by weighing out sodium, dissolving in alcohol and diluting, and the preparation of standard acid by measuring the density of sulphuric acid of 80 to 90 per cent. strength, and diluting, as described by Marshall in the Journal of the Society of Chemical Industry. In the experience of the present writer these methods, in the hands of students as well as in work of the highest attainable accuracy, lead to exact results more readily than most of those that have been described. In the use of permanganate it is doubtful how far it is safe to rely on the purity of the crystals, and as the solutions are not altogether permanent, it would be well to treat them from the beginning as only approximately correct.

(2) The best guarantee of the quality of the material printed on these cards is the name of the author, whose "Inorganic Chemistry" has almost created a new ideal in elementary text-books. How far the idea of using printed and varnished cards will prove superior to the system of practical text-books is a matter that can only be worked out by actual experience in the laboratory.

(3) In comparison with the majority of text-books of organic chemistry, this volume starts with one great advantage—that the authors have not attempted to make it into a dictionary or table of physical constants. They have, therefore, been enabled to deal in a small volume with an unusually large amount of interesting and "advanced" material, usually reserved for works of a more pretentious character. This is in many respects a distinct advantage. On the other hand, they have omitted almost entirely the details of methods of preparation, and so have conferred on the subject with which they deal a certain impression of unreality, which might easily have been removed. If, however, the student who reads the book is at the same time carrying out a course of organic preparations, the risk that he may come to regard the subject as one of algebra and geometry—only loosely attached to experiment by the necessities of verification—will be removed, and the book may then prove both useful and suggestive.

(4) The use of numerical examples is an excellent way of impressing upon a student the meaning of equivalents, vapour densities, molecular and atomic weights; it is also necessary in order to secure accuracy in the calculation of analytical results, especially if this is to be done correctly under the hurried and somewhat unpractical conditions of a "practical examination." This need the author has attempted with some measure of success to supply. The chief fault of the book arises from the fact that most of his examples appear to have originated in the study instead of in the laboratory. No chemist would be likely to use in actual work the bewildering array of standard solutions referred to in chapter x., 2N, N, N/2, N/4, N/5, N/6, N/8, N/10, N/20, &c.; neither would anyone who had experience of the subject expect to obtain a theoretical yield of nitric oxide from 7N nitric acid and copper. These and other calculations of a similar character suggest that the author

is merely attempting to teach chemical arithmetic with no regard for the opportunities which arise of teaching chemistry at the same time. The figures actually resulting from the best experiments are so readily accessible that a book which fails to make use of them and substitutes obvious fictions is scarcely to be recommended.

(5) This book of tables is well compiled, and should prove useful, but the printing and binding are not as good as might be desired in view of the small size of the book and the price at which it is issued.

MINERAL SPRINGS AND WELLS OF ESSEX.

A History of the Mineral Waters and Medicinal Springs of the County of Essex. By Miller Christy and Miss May Thresh, with a critical note by W. H. Dalton. Essex Field Club Special Memoirs, vol. iv. Pp. vi+73. (Stratford, Essex: Essex Field Club; London: Simpkin, Marshall and Co., Ltd., 1910.) Price 2*s*. 6*d*. net.

THIS work forms vol. iv. of the Essex Field Club Special Memoirs, and has been reprinted from the *Essex Naturalist,* with additions. As in most other English counties, there are in Essex a number of springs and wells that have attained notoriety as mineral or medicinal waters, and the authors have done well to prepare a full and precise account of them.

The earliest record is of a spring at Wanstead, which was regarded as a spa in 1619, but has long been lost to sight. Witham, Chigwell Row, and Upminster had mineral waters that were formerly reputed to be of medicinal value. No information is available concerning the particular constituents of the Witham Spa; the water of Chigwell Row was purgative, but of no importance; while that of Upminster contained Epsom salts. Tilbury water, obtained from a well, appears to have been most famous in Essex, but, as the authors remark, the saline ingredients were insufficient to justify its being considered a mineral water. Dr. Richard Russel, however, remarked in 1769 that the water "makes excellent Punch, and is extremely good for Tea." The only genuine mineral waters acknowledged in the present work are those of South Weald, Upminster, and Hockley, which contain as the more prominent ingredient magnesium sulphate. As the authors admit, every so-called mineral spring in Essex, with one exception, is now neglected, and almost forgotten; and as regards the waters in general they consider "that 'faith' was an important, if not the chief, element in the 'cures' they are credited with." Dovercourt Chalybeate Spa, discovered about 1852, is the sole remaining spa, and in a sample of the water sent in 1897 to Dr. J. C. Thresh, he reported that it contained under one grain of iron salts per gallon.

The authors express their indebtedness to Dr. Thresh for assistance in dealing with the Essex waters from a chemical point of view, and to Mr. W. H. Dalton for notes on the strata whence the waters are derived. Reference should have been made to the Bagshot Sands on p. 63, as the waters of Hockley, as well as those of South Weald, are derived from that formation or the passage-beds above the mass of London Clay. There are no deep-seated mineral waters in Essex, but the subject, as shown by the authors, is one of considerable interest, and by no means devoid of scientific importance.

H. B. W.

OUR BOOK SHELF.

(1) *Edible and Poisonous Fungi.* Board of Agriculture and Fisheries. Pp. 28. With 25 coloured plates. (London: His Majesty's Stationery Office, 1910.) Price 1*s*.

(2) *Guide to Mr. Worthington Smith's Drawings of Field and Cultivated Mushrooms and Poisonous or Worthless Fungi often Mistaken for Mushrooms, Exhibited in the Department of Botany, British Museum (Natural History).* Pp. 24. (London: Printed by Order of the Trustees of the British Museum, Natural History, 1910.) Price 1*s*.

(1) THE publication of this pamphlet by the Board of Agriculture and Fisheries is intended doubtless to broaden the "mushroom" diet of country dwellers. Whether this object will be attained depends primarily on the doubtful possibility of creating an interest in a lethargic public, and further, in making quite clear the somewhat abstruse differences between the clean and the unclean. With regard to means of discrimination, reliance is placed on coloured plates and short descriptions, to which are added a few hints on preparation for table. What is distinctly lacking is an attractive general account, with information regarding the kinds exposed for sale in foreign market places, where there is often a considerable variety. The list of edible species does not include either the chantarelle or the truffle, while another notable omission is a warning that individuals vary greatly in their power of digesting fungal ferments.

(2) The pamphlet issuing from the British Museum (Natural History) is valuable both as a scientific exposition by one of our most eminent fungologists and also as an authoritative guide for the use of those interested in mushroom cultivation. The descriptions are semi-popular, and the coloured figures are artistic, accurate and well rendered. The setting of the text, as also the plain directions for detecting the poisonous species, add to the practical utility of the pamphlet, which fulfils one of the chief objects of the Trustees, inasmuch as it provides accurate and useful information for the benefit of the general public.

Fractures and Separated Epiphyses. By A. J. Walton. Pp. vii+288. (London: E. Arnold, 1910.)

IN a short preface the author explains that this book is intended for the use of students and those first commencing hospital appointments, but there is every reason to believe it will prove of great value to practitioners in general. Mr. Walton does not confine himself to advising any one method of treatment, but concisely places before the reader the various treatments advocated, with an open-minded criticism of their several points.

The chapters dealing with the etiology and general methods of treatment are, considering the largeness of the subject, both clearly and shortly dealt with, yet nothing of importance has been omitted. In describing the fractures peculiar to each bone, with their treatment, special attention is given to the dates of union in the various epiphyses, and the injuries which they are liable to sustain. The accompanying illustrations, reproduced from radiographs of fractures seen at the London Hospital, are typical and excellent. The book show great care in preparation, and can be recommended to all who need a short, practical work on this subject.

FRANK ROMER.

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.*]

Gauss and Non-Euclidean Geometry.

PROBABLY someone will before this have directed your attention to a statement in NATURE of June 30 regarding Gauss's share in the discovery of non-Euclidean geometry; but in case this may have escaped notice, even after the lapse of three months, I venture to bring it again before your readers. Speaking of Mannoury's book—"Methodologisches und Philosophisches zur Elementarmathematik"—"G. B. M." says "there is one remarkable statement made which deserves mention. Dr. Mannoury says that in December, 1818, F. K. Schweikart sent to Gauss a note asserting the existence of a geometry in which the sum of the angles of a triangle is less than two right angles, and in which the altitude of an isosceles triangle with a finite base has a finite upper limit. This goes far to demolish the claim made for Gauss that he was the first to assert the possibility of a consistent system of geometry distinct from Euclid."

The story of Gauss and the non-Euclidean geometry will probably always be incomplete, as he never published his investigations on this subject, and what is known of them has been gleaned from his correspondence and some notes only recently found among his papers (cf. Gauss, "Werke," Bd. viii., Leipzig, 1900). But neither Engel nor Stäckel—to whom we owe much of what has been written on the theory of parallels—nor any of the other writers on this phase of non-Euclidean geometry, have asserted that Gauss ever published any statement of his theory, large or small. The most that has been claimed for Gauss is that before Lobatschewsky, in 1826, and Bolyai, in 1832, published their statement of the geometry which will always be associated with their names, also even before Schweikart in 1818 had drawn up the note to which reference is made above, Gauss himself was convinced of the logical possibility of a geometry independent of the fifth postulate, and had mentioned many of his conclusions to his friends, verbally or in writing.

What happened with reference to Schweikart is well known. The whole story is to be found in Gauss's letter of 1819 to Gerling, by whom the memorandum had been submitted to Gauss at the request of the author. Like the subject of a recent political controversy, it could be written on half a sheet of notepaper; and it called forth from Gauss the warmest praise. With it he fully agreed. In fact, his results were exactly the same as those he had already obtained. His own work, he added, he had developed so far as to have fully solved all the problems of the new geometry. Some of his results he sent to Gerling to be communicated to Schweikart himself.

It is not of much importance whether before this date we have any reference to these investigations; but such is actually forthcoming in Wachter's letter to Gauss two years earlier, where he speaks of their conversation at Göttingen, and wonders "whether the anti-Euclidean geometry or your geometry is true."

And more valuable, as showing Gauss's real position, is his well-known letter to Wolfgang Bolyai in 1832, when he had received from him a copy of Johann's famous work:—"If I begin by saying that I cannot praise this work [of Johann's] you will assuredly be surprised for a moment. But I cannot say anything else. To praise it would be to praise myself. In fact, the whole contents of this work, the path which your son has followed, and the results to which he has been led, agree almost completely with my own meditations on this subject, some of them as old as thirty to thirty-five years."

This is but one of several statements of the same kind which we find in the correspondence of Gauss now available. Still, he would have been the last person to assert any claim for himself in the matter. Indeed, it was "a very great pleasure to him that it was actually the son of his old friend who had made this advance upon him in such a remarkable fashion." Yet there is ample evidence that the ideas contained in Schweikart's memorandum were already known to him, and that with much of the work of Lobatschewsky and Bolyai he was familiar long before they themselves had made these discoveries. To them belongs the independent discovery of their geometry, and its complete and systematic development. By their names it will always be called. To Schweikart, to a small extent, to Gauss to a much larger, can be given the credit of having realised that, along the path which Lobatschewsky and Bolyai travelled, complete success was bound to be achieved. H. S. CARSLAW.

The University, Sydney, August 10.

An Oblique Belt on Jupiter.

OWING in the main part to the swift axial rotation of the planet Jupiter, it is usual to find the dark belts, which constitute the principal configuration of his visible surface, lying both parallel to one another and to the planet's equator. An instance of obliquity of one of the bands relatively to the others is rare, and a most definite and striking example of the kind was recorded in the northern hemisphere in 1860. A recent phenomenon akin to this was observed in the spring months of the present year. Although in this case the band was a faint one, yet the marked trend which it exhibited called for special notice, and the more important facts relating to it might be briefly recorded here.

It attracted my attention, when engaged in a systematic study of the planet, first on April 1, and was subsequently observed on the following nights:—April 6, 8, 23, 28, May 2 and 7. After the last-mentioned date it was not seen again, partly on account of its growing faintness, and partly because the prevailing telescopic seeing was not inducive to a close scrutiny of the planet. During this observed interval a number of careful drawings of the region in question were executed, as well as a series of central-meridian transits of spots situated in and around the slanting belt. Some of these spots had been watched several months[1] prior to the appearance of this belt, so that the rotational velocity of the surface matter in this particular region was, on the whole, fairly accurately ascertained.

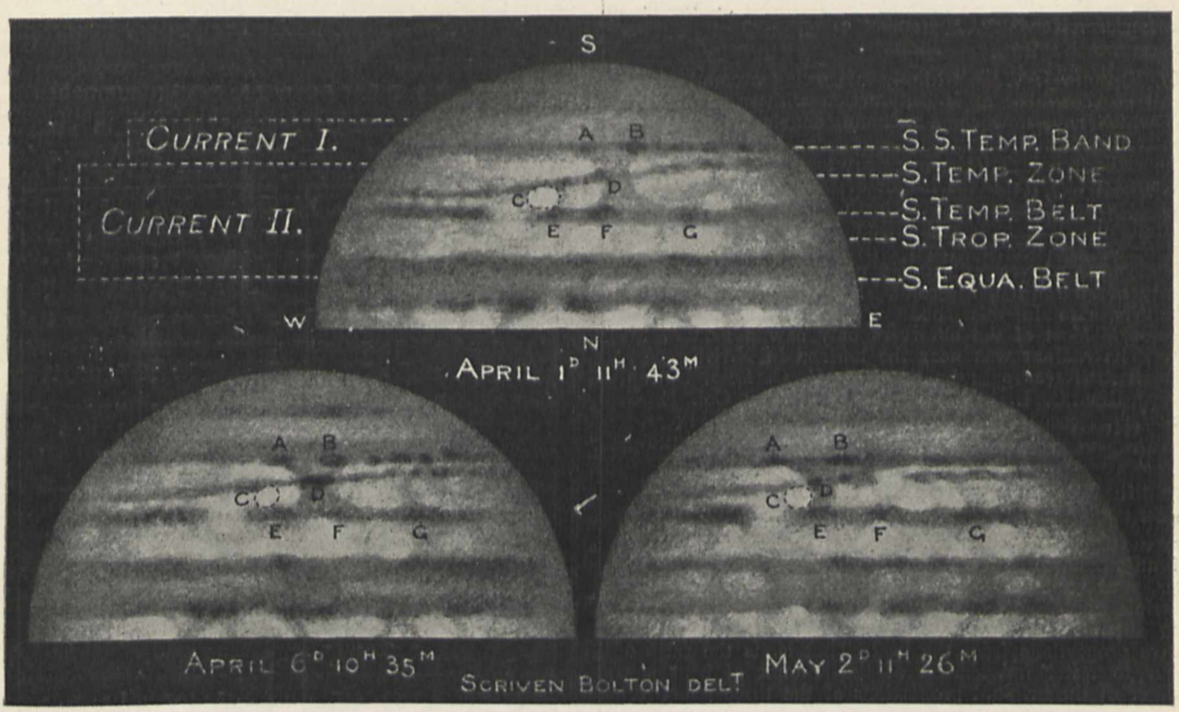
The oblique belt, which was a new formation, stretched itself across the white zone between the S. temperate and S.S. temperate belts. Nowhere, however, did it coalesce with these two belts, a point which can be better understood from the accompanying drawings than from a description alone. Its separate existence was due, evidently, to a repulsive action exerted upon it by the belts, which seemed to form a barrier against any further displacement in latitude.

The region of the oblique belt could always be readily recognised, even under poor definition, by reason of an abnormal dark patch of matter which occupied the site where the oblique belt crossed over the central part of the zone in which it was situated. This patch presented a concave outline both east and west, and the oblique belt passed uninterruptedly through it. A white spot (*c*) preceded it, and a fainter one was at times seen on the following side. This curious patch became visible earlier than did the oblique belt, and its greater durability enabled it to remain in view long after the belt had ceased to be visible.

The quicker drift of the spots A and B relatively to E, F, and G will be noticed in the drawings. The dark patch, with its condensation D, was carried along at about the same rate of velocity as A and B, and all, therefore, participated in one and the same current. The white spot C drifted at the same rate as the spots E, F, G, and, as will be noted, it was being gradually overtaken by the dark patch. Thus we observe the relative movements of two independent currents. They disclosed the noteworthy fact that the dark patch was in reality a distended part of the current about A and B, having evidently forced its way northwards across the slower current round C to the spots E, F, G. The condensation D formed part of the oblique belt. Whether the rest of this belt participated in the quick current of A and B is not known; but if such was really the case, we have here at least a clue as to the cause of the curious trend of the belt. The material of a

[1] Opposition of Jupiter occurred on March 31, 1910.

quick current often trespasses upon a slower moving one, a fact which is manifested by wispy shadings and spots protruding considerably into an adjacent current. Such an intrusion of matter might have occurred in the region of the S.S. temperate belt, and by continuing its northerly course slowly but interruptedly, its rapid westerly drift combined would cause it to drift in a W.N.W. direction. The result would be for the matter to form a slanting streak across the disc, and it is possible, and not improbable, that the oblique belt under discussion has found its origin through a similar cause.



An Oblique Belt in Jupiter, 1910.

The movements of the seven spots lettered in the drawings are tabulated as under :—

Name of spot	First and last date of observation	Average monthly drift (3 days)[1]	Rotation period h. m. s.	
A	1910, Feb. 9 1910, May 7	+28·5	9 55 2·8	Current I.
B	1910, April 1 1910, May 7	+31·0	9 54 59·5	
D	1910, April 1 1910, May 7	+28·5	9 55 2·8	
C	1910, Jan. 16 1910, April 23	+17·0	9 55 18·1	Current II.
E	1910, March 5 1910, April 23	+15·8	9 55 19·7	
F	1909, Dec. 13 1910, April 23	+14·3	9 55 21·7	
G	1909, Dec. 30 1910, April 1	+17·5	9 55 17·4	

The oblique belt was situated on the opposite side of the planet to the red spot, and the longitudes of the condensation D might be given here :—

1910	1910
April 1 = 169·2	April 23 = 146·9
,, 6 = 161·6	May 2 = 140·2
,, 8 = 156·1	,, 7 = 133·4

Leeds, September 3. SCRIVEN BOLTON.

[1] Relatively to the adopted zero meridian of System II., based on a rotation period of 9h. 55m. 40·6s. (*Nautical Almanac*).

Tests for Colour-vision.

AN article in NATURE for August 18 deals aptly with the question of testing for colour-vision. It is to be hoped that the committee at present inquiring into the matter will advocate that testing should be carried out in future in conditions resembling as nearly as possible those on which seamen ordinarily follow their calling. It does not seem quite practical or fair to test indoors a man's ability to pick up lights in the open. The conditions of light inside and outside vary so much, as do those of inside and outside darkness. A sailor's business is not to match colours, but to pick up and distinguish instantly lights that may be seen, far or near, through varying conditions of atmosphere.

The sight of the average seaman, from practice, is probably much keener than that of the average landsman. The sailor's eyes are trained to adapt themselves to varying conditions of outside darkness.

The suggestion of spectrum tests is good, provided that such testing is made supplementary only to the practical open-air tests with flags by day and sidelights by night. The object of the tests is to ascertain the candidate's faculty for instant recognition of a flag or light, and there is no difficulty whatever in providing efficient practical tests. It is unnecessary, and even mischievous, to try to puzzle a candidate with combinations of lights and shades such as never occur in the course of his practical work.

It is to be hoped that the committee which is investigating the matter will allow common sense and practical ability to rule its recommendations for future examinations. D. WILSON-BARKER.

The Thames Nautical Training College, H.M.S. *Worcester*, Greenhithe, September 19.

Fireball of September 2.

THE remark in NATURE of September 8 (p. 318), as to the necessity of further observations for determining the height and velocity of meteors encourages me to send the following note :—

At 9.5 p.m. on September 2, from Earlstone Common, four miles south of Newbury, I had a good view of the meteor described by the Rev. J. C W. Herschel as seen from near Wellington College. I have seen brighter meteors, but never one that remained so long in sight, and its course was marked for a long way by a streak of light, showing very clearly the route it had taken. When I first caught sight of it, it appeared to be rising in the sky, through the Camelopard, and it passed almost exactly over β and γ of the Little Bear, over η Draconis, between π and ρ Herculis, and over α Ophiuchi, vanishing perhaps 15 degrees further south in the Serpent. Rising and falling in its flight like a thrown cricket-ball, it seemed to be quite close at hand.

Edmund J. Webb.

Burghclere, Newbury, September 9.

Mr. Edmund J. Webb's highly interesting account of the fireball of September 2, in conjunction with other descriptions which have now come to hand, enable the real path to be well determined.

The radiant point of the meteor was near β Aurigæ, or at about $87° + 41°$, and the height of the object from about 98 to 44 miles from over the North Sea to S.S.W. coast of England. The meteor had an unusually long flight right across the country from N.N.E. to S.S.W., and its visible course of 352 miles was probably traversed at a velocity of 40 miles per second. It is only rarely that a fireball is seen in this country with such an extended trajectory. Most of the observers only saw a part of the path. The radiant was near the horizon in N.N.E.

The fireball was seen by the Rev. F. C. Lees, Sutton, Surrey; Rev. C. L. Tweedale, Otley, Yorks; Col. E. E. Markwick, Boscombe, Hants; and many other observers.

W. F. Denning.

The Law of Definite Proportions.

Perhaps a reader of Nature will be good enough to solve the following question.

If an amount of heat is supplied to a volume of ice, water, and vapour *at* the triple point, and *remaining at* the triple point, and the same volume, while the heat is being supplied, are water and vapour formed in definite relative proportions from the ice? That is, is the ratio of vapour to water independent of the amount of heat supplied, or of the original proportions of the three phases?

C. E.

King Edward VII. School, Sheffield.

FIRE TESTS WITH TEXTILES.[1]

The frequent accidents caused by the ignition of highly inflammable wearing apparel have directed wide attention to the possibility, by suitable treatment, of rendering materials like flannelette non-inflammable. The interest aroused by the subject is further increased by the fact that most of the fatal accidents occur to very young children, and apparently the number of such accidents is not diminishing.

Thanks must be given to the British Fire Prevention Committee for the efforts being made to investigate the subject in a thoroughly scientific manner, and for the report before us, which contains the results of experiments on 456 samples of cloth. These were divided into the five following groups:—(*a*) Flannelette ("non-flam," commercial); (*b*) flannelette ("non-flam," special); (*c*) flannelette (ordinary); (*d*) "union" (a mixture of cotton and wool); (*e*) flannel; (*f*) flannelette (fine finish). The method of testing employed was briefly as follows:—A yard of the cloth was suspended from three hooks fixed in a beam, the lower edge was kindled by the flame of a wax taper or spirit lamp. At the end of sixty seconds any flame was extinguished, and the portion of material burned carefully measured. In many cases photographs were taken before and after the ignition, and these supply more vivid illustrations of the results than the pages of statistics which follow. In some cases made-up garments were suspended on wire frames and tested as before. The different samples were also tested before and after repeated washings. Manifestly this is a point of great importance, and it was proved that in the case of "non-flam" materials there was practically no difference as regards fire resistance between samples washed once and those washed twenty times.

The general nature of the results may be briefly stated. Unquestionably the flannelette known as "non-flam" justifies its name. Samples of this material are only charred where they have been in contact with the flame; they are non-inflammable.

Ordinary flannelette as received from the manufacturer burned up through the centre of the sample,

(*a*) (*b*)

Demonstration Tests with Garments: (*a*) Flannelette ("Non Flam Commercial) at 120 seconds. (*b*) Flannelette (Ordinary) at 60 seconds.—From "Fire Tests with Textiles."

and from 25 to 40 per cent. of the material was consumed, while after *one washing* from 92 to 100 per cent. was destroyed. The material known as "union," a mixture of cotton and wool, as might be expected, is less inflammable than flannelette; from 57 to 66 per cent. of the material, after one washing, was burnt.

In the case of flannel the charring only reached as far as the power of the flame extended. Lastly, the flannelette (fine surface) is shown to be very like the ordinary, and in many cases the sample was completely consumed. This investigation appears to have been carefully conducted, and the report should be widely circulated. The illustrations explain themselves: (*a*) a "non-flam," made-up garment, after 120 seconds; (*b*) a made-up garment, ordinary flannelette, after 60 seconds.

[1] Fire Tests with Textiles. Flannelette known as "Non-Flam" Flannelette, Ordinary Flannelette, "Union" Flannelette submitted for test by Messrs. Whipp Bros. and Tod, Ltd., Manchester. The Committee's Report, pp. 48 ("Red Books" of the British Fire Prevention Committee, No. 148.) (London: The British Fire Prevention Committee, 1910.) Price 5*s*.

THE CASTES AND TRIBES OF SOUTHERN INDIA.[1]

THIS, if not quite the most workmanlike, may justly claim to be the most voluminous contribution to the publications of the Ethnographical Survey of India. The facts for which Mr. Thurston is personally responsible were collected in a series of tours throughout the Madras Presidency, in which he was able to combine the collection of specimens for the museum under his charge with a considerable amount of original work. He gives a lively account of the difficulties which he experienced in examining and measuring the shy jungle folk in whom he was most deeply interested; and the combined tact and enthusiasm with which he conducted these inquiries deserve hearty recognition. With his own personal investigations he has combined contributions from other writers, among whom the work of Mr. F. Fawcett, much of which is already familiar to students of the periodical bulletins of the Madras Museum, is the most valuable. To these have been added numerous extracts from census reports, district manuals, and similar literature; and the large series of excellent photographs adds largely to the interest and value of the work.

It is, however, to be regretted that, apparently from pressure of other duties, Mr. Thurston has been unable to arrange this great mass of material in a form suited to the needs of students. The articles contain much undigested material, and little has been done to classify this in a series of well-ordered paragraphs, each provided with a marginal heading, and bringing together the accounts of tribal organisation, domestic ceremonies, religious beliefs, and the like. It is obvious that the bulk of the work might have been much reduced by judicious compression; and, as native States like Mysore and Cochin are engaged in ethnographical surveys of their own population, it was unnecessary to give more than references to their preliminary bulletins. There is nothing in the shape of a subject-index; and though a good start was made by Mr. W. Francis in his report on the census of 1901 to compile a bibliography of the literature of the subject, Mr. Thurston has done nothing to supplement it. A protest must also be made against the habit of the writer, which has already greatly impaired the value of his useful "Ethnographic Notes on Southern India," published four years ago, of giving in the notes merely the names of his authorities without precise references. This gives a slovenly appearance to the work which it otherwise does not deserve.

We might also have expected from the author an exposition of his views on the prehistoric ethnology of the province. The Dravidian question is always with us, and though he supplies some facts which may assist in its solution, his personal views on the subject are nowhere definitely stated; and he seems to have abandoned in despair any attempt to indicate how far the existing jungle tribes are related to that remarkable people who reared the great series of megalithic monuments which abound on the Nilgiri plateau, the relics from which, excavated by Mr. Breeks and others, form the most interesting collection in the museum under his charge. Two important facts, however, can be gathered from his notes on the physical characteristics of the people; first, that the primitive Negrito element is not so widely distributed as some authorities have assumed. It is not apparent among the Kotas and Badagas, who seem to be later immigrants into the hill country from the plains, and it is found only among the more primitive tribes, like the Irulas and Kurumbas. Even among them it is important to note that prognathism and woolliness of hair appear as aberrant characters. In the second place, when we speak of the Dravidian head form, we must remember that it is not consistently uniform throughout the Presidency. Whatever may be the causes of this variance of type—the influence of environment or miscegenation—about which Mr. Thurston, with his characteristic caution, declines to express an opinion, it is certain that the type in the northern district is subbrachycephalic or mesaticephalic, while it is only in the Tamil and Malayalim countries that we find it to be dolicho- or subdolicho-cephalic.

The chief interest in the ethnography of southern India lies in the startling variances of culture which appear throughout the population. For an example of what is apparently the lowest type, we may turn to the Yānādis, a dark-skinned, platyrhine, under-

FIG. 1.—Toda Woman. From "Castes and Tribes of Southern India."

sized tribe inhabiting the Telugu country. Their religion is a crude form of animism; they make fire by friction; eat their food almost raw, merely scorching or warming the flesh of the animals which they kill; and yet, with the curious inconsistency which pervades the Hindu social system, they are regarded by the higher classes as gentlemen of the forest, are allowed to draw water from wells used by high-caste people, and may carry it to Brahmans. In direct contrast to them we may refer to the Nāyādis, a tribe in the plains little higher in culture than the Yānādis, who live by collecting jungle products, and are regarded as so impure that in their begging rounds they are compelled to stand at a distance from respectable houses, and to make their appeals for charity in stentorian tones.

A higher type of culture is reached in the Badagas, the agriculturists of the hills, where the pastoral element is represented by the Todas, and the industrial

[1] "The Castes and Tribes of Southern India." By Edgar Thurston, assisted by K. Rangachari. Vol. i., A and B. Pp. lxxiii+397. Vol. ii., C—J. Pp. 501. Vol. iii., K. Pp. 500. Vol. iv., K—M. Pp. 501. Vol. v., M—P. Pp. 487. Vol. vi., P—S. Pp. 458. Vol. vii., T—Z. Pp. 439. (Madras: Government Press, 1909.)

by the Kotas. Mr. Thurston's account of these people forms one of the best articles in his work. They live in dread of the more savage Kurumbas, by origin

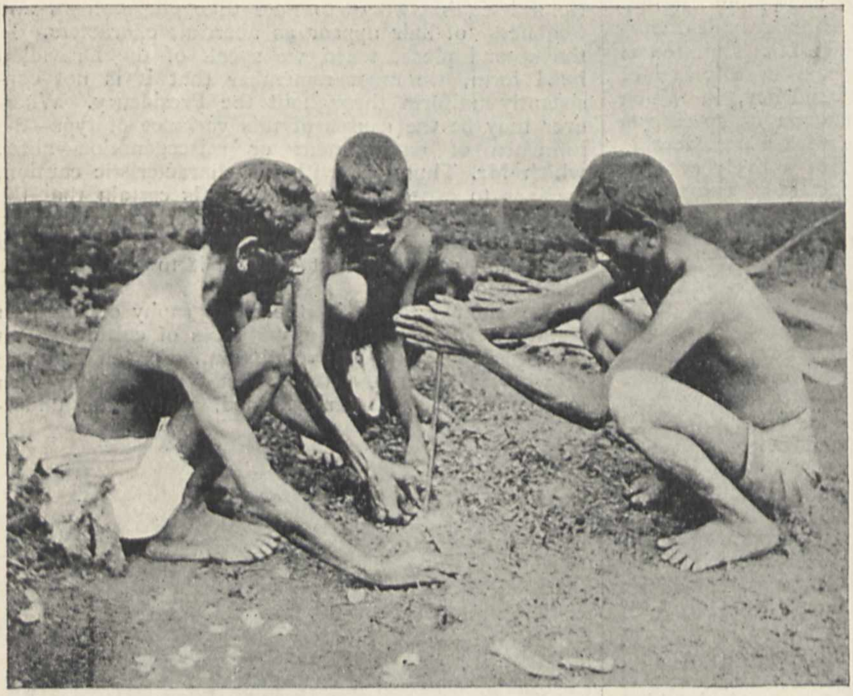


FIG. 2.—Nāyādis making Fire. From "Castes and Tribes of Southern India."

Negritos, who, like many other secluded races, are supposed to possess the power of necromancy. Every Badaga family pays them a sort of retaining fee in the shape of an annual tax and special dues at funeral and pregnancy rites, in return for which the Kurumba is bound to treat cases of diabolical possession or of the evil eye by means of appropriate spells. But the Kurumba needs to be cautious in exercising these uncanny powers, for instances are quoted of cases in which he has been suspected of unfair dealing, and "his hut is surrounded at night, and the entire household massacred in cold blood and their houses set on fire."

At the head of the social system stand the Brahman and the Toda. The entry of both into the social system of south India is comparatively modern. Mr. Lewis Rice, in his recent summary of the epigraphical evidence from Mysore and Coorg, finds that there is no record of Brahmans in those regions before the second century of our era; and other authorities, like that great scholar, the late Dr. Burnell, fix their migration from the north at even a later date. This fact accounts for two interesting characteristics of religious and social life. The Brahman being a newcomer, and not, as in northern India, evolved from the family priests of the invading tribes from Central Asia, reached the south with all his tabus and restrictions well established, and these were intensified by contact with the non-Aryan tribes, who were regarded as quite outside the pale of orthodoxy. The result was twofold. In the first place, the line of distinction between the Brahman and the outcast was more clearly marked than in the north; and, secondly, south Indian Brahmanism, affected by its environment, and saved from the disturbing influences of cataclysms to which it was exposed in north India from the successive invasions of foreign tribes like Scythians, Huns, and Mongols, was permitted to develop on lines peculiar to itself, and thus assumed a character very different from that which it displays in the Panjab, the Gangetic Valley, and the Delta of Bengal.

The special characteristics of south Indian Brahmanism are most effectively illustrated by Mr. Fawcett's excellent account of the Nambutiris of Malabar, with their intense craving after what they deem personal purity, their elaborate system of tabus, and their placid, reflective life spent in an endless round of elaborate ceremonial and devotion to the study of the Sanskrit Scriptures. In these respects they hold a position unique among the Brahmans of India, and the remarkable phase of religious and social life illustrated by them deserves attentive study.

Even more interesting is that remarkable race, the Todas. Mr. Thurston has wisely referred his readers

FIG. 3.—Yānādis. From "Castes and Tribes of Southern India."

to the exhaustive monograph on this tribe by Dr. W. H. R. Rivers, an excellent example of the successful application of the intensive methods of study applied to one of the smaller groups. Mainly on the ground of the exceptional hairiness observable in the Nambutiri Brahmans, he is inclined to accept the brilliant suggestion made by Dr. Rivers from a study of their emigrations preserved by the tribe, that the Todas are comparatively new arrivals in the Nilgiri plateau, and that they are connected in race with the Malabar group of Brahmans. Mr. Thurston records a curious fact which escaped the observation of Dr. Rivers, that their extreme reverence for the herd of sacred buffaloes is shown by the rule that when the animals are driven from one grazing ground to another, the women of the tribe are not permitted to tread upon the track of the holy beasts, but must be lifted over it by the men of the tribe.

In spite of the imperfections in the literary arrangement of his work, to which we have directed attention, Mr. Thurston's volumes constitute a monumental record of varied phases of south Indian tribal life, the traditions, manners, and customs of the people. Though in some respects it may be corrected or supplemented by future research, it will long retain its value as an example of out-of-door investigation, and will remain a veritable mine of information, which will be of value to his fellow-officers in acquiring a knowledge of the people, and a storehouse from which the armchair ethnologist will draw abundant facts of the highest value and interest.

A HISTORY OF BIRDS.[1]

Of the series of four volumes to be published under the title of "Animal Life: an Evolutionary Natural History," the editor, Mr. Pycraft, has himself contributed that on birds. The reader will at once be struck by two facts, first, that the subject is treated from the point of view of the evolutionist, as opposed to that of the systematist, and, secondly, that the author is never satisfied until he has inquired into, and, if possible, explained, the various phenomena that meet the eye of the ornithologist. As he tells us in his preface, and as we gather from the excellent introduction by Sir Ray Lankester, which practically summarises the whole work, the study of birds is here presented as one of living organisms, moulded in part by an inherent constitution, and in part by the struggle for existence.

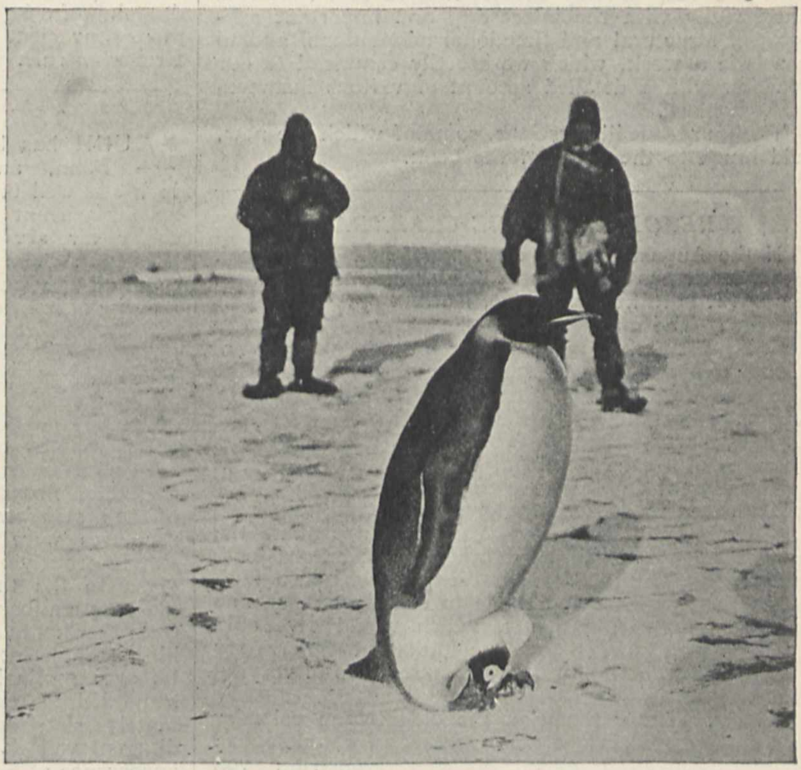
A great array of facts is marshalled in order before us, and presented in attractive fashion, while Mr. Pycraft's well-known skill is particularly evident in the osteology and pterylography; but we must confess that he seems to us somewhat hard upon the "field-naturalist," the results of whose labours he terms "a pitifully small gain to science." It is true that such an one often lacks the training or opportunity necessary for scientific research, but his province is more especially to supply material for the work of his fellows, and must never forget that Darwin and Wallace—not to mention later instances—were essentially field-naturalists.

[1] "A History of Birds." By W. P. Pycraft. With an introduction by Sir Ray Lankester, K.C.B., F.R.S. Pp. xxx+458. (London: Methuen and Co., 1910.) Price 10s. 6d. net.

The volume begins with a brief but sufficient summary of the general structure of birds, and proceeds to consider their phylogeny, their relationship to reptiles, and their development from climbing arboreal forms to those endowed with full powers of flight. The writer's views on this part of the subject are clearly shown by a "genealogical tree," while a woodcut is given of one of the hypothetical primitive types, or pro-aves.

From the ancestral forms of birds we pass on to a sketch of their present distribution and of the generally accepted zoo-geographical regions. Mr. Pycraft accepts the theory that the entire class originated in the northern hemisphere, with the possible exception of the Sphenisci; but the close connection of the latter in his tree of descent with the decidedly northern Colymbi seems to run counter to this contention.

Environment and its effects next come under discussion, with selected examples of adaptation to the surroundings. Here we find the view definitely adopted that a moist atmosphere leads to darker pigmentation and a dry atmosphere to lighter tints, but we are not inclined to follow our author implicitly here without further proof.



Emperor Penguin brooding its Young. From "A History of Birds."

Migration is always an interesting subject, and we concur with Mr. Pycraft in paying little attention to very precise "lines of flight"; whether, however, he is right in holding that the trend of migration is due north and south, apart from physical obstructions, is a much more debatable question.

The interrelations of birds and other animals, and their connections with plants, form the subject-matter of three well-written chapters, while an account of the relations between the sexes is not only instructive in itself, but naturally leads us on to the theory of sexual selection. The "displays" of various species, the pugnacity of the males, and so forth, are set forth at due length; but, on the whole, our author minimises the importance of sexual as opposed to natural selection, and believes that the latter, working on the discontinuous variations which undoubtedly occur, tends to preserve those varieties which finally persist.

Nidification and incubation, eggs and young, and the care of the latter, are next considered, while Mr. Pycraft has much to tell us of what we may learn from the immature bird, whether in the embryonic stage or otherwise, of its precocity or helplessness, its downy condition, its seasonal changes, and its differences from the adult. We notice that he thinks that nest-building is "a product of selection and is instinctive," and that all eggs were perhaps originally white and assumed protective coloration only where necessary.

Artificial varieties and the question of inheritance of acquired characters are treated by the author at some length, while his natural bent towards anatomy enables him to deal fully and successfully with the interesting and important subjects of structural and functional adaptations, and to conclude a work, which we heartily commend to our readers, with a detailed account of various instances of homoplasy.

The numerous illustrations, some of which are new, add much to the value of the book.

REFORMS OF THE CALENDAR.

In the August number of *Himmel und Erde*, Prof. Förster has a paper on calendar reform, on which, though it is rather discursive, a few words may be of interest. The main point of the paper is to suggest that the International Congress of Chambers of Commerce should take up the question of altering the rule for keeping Easter, which has, from the beginning of the Christian Church, been regulated by luni-solar chronology. That sort of chronology was observed over a large part of Asia, and is by the Jews to the present day, making the year consist of twelve and thirteen months alternately, the months following the moon. But, of course, this does not make the correspondence exact, and other intercalations were necessary. The old Roman calendar was also luni-solar, the months being made to contain twenty-nine and thirty days alternately, which would give only 354 days in a year, so that an additional or intercalary month had to be inserted in alternate years of varying length.

As Dr. Förster remarks, the old Roman calendar had degenerated into a true monster of chronological complication ("zu einem wahren Monstrum von chronologischer Verwirrung"), when it occurred to Julius Cæsar that it would be best to discard the moon altogether as a time-measurement and regulate the calendar by the sun, as had been done in the old Egyptian chronology, a country in which the annual overflow of the Nile was of surpassing importance, and, of course, depended on the solar season.

Cæsar had no occasion to trouble about the days of the week in his calendar. All European nations have followed in the main his calendar, but have had to make a special case of the great Easter festival and the ecclesiastical dates depending on it. But there is no real necessity for falling back upon a Jewish or luni-solar method of reckoning in this respect.

In the years 1872 and 1873 the Rev. J. Newland Smith, of Greenwich, published and distributed two pamphlets on "Eastertide," pointing out that the present complicated rule for keeping Easter was not fixed by any Church regulation; the Council of Nicæa having only decided that it should always be kept on a Sunday. Had Mr. Newland Smith lived (he died in 1880) he hoped that a Bill would have been introduced into Parliament on the question. The proposal in his first pamphlet was that Easter should be kept either on April 9 (that being one probable date of the first Easter day), if that day were a Sunday, or, if not, on the following Sunday; in the second, that it should be always kept on the second Sunday in April, which would include the 9th.

Dr. Förster, in the article before us, makes a similar proposition, which he commends to the International Congress of Chambers of Commerce, that Easter should be kept on the Sunday following April 4, so that it would always fall between the 5th and 11th.

He hopes that other changes may be effected in the calendar, and particularly that the congress may be the means of inducing the Russians and the Greek Church generally to follow the Western usage and replace the Julian by the Gregorian calendar, or some modification of it.

Perhaps we may be allowed the suggestion that the dropping of a leap year each 128th year would be both more convenient and more accurate than the existing Gregorian rule.

W. T. L.

THE DYNAMICS OF FÖHN.[1]

Much has been written about the dynamics of Föhn, and the general principles involved in it are well understood, yet the processes by which an air current descends and displaces potentially colder air are still somewhat obscure. As in his previous studies of the same subject, Dr. Ficker has followed the method of examining in detail a large number of individual cases. The process is a laborious one, but we agree with the author that it is essential to follow out individual cases if we wish to arrive at a clear understanding of the processes involved. Average results may be very misleading; very probably the condition of things represented by averages never actually occurs.

In all cases examined, Föhn was preceded by typical anticyclonic conditions, with a very stable stratification of the atmosphere. In many instances the valley temperatures were actually lower than those observed simultaneously on the summits. Special attention was given to the time of commencement of Föhn at different stations, which can be accurately determined from thermograph traces. Föhn sets in earliest at the high stations at the head of the valleys, and makes its way gradually to lower levels. Stations at the same altitude experience the onset of Föhn approximately simultaneously, even though they be in different valleys. In a few instances, Föhn made its appearance at Hachlaching, a station near Munich, on the Bavarian plateau, but on all such occasions the outbreak occurred there long after Föhn had established itself in the higher valleys. The suggestion that barometric minima skirting the north-west coast of Europe exert an aspirating action on the lower strata of the atmosphere, and so cause the Föhn, thus falls to the ground.

Local conditions determine the outbreak of Föhn. During the continuance of anticyclonic conditions the valleys become filled with a mass of more or less stagnant air, cold, at any rate in winter, by reason of its contact with the mountain sides, which are chilled by radiation. Above this we find a region of potentially warmer air, and at the junction of the two layers there is often a sudden actual increase of temperature with altitude. The cold air drains away to lower levels. This process is accompanied by a gradual rise of temperature, but the winds associated with it cannot be regarded as true Föhn, because the vertical temperature gradient in them is much less

[1] "Innsbrucker Föhnstudien IV. Weitere Beiträge zur Dynamik der Föhns." By Dr. H. v. Ficker. Pp. 61. (Wien: Alfred Holder, 1910.)

than the adiabatic for dry air. The air removed by drainage is replaced by air from above, which flows down the mountain valleys like a river, often with a tumultuous rush. In this descending current, which is the true Föhn, the temperature gradient is that of the dry adiabatic. The onset of Föhn at a given station occurs when the upper level of the cold air sinks to the level of the station.

In their early stages all Föhns are fed by air which has travelled horizontally to the mountain ridges, and then descended on the northern side. There is no evidence of ascent of air on the southern side of the range during this first, or "anticyclonic," stage. If Föhn persists, a condition of things often develops in which there is heavy rain, and a marked absence of diurnal range of temperature on the south side of the Alps, and simultaneously the temperatures are much lower to the south than to the north of the range. We have then unmistakable evidence of the ascent of air on the south and of its subsequent descent on the north of the range. The conditions which determine whether an "anticyclonic" Föhn shall develop into this second or "stationary" stage need further investigation.

R. G. K. L.

RESPIRATION AT HIGH ALTITUDES.[1]

PROF R. F. FUCHS, with Dr. Deimler, has confirmed the statement of Zuntz and his co-workers and of Durig, that the oxygen use of the human body during work is greatly increased at altitudes above 3000–4000 metres. While on the Colle d'Olen the O_2 use of Fuchs was only 3 per cent. more than at Erlangen; it was 36 per cent. more on the Capana Regina Margherita.

Fuchs and Deimler lived in the hut on the top of Monte Rosa for some weeks, and proved this point conclusively. This increased use of oxygen explains why most tourists are taken with mountain sickness at altitudes above 3000–4000 metres.

The oxygen needs cannot be supplied by the respiratory and circulatory mechanisms in the face of the falling partial pressure of oxygen, and the high oxygen use. Training and acclimatisation economise the oxygen use, increase the oxygen combining power of the blood, the power of the respiratory and circulating mechanisms.

The respiratory quotient sinks to a very low level, *e.g.* 0·53 after work, while the resting value is only 0·6–0·7 at these high altitudes. To explain this, it is supposed either that glycogen is built out of fat and protein in the body, or that substances are not completely burnt in the body, but are given off as lactic acid in the urine. We know that lactic acid is excreted in the urine after a hard run, when the oxygen used is greater than the supply.

A. Loewy and Franz Müller recently have found that the respiratory quotient is reduced by sea-bathing, *e.g.* from 0·88 at Berlin to 0·73 at the North Sea. The diet was the same. There is some evidence that the protein metabolism is different both in high altitudes and after the sea-bathing, but further work is required to explain the low quotients. Under the special conditions substances, such as proteins and their derivatives, may be oxidised, which share but little in the combustion process of the body. Fuchs suggests that the new building of hæmoglobin may explain partly the high oxygen use and the low respiratory quotient. It is generally agreed that a stay in high altitudes does increase the hæmoglobin of the body.

LEONARD HILL.

[1] "Physiologische Studien im Hochgebirge: Versuche über den repiratorischen Stoffwechsel im Hochgebirge." By R. F. Fuchs and T. Deimler. Sitzungsberichte der Physikalish-medizinischen Sozietät in Erlangen. Band 41, 1909.

NOTES.

THE ninth meeting of the International Meteorological Committee will be held in Berlin on Monday next, September 26, and following days. It will be preceded by meetings of the Commission for Terrestrial Magnetism and Atmospheric Electricity, of which General Rykatcheff is president and Dr. A. Schmidt is secretary, and by meetings of the Magnetic Observations Committee of the International Association of Academies. Of other commissions which originated with the International Meteorological Committee, those concerning scientific aëronautics, the correlation of solar and terrestrial changes, a proposed *Système Mondial*, weather telegraphy, and maritime weather signals have held meetings in the past year, and their reports will come up for consideration at Berlin. Among new proposals to be considered is one by Prof. V. Bjerknes, of Christiania, for the organisation and publication of strictly synchronous meteorological hourly observations of the air at the surface and above at a large number of stations, with the view of studying in detail the precise changes that take place. Since the last meeting of the International Meteorological Committee, at Paris in 1907, many changes have taken place in the *personnel* of the committee. Death has removed MM. Lancaster, Pernter, and Eliot, while M. Hepites has resigned his directorship of the Roumanian Meteorological Service, and consequently ceases to be a member of the committee. The new members appointed to fill the vacancies are MM. van Everdingen (Holland), Ryder (Denmark), Trabert (Austria), and G. T. Walker (India). Dr. W. N. Shaw, director of the Meteorological Office, is the president of the committee, and Prof. G. Hellmann, director of the Royal Prussian Meteorological Institute, is the secretary.

MR. R. NEWSTEAD, of the University of Liverpool, who, it will be remembered (see NATURE, June 30, p. 530), was dispatched three months ago to Malta by the Liverpool School of Tropical Medicine to investigate the relation of sand-flies to public health, has now returned. It is understood that in the forthcoming report upon the expedition practical measures for dealing with the various disease-carrying insects in the island will be suggested, Mr. Newstead having brought back a considerable amount of material, not only with reference to sand-flies, but also to other carriers of disease.

THE National Fund Airship, which has just been completed, made its first successful flight at Moisson on September 14. It is a little more than a year ago since Mr. Eric Stuart Bruce, the late honorary secretary of the Aëronautical Society of Great Britain, was asked to visit France to make an exhaustive examination into the various types of dirigibles in connection with the national airship, with the result that the Lebaudy type was selected. This latest Lebaudy airship may certainly be said to be the finest semi-rigid dirigible in the world. It is 337 feet 10 inches long, 39 feet 5½ inches in diameter, and has a gas capacity of 353,165·8 cubic feet. It contains three ballonets. The motive power is derived from two four-cylinder Panhard-Levassor petrol motors of 135 horse-power each. The two propellers are made of wood. Mr. Bruce is now acting as honorary secretary to the test committee of the National Fund Airship.

ATTENTION has from time to time been directed to the flower gardens upon vacant land in the neighbourhood of the Strand. The Selborne Society has been investigating a still more interesting building site in Farringdon Street, scarcely removed from the heart of the city. Although this plot has only been cleared for about two years, no fewer than twenty-eight species of flowering plants and ferns have established themselves upon it. Mosses, liverworts, and others of the more simple plants are also represented. Mr. J. C. Shenstone is preparing a detailed list, which will be published in the October number of the *Selborne Magazine*.

THE council of the Concrete Institute has decided to offer a medal annually for the best paper submitted relating to concrete and its applications.

THE Royal Philosophical Society of Glasgow announces that its Graham medal, awarded for original research in any branch of chemical science, is now open to competition. Particulars as to the award are obtainable from the secretary of the society, 207 Bath Street, Glasgow.

THE Incorporated Institution of Automobile Engineers will hold its opening meeting for the present session on October 12, when the president, Mr. F. W. Lanchester, will deliver an address on "Factors that have Contributed to the Advance of Automobile Engineering, and which Control the Development of the Self-propelled Vehicle."

DR. FREDERICK A. GENTH, jun., a prominent American toxicologist, died on September 1 at Lansdowne, Pennsylvania, at the age of fifty-five. He was a member of several foreign chemical societies, and had held official positions at home in connection with the University of Pennsylvania, the Medico-chirurgical Hospital of Philadelphia, and the State Department of Agriculture.

MR. JOSEPH A. HOLMES, director of the technological branch of the U.S. Geological Survey, has been appointed by President Taft to the directorship of the newly established Bureau of Mines. The functions of the new office will be to investigate and report upon safety appliances, and to inquire into the improvement of the methods of mining in general. Mr. Holmes, who is now in his fifty-first year, was professor of geology and natural history in the University of North Carolina from 1881 to 1891, and State geologist of North Carolina from 1891 to 1904, when he entered the service of the national geological survey. He was chief of the department of mines and metallurgy at the St. Louis Exposition in 1904.

THE death is announced of Prof. William H. Niles, who was professor of geology and geography in the Institute of Technology at Massachusetts from 1871 to 1902, and head of the department of geology at Wellesley College since 1888. Although perhaps best known as a teacher and public lecturer, he was author of papers on glacial phenomena and on the physical geology and geography of Massachusetts. In 1874 he directed attention to natural disturbances which occurred in quarries, whereby anticlinal structures were produced, owing to lateral pressure and the relief caused by the removal of rock. Prof. Niles was president of the Boston Natural History Society from 1892 to 1897. He was born on May 18, 1838, and died on September 13 of this year.

THE death is reported, at the ripe age of eighty-three, of Dr. Charles A. Goessmann, for nearly forty years professor of chemistry at the Massachusetts Agricultural College. A native of Naumburg, he graduated at Göttingen, where he was a favourite student, and afterward the assistant, of Wöhler. A report he had made on the value of sorghum as a source of sugar led to his invitation by a former American fellow-student to become scientific director of a sugar refinery in Philadelphia. After occupying that post from 1857 to 1861, he spent eight years as chemist of the Onondaga salt works, where he made important contributions to the chemistry of brines, meanwhile devoting part of his time to the professorship of chemistry at the Rensselaer Polytechnic Institute at Troy, N.Y. The most valuable part of his life-work was done at the Agricultural College at Amherst, which he made a training ground for agricultural and technical chemists. The State of Massachusetts appointed him also director of its agricultural experiment station and analyst to its board of health. He is credited with having exerted, directly and through his pupils, a powerful influence over the attitude of American agriculturists to scientific education.

WRITING in the *Times* of Friday last, Prof. R. Meldola says that it appears to have been overlooked that Erasmus Darwin, the grandfather of Charles Darwin, besides prophesying the introduction of steam as a motive power, foretold, in the following lines, the advent of aërial navigation :—

"Soon shall thy arm, unconquered steam, afar,
Drag the slow barge and drive the rapid car;
Or on wide waving wings expanded bear
The flying chariot through the streams of air;
Fair crews triumphant leaning from above
Shall wave their fluttering kerchiefs as they move;
Or warrior bands alarm the gaping crowd,
And armies shrink beneath the shadowy cloud."

THE first Universal Races Congress, "to discuss, in the light of modern knowledge and the modern conscience, the general relations subsisting between the peoples of the West and those of the East, between so-called white and so-called coloured peoples, with a view to encouraging between them a fuller understanding, the most friendly feelings, and a heartier cooperation," is to be held, under the presidency of Lord Weardale, in London on July 26–29, 1911. We notice that among the papers to be brought before the congress are the following:—Definition of race, tribe, and nation, by Brajendranath Seal; anthropological view of race, by Prof. v. Luschan; sociological view of race, by Prof. A. Fouillée; the problem of race equality, Mr. G. Spiller; differences in customs and morals and their resistance to rapid change, by Prof. G. Sergi; intellectual standing of different races and their respective opportunities for culture, by Mr. J. Gray; inter-racial marriage, by Dr. J. Deniker.

THE report for the past year of the Madras Government Museum, so long associated with the reports and bulletins issued by Mr. E. Thurston, now appears under the signature of his successor, Mr. J. R. Henderson. The most important addition during the year was the establishment of the marine aquarium, of which a description appeared in these columns (February 3). This is now stocked with fish and other marine forms of life collected on the coast, and forms a most attractive exhibit. Numerous accessions to the numismatic cabinet are recorded, the most important being a Roman *denarius* attributed to Quintus Cassius Longinus (B.C. 60), and a second to the Emperor Augustus. These furnish additional corroboration of the importance of the sea trade between Rome and southern India during this period. The present specimens were unearthed in the Coimbatore district.

THE last issue (vol. v., part v.) of the Archæological Publication of the University of California is devoted to an account of the Chimariko tribe of Indians inhabiting Trinity County, in north California. They first came into contact with the whites early in the last century; but their final destruction began with the sudden eruption of gold miners in the early 'fifties, by whom they were overwhelmed and dispersed. The information now collected was obtained by Mr. R. B. Dixon from a woman, the sole survivor of the tribe, and from a male member of a neighbouring group who was well acquainted with their language and customs. They seem never to have assimilated their culture to that of the neighbouring powerful Huba tribe, and it has been suggested, with some degree of probability, that they were a branch of the Shastan stock, which advanced from the north in a south-westerly direction, and with which they exhibit in their mythology certain resemblances. All the scanty available information about their culture and language has now been adequately collected by Mr. Dixon.

MESSRS. DULAU AND CO., LTD., have published in the series of Drapers' Company Research Memoirs a study of the mortality of the tuberculous in relation to sanatorium treatment, by Mr. W. Palin Elderton and Mr. S. J. Perry. The method adopted is to compare the number of deaths observed amongst the tuberculous with the number that would be expected on the basis of the English life-table (1) for patients of certain sanatoria, (2) for Pollock and Williams's cases, which were observed before the days of sanatorium treatment. The authors show that the mortality of tuberculous patients who are undergoing or have undergone treatment is much heavier than that of the general population, and the mortality even of the apparently cured cases is about twice as heavy. The mortality of sanatorium patients does not show any improvement on that of Williams and Pollock's cases, but comparison is difficult, owing to the way in which the older figures were given. It is precisely this comparison, however, which is of importance. The fact that the mortality of sanatorium patients is greater than that of the general population has no bearing on the real question at issue, for even a perfect cure of tuberculosis could surely not be expected, as an incidental result, to turn a weakling into a strong man, nor to render the mortality of the highly selected population in question the same as that of the population at large.

IN the report of the Warrington Museum for the year ending on June 30 last, attention is directed to the large number of donations received, which included 2436 specimens, as against 1645 in the previous twelvemonth.

IN the September number of the *Selborne Magazine* Mr. E. G. Woodd states that an additional protected area for birds has recently been established by the County Council in east Sussex. The area extends from Eastbourne to Hastings, and inland so far as Lewes, and within these limits such birds and their eggs as specially need protection have been scheduled.

WE have received the report of the Sarawak Museum for 1908–9, in which it is announced that Mr. J. Hewitt has been succeeded as curator by Mr. J. C. Moulton. Collecting expeditions have been made to neighbouring districts, which resulted in the addition of interesting specimens, and a catalogue of the birds in the collection was completed during the period under review.

THE International Commission on Zoological Nomenclature has issued through the Smithsonian Institution (Publication No. 1938) a series of twenty-five opinions in regard to matters of dispute in nomenclature. Among many cases, it will perhaps suffice to mention that the committee are in favour of retaining the generic name Simia for the orang-utan.

THE *Entomologists' Monthly Magazine* for September contains a beautifully coloured plate of nine species of rare British beetles, all of small size. According to the authors—Messrs. Champion and Lloyd—of the accompanying notes, one of the most interesting of these is the species named by Dr. Sharp *Eudectus whitei*, of which the single known example was captured by its describer on the summit of Ben-a-Bhuid, Braemar, in the summer of 1871.

A USEFUL catalogue of Danish zoological literature, compiled by Mr. Svend Dahl, has been published by J. B. Lybecker at Copenhagen under the title of "Bibliotheca Danica, 1876–1906." It comprises 262 pages of text, of which 186 are devoted to a list of authors and their works. The manner in which this list is arranged is, however, difficult to understand, as the names are given neither in alphabetical order nor according to date of birth. A specific and subject index to the various papers and books occupies 68 pages, and the volume concludes with an index of authors.

To vol. xii., part ii., of the Proceedings and Transactions of the Nova Scotian Institute of Science, Prof. G. H. Perkins communicates a fully illustrated memoir on cetacean remains from the superficial deposits of Canada. The main object of the communication is a skeleton in the museum at Halifax, discovered about 1873 on the Jacquet River, New Brunswick, which is identified as that of a narwhal (*Monodon monoceros*). Other skeletons, respectively in the museums of MacGill University, Montreal, and Montpelier, belong to the white whale described by Thompson as *Delphinapterus vermontanus*. Whether this is more than a large race of the existing *D. leucas* the author is doubtful.

THE third number of vol. ii. of the Journal of the College of Agriculture, Imperial University of Tokyo, is devoted to entomological subjects, such as Japanese Arctianæ, Panorpidæ, and Mantispidæ, mainly of interest to specialists. Mr. R. Inoue communicates, however, a paper on experiments with silkworms, in which the quantity of mulberry-leaves consumed by the larvæ at different periods of their existence is recorded. Other experiments show that "carbon dioxide, even when pure, has no influence upon the silkworms, and does not act as poison; but when the worms are reared in air containing more than 5 per cent. of the gas they lose their appetite, and their growth is more or less retarded, especially in the earlier stages."

SOME interesting observations on the eyes of trilobites are published by Prof. C. D. Walcott in a paper on Olenellus and other genera of the Mesonacidæ (forming the sixth of a series on Cambrian geology and palæontology), published as No. 6 of vol. liii. of the Smithsonian Miscellaneous Collections. Dr. Lindström expressed the opinion some years ago that all Cambrian trilobites were blind, as he was unable to detect eyes on the upper surface of the cephalon. Such eyes have, however, been detected in one of the American forms by the author, and show the facetted outer surface. It is also suggested that maculæ may occur on the under surface—hypostoma—of the Mesonacidæ, as these have been detected by Lindström in other types. After quoting Prof. A. Agassiz to the effect that trilobites are frequently found lying on their backs, and that young king-crabs (Limulus) often swim and feed in an inverted position, Prof. Walcott suggests that "in all probability the eyes of the hypostoma were of service when the trilobite was lying on its back on the sand or mud, and it was on this account that they were thus developed. It is highly probable that the adult trilobite crawled about the bottom and did not swim freely in the water to the extent that it would be necessary for it to see the bottom. Its habits must have been very much like those of Limulus when in search of food."

WE have received from Mr. J. Wrench Towse, clerk to the Fishmongers' Company, two notices which give useful summaries of the regulations made by Parliament and by the Fisheries Local Committees relative to the seasons for fishing with respect to salmon, trout and char, crabs and lobsters.

A SCHEME for the cultivation in Dalmatia of the spineless variety of cactus raised by Burbank is advocated with considerable reason by Dr. C. C. Hosseus in *Adria* (August), the object being to supply cattle fodder, of which there is a deficiency. The author points out that the natural conditions are favourable, and indicates how the scheme should be inaugurated.

THE details of a Rhododendron producing double flowers in its wild state are given by Dr. M. Miyoshi in the Journal of the College of Science, Imperial University, Tokyo (vol. xxvii., art. 11). The species *Rhododendron brachycarpum* grows in the mountains of central and northern Japan. The anomalous plants shower a second partial or complete corolla whorl. The author notes that double flowers have also been recorded for *Rhododendron ferrugineum* in the Tyrolese Alps, and for *Rhododendron albiflorum* in North America.

MR. C. J. CHAMBERLAIN continues to provide original information regarding the lesser known cycads, his latest contribution, in the *Botanical Gazette* (December, 1909), being a general description of *Dioon spinulosum*, based upon observations made in southern Mexico, where the plants grow in such profusion as to form almost a forest, and the largest specimens attain a height of 16 metres; this species, therefore, in contrast to the short-stemmed *Dioon edule*, supplies the tallest cycads known, with the exception of *Cycas media*. The leaves of an average specimen are about 20 cm. long, and bear more than a hundred pinnæ on either side. The ovulate cones are the largest known for any gymnosperm, as they may weigh as much as 15 kilos, and measure 50 cm. in length by 27 cm. in diameter. No staminate cones were collected in Mexico, but the author describes a specimen received from the Missouri Botanical Garden.

ONE of the most interesting articles in the Transactions of the Scottish Arboricultural Society (vol. xxiii., part ii.) is a contribution by Sir John Stirling-Maxwell giving early results of trials in Inverness-shire with the Belgian system of tree planting on turfs. Intended primarily for afforestation on moors, but also suitable for rough, grass-covered ground, the system consists in turning over turfs, leaving them to dry and sweeten for some months, and then planting in the centre in a heap of soil enriched with a small proportion of basic slag. The young plants take a year to become established, and then grow on quickly. The author also recommends the Sitka spruce, *Picea sitchensis*, for planting at an elevation of about 1000 feet, in which there is agreement with the conclusions communicated in an article by Mr. H. M. Cadell, who considers that it is superior to larch, Scots pine, and Norway spruce for growing in an exposed situation.

DR. A. WILMORE, in a paper in the *Geological Magazine*, 1910, p. 357, has carefully reviewed what is known of the relations of uralite and other secondary amphiboles to their parent minerals. He accepts the possibility of an interchange of material between permeating liquids and an original pyroxene, and does not regard uralite as necessarily an exact paramorph of a pyroxene.

THE geological section of the Belfast Naturalists' Field Club has issued its report for 1909–10 in the Proceedings of the club, and it is clear that a large amount of educational work results from its meetings and excursions. The interesting volcanic neck at Scawt Hill, and a selected series of Cretaceous exposures, have been studied, and a class has been formed under Dr. Dwerryhouse for petrological work. The section is fortunate in continuing to include several members whose contributions involve sound original research.

WE have received the *Bibliotheca Geographica*, issued by the Berlin Gesellschaft für Erdkunde, for the year 1906. This volume, the fifteenth of the series, has been prepared under the editorship of Dr. Otto Baschin; it contains no important changes in general arrangement, but, like all works of the kind, tends to grow in bulk with the ever-increasing volume of the annual output of geographical literature. One of the most characteristic features is the steady increase in the proportion of publications dealing with geographical principles and methods as distinct from purely regional and descriptive matter.

IN vol. xxiii. of the *Annalen des k.k. Naturhistorischen Hofmuseums* Prof. Friedrich Berwerth describes in full detail the meteoric iron which fell on August 1, 1898, near Quesa (39° N., 0° 40′ W.), in the province of Valencia, Spain, and makes an important contribution to the study of the structure of such bodies. Thanks to the generosity of Kommerzialrat J. Weinberger, the entire mass, with the exception of a small piece weighing 30 grams, which had been previously broken off in Spain for use in the investigation of the character of the meteorite, has been added to the fine collection in the Vienna Museum. A slice weighing 375 grams has been cut from it, and the total weight of the mass is now 10,370 grams, 300 grams being lost in cutting. Thanks to its excellent state of preservation, Prof. Berwerth is able to determine that the wedge-like shape of the iron is due to the large development of an octahedron and an icositetrahedron face, the remaining surfaces being three small octahedron faces. He discusses at some length the nature of the depressions —rhegmaglypts (ῥῆγμα, fracture; γλύφειν, engrave) as he terms them—caused by the fierce heat generated by the meteorite's swift rush through the earth's atmosphere; they must not be confused with the hollows due to weathering which are ordinarily seen in irons. The paper is illustrated by reproductions of several excellent photographs.

THE meteorological chart of the North Atlantic for October, issued by the U.S. Weather Bureau, contains an instructive account of the great tropical storm of October, 1909, known as the Key West Hurricane, accompanied by synoptic charts showing the weather conditions over the North Atlantic from October 10–15. The Weather Bureau records verify the general laws of cyclonic movements in the West Indies, announced by the late Father Viñes, that the storms reach further westward as the season advances; they also show that averages of tracks can be given but little weight in forecasting those of individual hurricanes. Observations indicated that a disturbance was developing in the Caribbean Sea on October 2, but the probable course of the storm could not be determined until October 6. On October 9, during its passage over the western part of that sea, a destructive wave swept from the Gulf of Mexico over the low-lying islands and coast of Yucatan. On October 10 the centre of the disturbance had curved and began to move north and north-east, and on October 11 the barometer at Key West (Florida Channel) fell to 28·50 inches, the lowest ever recorded there, and more than 6 inches of rain fell in 2¼ hours, the damage being estimated at nearly a million dollars. The Weather Bureau duly warned the seaports of the progress of the storm, and thereby effected great saving of life; on the Florida East Coast Railway, for instance, 3000 workmen were withdrawn from dangerous points; and the vice-president of the line writes:—"Positively not a life was lost in the storm. . . . Warning by the Weather Bureau enabled us to fully protect all employés and equipment."

THE Central Weather Bureau at Melbourne has recently issued an average rainfall map and isohyets of New South Wales, the first of a series now in course of preparation which will include all the States. These maps will be of great economic value in connection with corn-growing and the keeping of all kinds of stock, for which a knowledge of the rainfall is of prime importance. The map in question clearly shows that the greatest rainfall occurs on and adjacent to the Pacific coast, where the annual amounts range from 30 inches in the south to 60 and even 70 inches in the north. The isohyets and grades of shading plainly show the decrease of the rainfall to the westward. If a 15-inch rainfall is sufficient to ensure payable wheat-growing, the map shows that it can safely be done practically as far west as long. 146°, and even further in the south; but, generally speaking, over the country further to the westward, embracing an area of some 122,000 square miles, the rainfall does not reach 15 inches, and is under 10 inches over an area of about 45,000 square miles in the extreme west of the colony. Mr. Hunt points out that the most remarkable feature of the map is the comparatively light rainfall in the district extending from Delegate, in the south, to Yass, about 2° to the northward, owing to the condensation of moisture by the ranges of mountains by which it is enclosed.

DR. H. FRITSCHE, emeritus director of the Pekin Observatory, in a recent work ("Die saecularen Aenderungen der Erdmagnetischen Elemente," Riga, 1910) makes an attempt, to which boldness at least must be conceded, to extend our knowledge of terrestrial magnetism to epochs prior to direct observation. He starts with the assumption that during the last several thousand years there have been no outstandingly large changes in the earth's magnetism—a hypothesis for which much may be said in spite of the deductions drawn by Folgheraiter from the magnetism of Etruscan vases—and that such changes as have occurred can be represented by periodic terms. For these periods he assumes 500, 700, and 900 years, but his reasons for this choice of periods are rather obscure. He attacks the problem by taking as his knowns the values he has calculated from observations for the Gaussian coefficients for the epochs 1575, 1675, 1811, and 1892. Regarding the Gaussian coefficients as expressed by periodic terms with unknown coefficients, he determines the coefficients by reference to the four epochs just mentioned. He thus obtains general expressions from which Gaussian constants are derivable for any given epoch, and he makes use of these for the construction of isogonal charts for the epochs 1200, 1300, 1400, and 1500 A.D. Tables are given for the values of the Gaussian constants extending back to 2700 B.C. Dr. Fritsche's work must have entailed an enormous amount of onerous calculation, but it must be regarded as of an exceptionally speculative character.

IN a communication made to the Institution of Electrical Engineers in April last, which appears in the August number of the Journal of the institution, Mr. W. P. Digby directs attention to the advantages to engineers of tests of the electrical conductivity of the water with which they have to deal. He shows how, with a simplified conductivity tube and a form of "megger" with its scale graduated to give conductivity directly, an engineer may detect immediately a change in the nature of the feed-water for a boiler, or the amount of priming, or the development of a leak in the condensers, and may control with much greater certainty water-softening or oil-eliminating plants. It is only by actual work with the apparatus under workshop conditions that its utility in practice can be tested and established, and it seems well worthy of a thorough trial by engineers.

THE *Engineer* for September 9 contains an illustrated article on the new armoured concrete viaduct at Rotterdam. This viaduct measures 1600 m.—very nearly a mile—in length, and was commenced in 1904, and is composed of many normal bays and bridges of various types. Each pier of a normal bay is composed of four columns supporting the four armoured concrete girders which go to make up the arch. The lower faces of these girders are curved or arched, while the upper faces are flat. The concrete used was composed, for the most part, of 450 kilos. of Portland cement to half a cubic metre of river sand and one cubic metre of gravel, the sizes of the stones in which varied between 5 mm. and 30 mm. in diameter. Under test loads, a 20 m. arch was deflected 3·26 mm., or 1/6140 of the span. A 15 m. arch was deflected 1·57 mm., or 1/9550 of the span. Normal bays not resting on abutments were deflected, as an average, 1 mm., or 1/9770 of the span; normal bays resting on abutments were only deflected 0·6125 mm., or 1/12600 of the span.

AN article in *Engineering* for September 9 contains an interesting discussion on the progress of aviation during the past year. The progress on the more practical side has been much more striking than in the records achieved. The number of machines which will actually fly is enormously greater, and they do so with much less uncertainty. The greatest advance has been made in cross-country flight, and this is of the utmost importance. While flight may now be looked upon as a fair certainty when the weather is really calm, such weather is rare, in this country at all events. Hence the greatest interest attaches to the progress of flight in a wind, and in this direction the advance has been considerable. Cross-country flights are now undertaken in quite strong winds. The aëroplane has, in the last year, ceased to be a mechanical curiosity, which could do little save make exhibition flights in exceptional weather over a prepared track, and has become a practical machine for progress across country. We have therefore now got to the stage when the aëroplane must be reckoned with as a machine which is a practical factor in human life, and, if progress is as rapid in the future as in the past, it will very soon be a most serious factor. Even in its present state, a machine which can travel seventy miles an hour, and fly at such a height that hitting it would be extremely difficult, must have its uses in war, and with increase in the lifting power, speed, and radius of action, these uses must very rapidly augment. Its useful capabilities in time of peace are less easy to foresee; but that a machine which can travel in any direction with the speed of an express train is destined to have an important influence on civilised life is obvious.

OUR ASTRONOMICAL COLUMN.

FURTHER OBSERVATIONS OF HALLEY'S COMET.—In Bulletin No. 20 of the Kadaikánal Observatory Messrs. Michie Smith and John Evershed give an account of the observations of Halley's comet made with various instruments during April and May. A number of photographs, which may fill in the blanks between those taken in America and in Europe, were secured with a 5-inch Grubb portrait lens of 33·8 inches focal length. On certain of these there are many distinct tails and a number of fine details; other plates were exposed in a half-plate Ross camera giving a scale of 1 mm. = 17·5′. Mr. Evershed used a 9¼-inch reflector, of 74 inches focal length, fed by a 16-inch cœlostat, and secured a number of photographs showing the intricacies of the structure in the head, the scale being 1 mm. = 110″.

Spectrograms were also secured, and show the differences between the radiations from the head and those from the tail observed in Daniel's comet 1907*d*; the continuous spectrum of the nucleus shows, faintly, a considerable number of Fraunhoferic lines attributable to reflected sunlight. In the head, the pair of "cyanogen" radiations at λ 3871 and λ 3883 appear to account for at least two-thirds of the total emission, and the preliminary examination shows no essential variation in the spectrum between April 19 and May 15. In the very strong band at λ 4645–4744, five or six separate lines can be distinguished on some of the spectrograms. Visual observations showed that the very bright comet lines in the green and blue could be traced a long distance into the tail and to some considerable distance on the other side of the nucleus.

Notwithstanding the small dispersion (1 mm. = 73 A. at 4227), measurable displacements of the cometary lines, as compared with lines in the spectrum of Venus, were found, and on May 2 gave a relative approach of 77 km. per sec., the ephemeris value being 68 km. per sec.; but to this must be added the recessional velocity of Venus.

The programme for the detection of the comet during transit was very complete, and is described in detail, but, as has been stated before, no trace was found.

Observations of the tail were made by Mr. Evershed, who describes its appearance during May 18–21. He suggests that the persistence of the phenomenon in the east may be explained by supposing the tail to have been very broad in the direction of its motion, although relatively narrow in the direction at right angles to this; with a strong curvature, this would account for the apparent length of time for the earth to make the complete passage.

In the September number of the *Bulletin de la Société astronomique de France* there are reproduced some excellent photographs taken by M. Mascart at Teneriffe, as well as a number of drawings and accounts by various other observers.

Dr. C. D. Perrine, director of the Observatorio Astronómico of the Argentine Republic, writing from Córdoba on August 18, says:—"It will be of interest to your readers to know that we are still observing Halley's comet. It is some 2′ or 3′ in diameter, of about the ninth magnitude, with a nucleus of eleventh magnitude. It is getting so low in the west, however, that we will not be able to follow it much longer."

THE DISTANCES OF RED STARS.—Another contribution to the question of the correlation between spectral type and parallax, in the form of an abstract of a paper read by Dr. H. Norris Russell, appears in No. 195 (vol. xlix.) of the Proceedings of the American Philosophical Society. Dr. Russell compared the parallaxes of stars measured by Mr. Hinks and himself at Cambridge with the spectral types determined at Harvard, and found that the percentage of orange and red stars increases steadily as the distance from our system decreases. Further, a comparison of the observed parallaxes of stars having large proper motions with the parallaxes computed from Kapteyn's formula shows that while the formula stands for the stars of all classes taken together, there are marked deviations when spectra types are considered separately; the observed parallax of the red stars is nearly twice the computed value. As all the stars considered are similar in apparent brightness, it follows that redness is attended by intrinsic faintness, the reddest stars averaging one-fiftieth the brightness of the sun. On the other hand, some bright-red stars, such as Arcturus and Antares, are known to be at great distances, and are probably at least one hundred times as bright as the sun.

This conclusion confirms the important hypothesis (now well established on other grounds) that there are two classes of red stars, one class getting hotter, the other cooling. In the intermediate stages the stars would be hotter, passing through orange and yellow to white, and back to red as it approached extinction.

"MOCK SUNS" AT EASTBOURNE.—From Mrs. A. M. Butler, of Reigate, we have received further particulars of the "mock suns" phenomena referred to in these columns last week as having been seen at Eastbourne on September 10. Mrs. Butler and her daughters watched the phenomena from 12.45 p.m., and saw everything described by Mr. Ronca except the fainter small circle to which the brilliant chromatic curve was tangential. In addition they saw, to the S.E. of the sun, part of another coloured curve, having its convex side turned towards the actual sun. From an effective coloured sketch of the phenomena, drawn by Mrs. Butler, it would appear that this second curve, which was seen at 1.20 p.m., was of about the same radius as the former, and would have barely intersected it had both been continued.

ASTRONOMY IN INDIA.—From the *Pioneer Mail* of August 26 we are pleased to learn that an association for the promotion of astronomy has been formed in India. It is to be known as the Astronomical Society of India, and has its headquarters at Calcutta.

The special objects of the society will be to assist observers by holding meetings, whereat papers will be read and discussed, and by disseminating astronomical news. It is proposed also to found a library of astronomical literature and to publish a journal for each month of the session. The president is Mr. H. G. Tompkins, Treasury Buildings, Calcutta, to whom all communications should be addressed.

THE CRUSADE AGAINST CONSUMPTION.

FOR many years the National Association for the Prevention of Consumption worked away unostentatiously but pertinaciously. The experience gained during these years must now be to them of great value in the educational crusade they have undertaken. During the past year an educational exhibition has been going the round of London, into the provinces, east and west and north, to Oxford, Cambridge, Liverpool, Edinburgh, &c. Nothing has been more gratifying or more promising for the ultimate success of this crusade than the keen interest that has been taken in this exhibition, and in the lectures and conferences by all sorts and conditions of men—and women, too, for that matter. We should, naturally, expect public health authorities to be interested, but all who have seen the audiences gathered together at these lectures and conferences cannot but have been impressed by the intelligent interest taken, even by the very poor, in the question of the prevention of the spread of tuberculosis. Some of the work undertaken by the association at one time appeared to come dangerously near interfering with or overlapping the work of the local medical authorities, and with hospitals and associations already in existence; but through the good sense of those who, though working in different directions, are mutually interested in putting a check on the spread of consumption, the danger of such overlapping is gradually being minimised.

The class amongst which tuberculosis is most prevalent, the badly housed and badly fed, has, up to the present, and very naturally, entertained a suspicion that those who looked upon tuberculosis as an infective disease might interfere too much with the liberty of the tuberculous worker, and by isolating him deprive him of his means of subsistence. Nowhere has the educational campaign done better work than in bringing home to these people the immense importance of observing certain fundamental principles of hygiene, not only in their own immediate interest, but in the interests of those with whom they are most closely associated. It is now well known what precautions tuberculous patients should take, and as soon as this knowledge can be brought to the patient and his friends there will be some chance of getting these precautions adopted. There seems to be little doubt that the National Association for the Prevention of Consumption has the power to help and cooperate with similar organisations already in existence, and that it may even be of assistance to the authorities working with and under the Local Government Board, but what they are best qualified to undertake is, undoubtedly, that national educational movement to which Mr. John Burns has given his official approval.

The carrying on of this movement requires funds, large funds, and a special appeal committee has been formed, which, acting under the presidency of the Earl of Derby, is setting about to collect, in the first instance, a sum of 5000*l.* annually to be devoted to this work. That the necessary fund will be obtained can scarcely be doubted, especially as a most elaborate system of collecting small sums has been organised; moreover, those who will be most immediately benefited are already taking a very keen interest in making this scheme a success, and the committee have announced that they have already received offers of assistance from working-men's clubs and institutes affiliated to the Institute Union, and the Billposters' Association of Great Britain; whilst the post-office authorities have promised assistance, or have granted facilities which will help to form the nucleus of a fund such as could be obtained in no other way. Further, those endowed with a larger share of this world's goods have manifested an equal willingness to help, but the object is such a good one, the outlet for expenditure is so wide, and the promise of such an enormous return is so great, that if five times the sum asked for be subscribed it may be advantageously spent. The time has come when the annual loss of 50,000 or 60,000 lives from consumption—a preventable disease—is a blot on our civilisation. When we *knew not* we could not be blamed for our want of initiative and lack of energy, but now that we *know*, inaction is criminal.

RECENT PAPERS ON PETROLOGY.

UNDER this head may be included work on the minerals that build up rocks, since modern petrology depends on the understanding of the causes that have brought certain mineral constituents into association. This is true even of the fragmental rocks, where the correct appreciation of a detrital mineral may lead up to the source and the relative age of the deposit. Experimental work on minerals has, moreover, almost always a geological aim, though compounds have a way of arising artificially under conditions that seem improbable in nature.

Improvements in methods of research will be found in Mr. F. E. Wright's paper on the "Measurement of Extinction Angles in Thin Section" (*Amer. Journ. Sci.*, vol. xxvi., p. 349), where the intensity of light for different positions of a crystal-plate between crossed nicols is dealt with mathematically. The methods of observation in general use are critically discussed, and the principle of the twinned selenite plate, introduced by Sommerfeldt in 1907, is further developed by the author in his artificial quartz twin plate (p. 374). Since the eyes of observers differ in regard to their sensitiveness to certain tints, this plate may be made wedge-shaped, so that the most serviceable tint may be selected. Mr. Wright also introduces (p. 377) a bi-quartz wedge-plate. A plate of right-handed quartz, cut normal to the optic axis, is fixed side by side with a left-handed one of the same thickness. Above each is set a wedge of quartz of the opposite sign of rotary polarisation, the two wedges tapering in the same direction. Except where the wedge and the plate below it are of the same thickness, the two similar wedges will show colours of similar intensity. If a crystal-plate lies beneath the wedge-plate, and is not in a position of extinction, a difference of intensity appears in the two wedges, and a thickness can be selected that gives, by the rotation produced, the most sensitive effect to meet the case of each experiment.

Dr. J. W. Evans (Proc. Geol. Assoc., vol. xxi., p. 79) gives a useful paper for students on the systematic examination of a thin section of a crystal with an ordinary petrological microscope, in which his double quartz-wedge, described in 1905, is effectively introduced for determining the relative retardation of the rays in a section of a doubly refracting crystal.

Messrs. Allen, White, Wright, and Larsen (*Amer. Journ. Sci.*, vol. xxvii., p. 1) provide a characteristic synthetic study of diopside and its relations to calcium and magnesium metasilicates, in which the minerals produced at various temperatures are subjected to a thorough optical examination. Etch-figures are used to show minute crystallographic changes that result from dissolving one member of the metasilicate series in another, the resulting minerals being shown to be actual solid solutions (p. 39). Some of the substances produced are as yet unknown in nature, and a rhombic $MgSiO_3$ mineral arises at about 1365°, which resembles olivine in form, and which is quite distinct from enstatite (p. 30). The stable form of $MgSiO_3$ is, curiously enough, that known from meteorites only, and is styled clinoenstatite.

Messrs. Wright and Larsen also introduce us to new views on quartz (*ibid.*, p. 421). In treating of quartz as a geologic thermometer, they make use of Le Chatelier's observation in 1890 that quartz undergoes a reversible change at about 575°, as indicated by a sudden change in its expansion-coefficients, birefringence, and circular polarisation. Mügge regards the low temperature α-quartz as trapezohedral-tetartohedral, and the high temperature β-form as probably trapezohedral-hemihedral. "At ordinary temperatures all quartz is α-quartz, but if at any time in its history a particular piece of quartz has passed the inversion point and been heated above 575°, it bears ever afterward marks potentially present which on proper treatment can be made to appear" (p. 425). Quartz formed on the low temperature side, such as that of veins and geodes, shows trigonal trapezohedra, more regular twinning than the β-form (as discovered on etching), more frequent intergrowths of right- and left-handed forms, and an absence of the effects of shattering that appear in quartz cooled down from the high-temperature form. The authors verify these points by an examination of quartz from ordinary veins and from pegmatites.

M. Borisov (*Trav. Soc. imp. des. Nat. de St.-Pétersbourg*, vol. xl., p. 46) describes quartz in druses from the Government of Olonetz; the form is the rhombohedron, with a polar angle reading 85° 47′, so that we have a rare type resembling cubes. Mr. R. S. Bassler (Proc. U.S. Nat. Mus., vol. xxxv., p. 133) traces the remarkable changes by which fossils in the carboniferous limestone of Kentucky have been converted into geodes of chalcedony and quartz, and his photographs alone would claim the attention of petrologists and palæontologists alike.

Students of silicates will note the paper by Messrs. Shepherd, Rankin, and Wright (*Amer. Journ. Sci.*, vol. xxviii., p. 293), on the binary systems of alumina with silica, lime, and magnesia, in which andalusite and sillimanite receive experimental treatment. A very useful statement is included (p. 322) as to the six phases of crystallised silica now known, the α and β forms, respectively, of quartz, tridymite, and cristobalite. Mr. Larsen (*ibid.*, p. 263) examines the refractive indices and densities of some of his artificially prepared silicates and their glasses. Incidentally, he finds that glasses rich in lime and magnesia cannot be prepared, owing to their strong tendency to produce crystals—a tendency well recognised among basic igneous rocks. Messrs. Washington and Wright (*ibid.*, vol. xxix., p. 52) discover, in a felspar from the Mediterranean islet of Linosa, a molecule corresponding to soda-anorthite, and look forward (p. 70) to naming the actual $Na_2Al_2Si_2O_8$ felspar, when forthcoming, Carnegieite. Since the felspar that they really possess is a new species, and receives the name of Anemousite, it seems quite grasping to look so far ahead, even from the very open windows of the Carnegie Institution.

Mr. F. Cornu (*Verhandl. k. k. Reichsanstalt*, 1909, p. 41), in a preliminary and slightly polemical demonstration, promises an important work on the importance of "Hydrogelen im Mineralreiche" which will need to be considered by all who deal with soils and products of decay. The author claims that our method of heating thin slices in Canada balsam removes the water from essential substances in the case of weathered rocks, and he here opens up a new field, which will, we hope, be promptly cultivated.

M. G. Césaro (*Bull. classe des Sci., Acad. roy. de Belgique*, 1909, p. 435) has made a comprehensive study of the mesotype group of zeolites, including a mesolite from Kenbane Head, co. Antrim (p. 447), once alleged to be galactite. The author (p. 492) ultimately concludes that galactite is a mixture of natrolite and scolezite.

A new light is thrown on nephrite by Prof. Steinmann (*Sitzungsber. niederrhein. Gesell. Nat. u. Heilkunde in Bonn*, 1908, pub. 1909, p. 1), who concludes that the Ligurian examples were originally dykes in the surrounding olivine-rocks, and had the composition of websterite or diopside-rocks. The expansion of the peridotites, due to serpentinisation, caused pressures throughout the mass, and the dykes became converted into the schistose nephrites that now remain. The brecciated and slickensided character common in serpentine-rock is aptly accounted for by this chemical expansion. "Schwellungsmetamorphose" (p. 13) is introduced as an appropriate term, and Steinmann holds that the Ligurian serpentines received their main mineral characters before the occurrence of the great movements that folded them in among the Alps.

This paper, connecting mineral changes and large rock-masses, may lead us on to igneous rocks in general. Mr. R. A. Daly (Proc. Amer. Acad. Arts and Sci., vol. xlv., 1910, p. 211) has sought to establish the average chemical compositions of igneous-rock types, and his results, largely based on Osann's collection of modern analyses, are likely to serve as standards for all who use ordinary rock-names. The number of analyses employed is shown in each case, and we are naturally left to presume that no very widely differing types are included here under the same name. A second series of averages is generously given, in which the figures are re-calculated with water omitted. Mr. Daly (p 236) urges that Rosenbusch's classification, as here emphasised, is objective and natural in a highly useful degree. Comparisons can now be easily made, by using these tables, between rocks of different grain, and the author points out that dacite is the effusive type of "granodiorite," rather than of the far less siliceous quartz-diorites of our ordinary terminology. On p. 240 we find a characteristic suggestion as to the cause of the similarity of composition of rocks of various degrees of antiquity, since "in general, differentiation in batholiths, when well advanced, restores the condition temporarily disturbed by magmatic assimilation."

Mr. G. P. Merrill (*Amer. Journ. Sci.*, vol. xxvii., p. 469) concludes from averages of analyses of stony meteorites, compared with those of terrestrial rocks, that magmatic differentiation could not have produced our rocks from planetesimal material of meteoritic composition. But he does not quite touch the main question, though he goes near it (p. 470). Surely the rocks of our crust are an extremely thin film on an interior of unknown composition. A planet like the earth, when duly disrupted, would supply exceedingly little material of the kind familiar to the geologist, and a vastly preponderating mass of far more basic character. Æons might go by before a chip of the crust fell upon another planet. Moreover, have not the glassy globules found in the superficial deposits of Bohemia (Bouteillenstein and Moldavite) been claimed by a high authority as of meteoritic origin?

Mr. R. T. Chamberlin, while keeping his eye on planetesimals, has published through the Carnegie Institution a paper on "The Gases in Rocks," in which a large amount of new material is made available. In the course of experiments, most gas arises from rocks that contain the greatest proportion of ferromagnesian minerals (p. 27). The discussion of the condition of the gases that are found to exist in rocks covers ground of great interest to geologists. The author affirms, with Suess, that the water and gases of the interior (p. 69) "form an integral part in the magmas, having been vital factors in their development from the primitive planetary matter." Lavas, it is urged, originate far below the possible reach of surface-waters (p. 73), and thus bring up original water with them. On the other hand, Dr. Johnston-Lavis ("Mechanism of Volcanic Action," *Geol. Mag.*, 1909, p. 437) continues to urge that the water found in lavas is absorbed by them as they rise into the moist layers of the upper regions of the crust. Mr. R. A. Daly (*Journ. of Geology*, vol. xvi., p. 401), in a paper on the origin of augite-andesite, supports the views of Scrope and Darwin on the differentiation of an igneous magma by fractional crystallisation. His views are quoted several times, under the name of Daley, in a remarkable paper by Dr. H. I. Jensen, on the distribution, origin, and relationships of alkaline rocks (Proc. Linn. Soc. N.S.W., vol. xxxiii., p. 491). The rather dubious term "alkaline" is here used to denote "rich in combined alkalies," and the rocks discussed are those that might be conceived to originate by differentiation from a foyaite-magma. Dr. Jensen examines their distribution in space and time, and concludes that they are almost all associated with Cainozoic earth-movements. The Christiania series (p. 502) is merely known to be post-Silurian, and may therefore be Eocene. "Alkaline rocks are continental and occur in areas of normal faulting above and possibly shear below" (p. 515). They are attributed to the melting and assimilation of sediments rich in alkalies (such as were formed when our earth's surface first cooled below 100° C.), as they gradually sank under the weight of Palæozoic and Mesozoic deposits. The crustal re-adjustments of the Eocene period allowed them to be expelled within the low-pressure regions, *i.e.* the continents, towards which they had gradually flowed. There is much more in this paper than might appear from so generalised a summary. Dr. Jensen's thorough study of the types of rock with which he deals is evidenced by several papers on their occurrence in eastern Australia, published in the last two years (Linn. Soc. N.S.W. and Australasian Association for the Advancement of Science, 1908–9).

Messrs. A. Boudariat and Johnston-Lavis (*Bull. Soc. Belge de Géol.*, tome xxii., 1909, p. 103) describe the occurrence of a basalt in the volcanic cone of Tritriva in central Madagascar, which has enriched itself with abundant grains of quartz at the expense of an underlying gneiss. The quartz-grains show the aureole of augite that is so common round inclusions of quartz in basic rocks. At Tritriva the volcanic chimney that was blown through the gneiss is clearly visible, and Dr. Johnston-Lavis makes some just remarks on the analogy with the so-called quartz-basalts of other areas, and on the modification of lavas by absorption.

Mr. C. B. Travis (Proc. Liverpool Geol. Soc., vol. x., p. 311) has examined the Ordovician rhyolites of Nant Ffrancon, Carnarvonshire, and gives good reason for agreeing with Iddings and Parkinson that lithophysal cavities, such as those traceable in the large Welsh spherulites, were original features of the lavas. The view that all such cavities are due to decomposition of solid structures was abandoned, however, by its supporters so far back as 1892.

The petrology of sedimentary rocks still attracts few workers. Dr. Woolacott (Univ. Durham Phil. Soc., Memoir i., 1909) describes a brecciated magnesian limestone in a paper illustrated by views of the rock as it occurs in the open field. Experiment (p. 5) leads to an estimate of the thrust concerned as having generated a pressure of 300 tons to the square foot. Mr. G. Linck, so well known for his researches on chemically deposited limestones, contributes a lucid paper on these rocks to the *Naturwissenschaftliche Wochenschrift*, 1909, p. 689. The Canadian Mining Institute publishes (Journ., vol. xii., 1909) a general paper by Mr. E. Coste on petroleums and coals, strongly supporting the "solfataric" view of the origin of petroleum. Mr. A. J. Cox (*Philippine Journ. Sci.*, vol. iii., p. 301) investigates the Philippine coals as fuels, and concludes that they may compete successfully with those of Australia. This subject is also dealt with by Mr. W. D. Smith ("Mineral Resources of the Philippine Islands," Bureau of Science of Manila, 1909). Barytes is so frequent as a cementing material in rocks that Dr. Trener's discussion of its origin in mineral waters rising from below is of general petrological interest (*Jahrb. k.k. Reichsanstalt*, Bd. lviii., p. 439).

As regards the petrography of special areas, we may note the excellent "Introduction to Petrography and the Collections of Rocks" published by the Royal Scottish Museum, Edinburgh (1909, price 1*d*.). Emphasis is here laid on Scottish examples. Dr. W. F. Hume, in his "Notes on the Petrography of Egypt" (*Geol. Mag.*, 1908, p. 500) gives a concise sketch that ought to be reprinted for the use of travellers. Mr. F. Kretschmer (*Jahrb. k.k. Reichsanstalt*, Bd. lviii., p. 527) describes the "Kalksilikatfelse" near Mährisch-Schönberg in the Sudetic, and shows them to have become mineralised by the granite of the chain, while (p. 571) certain dyke-like pyroxene-pegmatites have arisen from the absorption of limestone into the invading igneous material. Dr. Hinterlechner and Mr. C. von John, in an elaborate paper on the eruptive rocks of the Bohemian Eisengebirge (*ibid.*, Bd. lix., p. 127), show that the alteration of the sediments into crystalline schists is not here dependent on the amount of dynamic influence. Where pressure has been least, the crystallisation is most marked, and is due to the intrusion of a mass that was once regarded as a primitive core. This, the earliest granite of the area, is later than Lower Silurian sediments, and Dr. Hinterlechner believes that it was intruded after the folding of the district. Since Devonian beds are here involved, this red gneiss may be of Upper Devonian or Carboniferous age. A paper of this kind emphasises the fact that in true petrology the laboratory merely subserves the work done in the open field.

G. A. J. C.

REPORTS ON CLIMATES.

THE results of the meteorological observations at the principal stations in the system of the Deutsche Seewarte for the five-year period 1901–5, and for the ten-year period 1896–1905, recently published, complete the series of these valuable statistics for the thirty years 1876–1905. They include the mean monthly, seasonal, and annual values, and extremes or other data relating to the various elements, deduced from observations generally made three times daily, and in practically the same form as in previous instalments. The heights of some of the barometers above sea-level have changed from time to time, but in order to permit easier comparison of one period with another, this inconvenience has been minimised by reducing the observations to agree with the levels given in previous publications. Otherwise, as usual in the case of barometrical observations at climatological stations, the readings are not reduced to sea-level.

The meteorology of Peru is discussed by Dr. J. Hann in the *Sitzungsberichte* of the Vienna Academy of November 4, 1909. The observations of the various stations on which the discussion is based have been published in the Annals of the Harvard College Observatory, to which we have previously referred; the tables were carefully prepared for publication under the direction of Prof. S. J. Bailey, of Arequipa, and are mostly printed *in extenso*, with mean values, but without discussion. In the present work Dr. Hann has submitted the results of the various elements to minute investigation by the laborious process of harmonic analysis. This brings out many interesting points; we propose here only to make a few general remarks on the most important station, on the summit of the Misti (lat. 16° 16′ S., long. 71° 25′ W.), at the great elevation of 5850 metres above sea-level. Dr. Hann points out that the agreement of the daily range of the barometer with that of the highest stations in Europe and America is very noteworthy; the principal maximum occurs between noon and 1h. p.m., and the minimum about 5h. a.m. The mean annual temperature (1893–5) was −7·8° C.; January, −6·0°; May, June, and August, −9·7°. The thermometer, even on very fine days, rarely rose above freezing point. Above 4600 metres, only snow or hail was observed; a certain amount of snow remains during nearly the whole year, but a few clear days suffice to clear off the greater part of a heavy snowfall.

A valuable paper on the climate of the Lower Guinea coast and hinterland, by Dr. R. Sieglerschmidt, appears in vol. xxiii., part i., of *Mitteilungen aus den deutschen Schutzgebieten*; it is the more important from the fact that, with the exception of a short discussion of the rainfall of the Cameroons by Fitzner in 1907, no general paper on the climate of that district has been published for some years. Among the earlier papers may be specially mentioned the results of the Loango expedition (published in 1878), observations at Vivi and other places by Freiherr v. Danckelman (1884), and the reports by Lancaster and Meuleman on the climate of the Lower Congo (1897). Dr. Sieglerschmidt's article deals exhaustively with each of the meteorological elements, and the general results confirm those given by Dr. Hann in his "Klimatologie," that the air-pressure on the Lower Guinea coast has a single yearly range, and that the yearly means decrease from south to north, while the temperature (reduced to sea-level) increases considerably towards the interior, except in the extreme north. Rainfall increases along the coast from almost complete rainlessness to that of the second wettest district of the globe. The oceanic air-current, which from June to September (or October) extends from the north of Angola to the Cameroons far into the interior, has a great influence on the yearly range of temperature, rainfall, &c., while in the hinterland of the north and south districts the yearly range is determined by the alternation of summer warmth and winter cold of higher latitudes.

The climate of Berlin, part ii., air-temperature, by Prof. G. Hellmann (with the assistance of Messrs. G. v. Elsner and G. Schwalbe), forms part No. 6, vol. iii., of the *Abhandlungen* of the Royal Prussian Meteorological Institute. In this valuable and laborious investigation the observations are dealt with in great detail and for various periods from the year 1701. In the following table we quote the maximum and minimum readings for 1830–1907, and the mean monthly and yearly values for 1822–1907, in centigrade degrees :—

	Jan.	Feb.	March	April	May	June
Mean max. ...	1·4	3·3	7·0	12·9	18·5	22·5
Mean min. ...	−3·2	−2·0	0·2	4·3	8·8	12·8
True mean ...	−1·1	0·5	3·4	8·6	13·6	17·5
	July	**August**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Mean max. ...	23·8	22·8	19·0	12·9	6·3	2·7
Mean min. ...	14·3	13·9	10·5	6·4	1·6	−1·4
True mean ...	18·9	18·1	14·6	9·5	3·9	0·7

Yearly mean, 9·0; absolute maximum, 37·0 (July 20, 1865); absolute minimum, −25·0 (January 29, 1830, January 22, 1850).

The author points out that the earlier period was somewhat colder than the later; this was noticeable in all the winter months, especially in January, while greater heat in summer, especially in May and August, was observed, but he considers that it would be premature to assume that a permanent change of climate has taken place. The principal anomalies in the yearly range are the cold periods in the middle of February and June, and the warm periods near the end of September and middle of December. The cold spell of May 11–13, popularly known as the days of the Ice Saints, is not specially noticeable. The chief cause of these anomalies in the annual range of temperature is the distribution of air-pressure in Eurasia, especially the position of the barometric maximum.

A comprehensive discussion of the rainfall of northern Spain and Portugal, by Dr. W. Semmelhack, is contained in *Aus dem Archiv der Deutschen Seewarte* (1910, No. 2). It deals with many aspects of the subject, including horizontal and vertical distribution of amount and frequency, isohyets and tabular means of years and seasons, thunderstorms, &c., embracing a period extending from 1861 to 1900. The rainfall is affected chiefly by conditions of pressure over the Atlantic, Mediterranean, and the Continent, and its yearly distribution is therefore subject to considerable fluctuation. To give details would require much space, but a rough idea may be gained from the fact that about 4 per cent. of the area in question receives an amount not exceeding 12 inches; 53 per cent., approximately 12–27½ inches; 17 per cent., 27½–39½ inches; 23 per cent., 39½–59 inches; 3 per cent., more than this amount. The extreme values are 9·6 inches at Palencia (Old Castile) and 113 inches at Sierra d'Estrella. The monthly extreme values vary very greatly; the highest are met with on the N., N.W., and W. coasts. In March, 1886, 48·7 inches were recorded at Sierra d'Estrella, but in the dry districts of the central plateau the greatest monthly amounts are little above 6 inches; rainless months occur at times at nearly all the stations.

BIRD NOTES.

To the July issue of the *Quarterly Review* Dr. H. Gadow communicates an instructive article on the nature and meaning of the colours of birds. After pointing out the fallacy of the idea that the colouring of such birds as the scarlet ibis or white egret can be in any sense protective, the author discusses the diverse means by which colour is produced in birds, showing that while black and the red and yellow group are pigmentary, blues and greens are so-called structural tints, due to the reflection from the surface of the feathers of an undue proportion of short light-rays. Metallic colouring, which usually occurs in black feathers, is due, of course, to another cause. Dr. Gadow next proceeds to describe the sequence in which various colours replace one another with the advance of specialisation. As regards the cause of colour-specialisation, the author rejects both natural and sexual selection, remarking that if the latter were the inducing factor, every group and species would have its own taste, and each individual would strive to develop its yellow patches into orange and then into red. For the explanation offered in place of natural and sexual selection, we must refer our readers to the article itself.

In the August number of Witherby's *British Birds* the editor congratulates his readers on the satisfactory response which has been made this season to his appeal for assistance in marking birds. Nearly 11,000 rings were distributed, and schedules recording the marking of between 5000 and 6000 birds have been already received. The cooperation is invoked of all into whose hands ringed birds may fall. In the same issue Mr. W. Frohawk describes and illustrates the feeding habits of the razorbill, remarking that all the specimens which have come under his special notice fed on sand-launces. These fish, to the number in some cases of so many as half a dozen at a time, are held transversely in the beak, and the marvel is how the bird manages to capture and hold one after the other without losing those previously caught. Possibly each is killed when caught; but even then it is difficult to see how the catch is procured and retained.

To the August number of the *Popular Science Monthly* Prof. F. H. Herrick contributes the third and final instalment of an article on instinct and intelligence in birds. It is concluded that many of the alleged cases of intelligence are really due to habit, and that "all the intelligence which birds may on occasion exhibit seems to give way under the spell of any of the strange instincts. . . . They seldom meet emergencies by doing the intelligent act, and, in spite of the anecdotes, probably but seldom come to the effective aid of their companions in distress. On the other hand, I have more than once seen a mother bird try to pluck a hair or piece of grass from the mouth of a nestling."

Another instance of intelligence is afforded, in the author's opinion, when a gull, after feeding its young for three weeks on partially digested fish, offers them entire squids to swallow. The practice displayed by young kingfishers of arranging themselves in a row and showing a tendency to walk backwards is, however, attributed to habit formed underground; while the time it takes for hole-nesting birds to change their place of entrance when a more convenient access has been afforded is an instance of the dominance of habit over intelligence.

THE BRITISH ASSOCIATION AT SHEFFIELD.

Section D.

ZOOLOGY.

Opening Address by Prof. G. C. Bourne, M.A., D.Sc., F.R.S., President of the Section.

In choosing a subject for the address with which it is my duty, as President of this Section, to trouble you, I have found myself in no small embarrassment. As one whose business it is to lecture and give instruction in the details of comparative anatomy, and whose published work, *qualecunque sit*, has been indited on typical and, as men would now say, old-fashioned morphological lines, I seem to stand self-condemned as a morphologist. For morphology, if I read the signs of the times aright, is no longer in favour in this country, and among a section of the zoological world has almost fallen into disgrace. At all events, I have been very frankly assured that this is the case by a large proportion of the young gentlemen whom it has been my fate to examine during the past two years; and, as this seems to be the opinion of the rising generation of English zoologists, and as there are evident signs that their opinion is backed by an influential section of their elders, I have thought that it might be of some interest, and perhaps of some use, if I took this opportunity of offering an apology for animal morphology.

It is a sound rule to begin with a definition of terms, so I will first try to give a short answer to the question "What is morphology?" and, when I have given a somewhat dogmatic answer, I will try to deal in the course of this address with two further questions: What has morphology done for zoological science in the past? What remains for morphology to do in the future?

To begin with, then, what do we include under the term morphology? I must, first of all, protest against the frequent assumption that we are bound by the definitions of C. F. Wolff or Goethe, or even of Haeckel, and that we may not enlarge the limits of morphological study beyond those laid down by the fathers of this branch of our science. We are not—at all events we should not be—bound by authority, and we owe no allegiance other than what reason commends to causes and principles enunciated by our predecessors, however eminent they may have been.

The term morphology, stripped of all the theoretical conceptions that have clustered around it, means nothing more than the study of form, and it is applicable to all branches of zoology in which the relationships of animals are determined by reference to their form and structure. Morphology, therefore, extends its sway not only over the comparative anatomy of adult and recent animals, but also over palæontology, comparative embryology, systematic zoology and cytology, for all these branches of our science are occupied with the study of form. And in treating of form they have all, since the acceptance of the doctrine of descent with modification, made use of the same guiding principle—namely, that likeness of form is the index to blood-relationship. It was the introduction of this principle that revolutionised the methods of morphology fifty years ago, and stimulated that vast output of morphological work which some persons, erroneously as I think, regard as a departure from the line of progress indicated by Darwin.

We may now ask, what has morphology done for the advancement of zoological science since the publication of the "Origin of Species"? We need not stop to inquire what facts it has accumulated: it is sufficiently obvious that it has added enormously to our stock of concrete knowledge. We have rather to ask what great general principles has it established on so secure a basis that they meet with universal acceptance at the hands of competent zoologists?

It has doubtless been the object of morphology during the past half-century to illustrate and confirm the Darwinian theory. How far has it been successful? To answer this question we have to be sure of what we mean when we speak of the Darwinian theory. I think that we mean at least two things. (1) That the assemblage of animal forms as we now see them, with all their diversities of form, habit, and structure, is directly descended from a precedent and somewhat different assemblage, and these in turn from a precedent and more different assemblage, and so on down to remote periods of geological time. Further, that throughout all these periods inheritance combined with changeability of structure have been the factors operative in producing the differences between the successive assemblages. (2) That the modifications of form which this theory of evolution implies have been rejected or preserved and accumulated by the action of natural selection.

As regards the first of these propositions, I think there can be no doubt that morphology has done great service in establishing our belief on a secure basis. The transmutation of animal forms in past time cannot be proved directly; it can only be shown that, as a theory, it has a much higher degree of probability than any other that can be brought forward, and in order to establish the highest possible degree of probability, it was necessary to demonstrate that all anatomical, embryological, and palæontological facts were consistent with it. We are apt to forget, nowadays, that there is no *a priori* reason for regarding the resemblances and differences that we observe in organic forms as something different in kind from the analogous series of resemblances and differences that obtain in inanimate objects. This was clearly pointed out by Fleeming Jenkin in a very able and much-referred to article in the *North British Review* for June, 1867, and his argument from the *a priori* standpoint has as much force to-day as when it was written forty-three years ago. But it has lost almost all its force through the arguments *a posteriori* supplied by morphological science. Our belief in the transmutation of animal organisation in past time is founded very largely upon our minute and intimate knowledge of the manifold relations of structural form that obtain among adult animals; on our precise knowledge of the steps by which these adult relations are established during the development of different kinds of animals; on our constantly increasing knowledge of the succession of animal forms in past time; and, generally, on the conviction that all the diverse forms of tissues, organs, and entire animals are but the expression of an infinite number of variations of a single theme, that theme being cell-division, multiplication, and differentiation. This conviction grew but slowly in men's minds. It was opposed to the cherished beliefs of centuries, and morphology rendered a necessary service when it spent all those years which have been described as "years in the wilderness" in accumulating such a mass of circumstantial evidence in favour of an evolutionary explanation of the order of animate nature as to place the doctrine of descent with modification on a secure foundation of fact. I do not believe that this foundation could have been so securely laid in any other way, and I hold that zoologists were actuated by a sound instinct in working so largely on morphological lines for forty years after Darwin wrote. For there was a large mass of fact and theory to be remodelled and brought into harmony with the new ideas, and a still larger vein of undiscovered fact to explore. The matter was difficult and the pace could not be forced. Morphology, therefore, deserves the credit of having done well in the past: the question remains, What can it do in the future?

It is evident, I think, that it cannot do much in the way of adding new truths and general principles to zoological science, nor even much more that is useful in the verification of established principles, without enlarging its scope and methods. Hitherto—or, at any rate, until very recently—it has accepted certain guiding principles on faith, and, without inquiring too closely into their validity, has occupied itself with showing that, on the assumption that these principles are true, the phenomena of animal structure, development, and succession receive a reasonable explanation.

We have seen that the fundamental principles relied upon during the last fifty years have been inheritance and variation. In every inference drawn from the comparison of one kind of animal structure with another, the morphologist founds himself on the assumption that different degrees of similitude correspond more or less closely to degrees of blood-relationship, and to-day there are probably few persons who doubt that this assumption is valid. But we must not forget that, before the publication of the "Origin of Species," it was rejected by the most influential zoologists as an idle speculation, and that it is imperilled by Mendelian experiments showing that characters may be split up and reunited in different combinations in the course of a few generations. We do not doubt the importance of the principle of inheritance, but we are not quite so sure as we were that close resemblances are due to close kinship and remoter resemblances to remoter kinship.

The principle of variation asserts that like does not beget exactly like, but something more or less different. For a long time morphologists did not inquire too closely into the question how these differences arose. They simply accepted it as a fact that they occur, and that they are of sufficient frequency and magnitude, and that a sufficient proportion of them lead in such directions that natural selection can take advantage of them. Difficulties and objections were raised, but morphology on the whole took little heed of them. Remaining steadfast in its adherence to the principles laid down by Darwin, it contented itself with piling up circumstantial evidence, and met objection and criticism with an ingenious apologetic. In brief, its labours have consisted in bringing fresh instances, and especially such instances as seemed unconformable, under the rules, and in perfecting a system of classification in illustration of the rules. It is obvious, however, that, although this kind of study is both useful and indispensable at a certain stage of scientific progress, it does not help us to form new rules, and fails altogether if the old rules are seriously called into question.

As a matter of fact, admitting that the old rules are valid, it has become increasingly evident that they are not sufficient. Until a few years ago morphologists were open to the reproach that, while they studied form in all its variety and detail, they occupied themselves too little—if, indeed, they could be said to occupy themselves at all—with the question of how form is produced, and how, when certain forms are established, they are caused to undergo change and give rise to fresh forms. As Klebs has pointed out, the forms of animals and plants were regarded as the expression of their inscrutable inner nature, and the stages passed through in the development of the individual were represented as the outcome of purely internal and hidden laws. This defect seems to have been more distinctly realised by botanical than by zoological morphologists, for Hofmeister, as long ago as 1868, wrote that the most pressing and immediate aim of the investigator was to discover to what extent external forces acting on the organism are of importance in determining its form.

If morphology was to be anything more than a descriptive science, if it was to progress any further in the discovery of the relations of cause and effect, it was clear that it must alter its methods and follow the course indicated by Hofmeister. And I submit that an inquiry into the causes which produce alteration of form is as much the province of, and is as fitly called, morphology as, let us say, a discussion of the significance of the patterns of the molar teeth of mammals or a disputation about the origin of the cœlomic cavities of vertebrated and invertebrated animals.

There remains, therefore, a large field for morphology to explore. Exploration has begun from several sides, and in some quarters has made substantial progress. It will be of interest to consider how much progress has been made along certain lines of research—we cannot now follow all the lines—and to forecast, if possible, the direction that this pioneer work will give to the morphology of the future.

I am not aware that morphologists have, until quite recently, had any very clear concept of what may be expected to underlie form and structure. Dealing, as they have dealt, almost exclusively with things that can be seen or rendered visible by the microscope, they have acquired the habit of thinking of the organism as made up of organs, the organs of tissues, the tissues of cells, and the cells as made up—of what? Of vital units of a lower order, as several very distinguished biologists would have us believe; of physiological units, of micellæ, of determinants and biophors, or of pangenes; all of them essentially morphological conceptions; the products of imagination projected beyond the confines of the visible, yet always restrained by having only one source of experience—namely, the visible. One may give unstinted admiration to the brilliancy, and even set a high value on the usefulness, of these attempts to give formal representations of the genesis of organic structure, and yet recognise that their chief utility has been to make us realise more clearly the problems that have yet to be solved.

Stripped of all the verbiage that has accumulated about them, the simple questions that lie immediately before us are: What are the causes which produce changes in the forms of animals and plants? Are they purely internal, and, if so, are their laws discoverable? Or are they partly or wholly external, and, if so, how far can we find relations of cause and effect between ascertained chemical and physical phenomena and the structural responses of living beings?

As an attempt to answer the last of these questions, we have the recent researches of the experimental morphologists and embryologists directed towards the very aim that Hofmeister proposed. Originally founded by Roux, the school of experimental embryology has outgrown its infancy and has developed into a vigorous youth. It has produced some very remarkable results, which cannot fail to exercise a lasting influence on the course of zoological studies. We have learnt from it a number of positive facts, from which we may draw very important conclusions, subversive of some of the most cherished ideas of whilom morphologists. It has been proved by experiment that very small changes in the chemical and physical environment may and do produce specific form-changes in developing organisms, and in such experiments the consequence follows so regularly on the antecedent that we cannot doubt that we have true relations of cause and effect. It is not the least interesting outcome of these experiments that, as Loeb has remarked, it is as yet impossible to connect in a rational way the effects produced with the causes which produced them, and it is also impossible to define in a simple way the character of the change so produced. For example, there is no obvious connection between the minute quantity of sulphates present in sea-water and the number and position of the characteristic calcareous spicules in the larva of a sea-urchin. Yet Herbst has shown that if the eggs of sea-urchins are reared in sea-water deprived of the needful sulphates (normally 0·26 per cent. magnesium sulphate and 0·1 per cent. calcium sulphate), the number and relative positions of these spicules are altered, and, in addition, changes are produced in other organs, such as the gut and the ciliated bands. Again, there is no obvious connection between the presence of a small excess of magnesium chloride in sea-water and the development of the paired optic vesicles. Yet Stockard, by adding magnesium chloride to sea-water in the proportion of 6 grams of the former to 100 c.c. of the latter, has produced specific effects on the eyes of developing embryos of the minnow *Fundulus heteroclitus*: the optic vesicles, instead of being formed as a widely separated pair, were caused to approach the median line, and in about 50 per cent. of the embryos experimented upon the changes were so profound as to give rise to cyclopean monsters. Many other instances might be cited of definite effects of physical and chemical agencies on particular organs, and we are now forced to admit that inherited tendencies may be completely overcome by a minimal change in the environment. The nature of the organism, therefore, is not all important, since it yields readily to influences which at one time we should have thought inadequate to produce perceptible changes in it.

It is open to anyone to argue that, interesting as experiments of this kind may be, they throw no light on the origin of permanent—that is to say, inheritable—modifications of structure. It has for a long time been a matter of common knowledge that individual plants and animals react to their environment, but the modifications induced by these reactions are somatic; the germ-plasm is not affected, therefore the changes are not inherited, and no permanent effect is produced in the characters of the race or species. It is true that no evidence has yet been produced to show that form-changes as profound as those that I have mentioned are transmitted to the offspring. So far the experimenters have not been able to rear the modified organisms beyond the larval stages, and so there are no offspring to show whether cyclopean eyes or modified forms of spicules are inherited or not. Indeed, it is possible that the balance of organisation of animals thus modified has been upset to such an extent that they are incapable of growing into adults and reproducing their kind.

But evidence is beginning to accumulate which shows that external conditions may produce changes in the germ-cells as well as in the soma, and that such changes may be specific and of the same kind as similarly produced somatic changes. Further, there is evidence that such germinal changes are inherited—and, indeed, we should expect them to be, because they are germinal.

The evidence on this subject is as yet meagre, but it is of good quality and comes from more than one source.

There are the well-known experiments of Weismann, Standfuss, Merrifield, and E. Fischer on the modification of the colour patterns on the wings of various Lepidoptera. In the more northern forms of the fire-butterfly, *Chrysophanus* (*Polyommatus*) *phlaeas*, the upper surfaces of the wings are of a bright red-gold or copper colour with a narrow black margin, but in southern Europe the black tends to extend over the whole surface of the wing and may nearly obliterate the red-gold colour. By exposing pupæ of caterpillars collected at Naples to a temperature of 10° C. Weismann obtained butterflies more golden than the Neapolitan, but blacker than the ordinary German race, and conversely, by exposing pupæ of the German variety to a temperature of about 38° C., butterflies were obtained blacker than the German, but not so black as the Neapolitan variety. Similar deviations from the normal standard have been obtained by like means in various species of Vanessa by Standfuss and Merrifield. Standfuss, working with the small tortoiseshell butterfly (*Vanessa urticae*), produced colour aberrations by subjecting the pupæ to cold, and found that some specimens reared under normal conditions from the eggs produced by the aberrant forms exhibited the same aberrations, but in a lesser degree. Weismann obtained similar results with the same species. E. Fischer obtained parallel results with *Arctia caja*, a brightly coloured diurnal moth of the family Bombycidæ. Pupæ of this moth were exposed to a temperature of 8° C., and some of the butterflies that emerged were very dark-coloured aberrant forms. A pair of these dark aberrants were mated, and the female produced eggs, and from these larvæ and pupæ were reared at a normal temperature. The progeny was for the most part normal, but some few individuals exhibited the dark colour of the parents, though in a less degree. The simple conclusions to be drawn from the results of these experiments is that a proportion of the germ-cells of the animals experimented upon were affected by the abnormal temperatures, and that the reaction of the germ-cells was of the same kind as the reaction of the somatic cells and produced similar results. As everybody knows, Weismann, while admitting that the germ-cells were affected, would not admit the simple explanation, but gave another complicated and, in my opinion, wholly unsupported explanation of the phenomena.

In any case this series of experiments was on too small a scale, and the separate experiments were not sufficiently carefully planned to exclude the possibility of error. But no objection of this kind can be urged against the careful and prolonged studies of Tower on the evolution of chrysomelid beetles of the genus Leptinotarsa. Leptinotarsa—better known, perhaps, by the name Doryphora—is the potato-beetle, which has spread from a centre in North Mexico southwards into the isthmus of Panama and northwards over a great part of the United States. It is divisible into a large number of species, some of which are dominant and widely ranging; others are restricted to very small localities. The specific characters relied upon are chiefly referable to the coloration and colour patterns of the epicranium, pronotum, elytra, and underside of the abdominal segments. In some species the specific markings are very constant, in others, particularly in the common and wide-ranging *L. decemlineata*, they vary to an extreme degree. As the potato-beetle is easily reared and maintained in captivity, and produces two broods every year, it is a particularly favourable subject for experimental investigation. Tower's experiments have extended over a period of eleven years, and he has made a thorough study of the geographical distribution, dispersal, habits, and natural history of the genus. The whole work appears to have been carried out with the most scrupulous regard to scientific accuracy, and the author is unusually cautious in drawing conclusions and chary of offering hypothetical explanations of his results. I have been greatly impressed by the large scale on which the experiments have been conducted, by the methods used, by the care taken to verify every result obtained, and by the great theoretical importance of Tower's conclusions. I can do no more now than allude to some of the most remarkable of them.

After showing that there are good grounds for believing that colour production in insects is dependent on the action of a group of closely related enzymes, of which chitase, the agent which produces hardening of chitin, is the most important, Tower demonstrates by a series of well-planned experiments that colours are directly modified by the action of external agencies—viz., temperature, humidity, food, altitude, and light. Food chiefly affects the subhypodermal colours of the larvæ, and does not enter much into account; the most important agents affecting the adult coloration being temperature and humidity. A *slight* increase or a *slight* decrease of temperature or humidity was found to stimulate the action of the colour-producing enzymes, giving a tendency to melanism; but a large increase or decrease of temperature or humidity was found to inhibit the action of the enzymes, producing a strong tendency to albinism.

A set of experiments was undertaken to test the question whether colouration changes induced by changed environmental conditions were inherited, increased, or dropped in successive generations. These experiments, carried on for ten lineal generations, showed that the changed conditions immediately produced their maximum effect; that they were purely somatic and were not inherited, the progeny of individuals which had been exposed to changed conditions through several generations promptly reverting when returned to normal conditions of environment. So far the results are confirmatory of the well-established proposition that induced somatic changes are not inheritable.

But it was found necessary to remove the individuals experimented upon from the influence of changed conditions during the periods of growth and maturation of the germ-cells. Potato-beetles emerge from the pupa or from hibernation with the germ-cells in an undeveloped condition, and the ova do not all undergo their development at once, but are matured in batches. The first batch matures during the first few days following emergence, then follows an interval of from four to ten days, after which the next batch of eggs is matured, and so on. This fact made it possible to test the effect of altered conditions on the maturing germ-cells by subjecting its imagos to experimental conditions during the development of some of the batches of ova and to normal conditions during the development of other batches.

In one of the experiments four male and four female individuals of *L. decemlineata* were subjected to very hot and dry conditions, accompanied by low atmospheric pressure, during the development and fertilisation of the first three batches of eggs. Such conditions had been found productive of albinic deviations in previous experiments. As soon as the eggs were laid they were removed to normal conditions, and the larvæ and pupæ reared from them were kept in normal conditions. Ninety-eight adult beetles were reared from these batches of eggs, of which eighty-two exhibited the characters of an albinic variety found in nature and described as a species under the name *pallida*; two exhibited the characters of another albinic species named *immaculothorax*, and fourteen were unmodified *decemlineatas*. This gave a clear indication that the altered conditions had produced modifications in the germ-cells which were expressed by colour changes in the adult individuals reared from them. To prove that the deviations were not inherent in the germ-plasm of the parents, the latter were kept under normal conditions during the periods of development and fertilisation of the last two batches of eggs; the larvæ and pupæ reared from these eggs were similarly subjected to normal conditions, and gave rise to sixty-one unmodified *decemlineatas*, which, when bred together, came true to type for three generations. The *decemlineata* forms produced under experimental conditions also came true to type when bred together. Of the *pallida* forms produced by experimental conditions all but two males were killed by a bacterial disease. These two were crossed with normal *decemlineata* females, and the result was a typical Mendelian segregation, as shown by the following table:—

2 ♂ pallida × 2 ♀ decemlineata

Hybrids, decemlineata characters dominant

5 ♂ × 3 ♀

Pallida 6 ♂, 4 ♀ — Decemlineata and hybrids 16 ♂, 14 ♀

Pallida 18 ♂, 23 ♀ — Pallida 8 ♂, 7 ♀ — Decemlineata and hybrids 26 ♂, 28 ♀

This is a much more detailed experiment than those of Standfuss, Merrifield, and Fischer, and it shows that the changes produced by the action of altered conditions on the maturing germ-cells were definite and discontinuous, and therefore of the nature of mutations in De Vries' sense.

In another experiment Tower reared three generations of *decemlineata* to test the purity of his stock. He found that they showed no tendency to produce extreme variations under normal conditions. From this pure stock seven males and seven females were chosen, and subjected during the maturation periods of the first two batches of ova to hot and dry conditions. Four hundred and nine eggs were laid, from which sixty-nine adults were reared, constituted as follows:—

Twenty (12 ♂, 8 ♀) . .	apparently normal *decemlineata*.
Twenty-three (10 ♂, 13 ♀).	*pallida*.
Five (2 ♂, 3 ♀) . . .	*immaculotho. ax*.
Sixteen (9 ♂, 7 ♀) . .	*albida*.

These constituted lot A.

The same seven pairs of parents subjected during the second half of the reproductive period to normal conditions gave 840 eggs, from which were reared 123 adults, all *decemlineatas*. These constituted lot B. The *decemlineatas* of lot A and lot B were reared side by side under normal and exactly similar conditions. The results were striking. From lot B normal progeny were reared up to the tenth generation, and, as usual in the genus, two generations were produced in each year. The *decemlineatas* of lot A segregated into two lots in the second generation. A^1 were normal in all respects, but A^2, while retaining the normal appearance of *decemlineata*, went through five generations in a year, and this for three successive years, thus exhibiting a remarkable physiological modification, and one without parallel in nature, for no species of the genus Leptinotarsa are known which produce more than two generations in the year. This experiment is a sufficient refutation of Weismann's argument that the inheritance of induced modifications in *Vanessa urticae* is only apparent, the phenomena observed being due to the inheritance of two kinds of determinants —one from dark-coloured forms which are phyletically the oldest, and the other from more gaily coloured forms derived from the darker forms. There is no evidence whatever that there was ever a species or variety of potato-beetle that produced more than two, or at the most, and then as an exception, three broods in a year.

The modified albinic forms in this last experiment of Tower's were weakly; they were bred through two or three generations, and came true to type, but then died out. No hybridisation experiments were made with them, but in other similar experiments, which I have not time to mention in detail, modified forms produced by the action of changed conditions gave typical Mendelian characters when crossed with unmodified *decemlineatas*, thus proving that the induced characters were constant and heritable according to the regular laws.

I have thought it worth while to relate these experiments at some length, because they seem to me to be very important, and because they do not appear to have attracted the attention in this country that they deserve.

They are confirmed to a very large extent by the experiments of Prof. Klebs on plants, the results of which were published this summer in the Croonian Lecture on "Alterations of the Development and Forms of Plants as a Result of Environment." As I have only a short abstract of the Croonian Lecture to refer to, I cannot say much on this subject for fear of misrepresenting the author; but, as far as I can judge, his results are quite consistent with those of Tower. *Sempervivum funckii* and *S. acuminatum* were subjected to altered conditions of light and nutrition, with the result that striking variations, such as the transformation of sepals into petals, of petals into stamens, of stamens into petals and into carpels, were produced. Experiments were made on *Sempervivum acuminatum* with the view of answering the question whether such alterations of flowers can be transmitted. The answer was in the affirmative. The seeds of flowers artificially altered and self-fertilised gave rise to twenty-one seedlings, among which four showed surprising deviations of floral structure. In two of these seedlings all the flowers were greatly altered, and presented some of the modifications of the mother plant, especially the transformation of stamens into petals. These experiments are still in progress, and it would perhaps be premature to lay too much stress upon them if it were not for the fact that they are so completely confirmatory of the results obtained by similar methods in the animal kingdom.

I submit to you that evidence is forthcoming that external conditions may give rise to inheritable alterations of structure. Not, however, as was once supposed, by producing specific changes in the parental soma, which changes were reflected, so to speak, upon the germ-cells. The new evidence confirms the distinctions drawn by Weismann between somatic and germinal variations. It shows that the former are not inherited, while the latter are; but it indicates that the germ may be caused to vary by the action of external conditions in such a manner as to produce specific changes in the progeny resulting from it. It is no more possible at the present time to connect rationally the action of external conditions on the germ-cells with the specific results produced in the progeny than it is possible to connect cause with effect in the experiments of Herbst and Stockard; but when we compare these two kinds of experiments, we are no longer able to argue that it is inconceivable that such and such conditions acting on the germ-plasm can produce such and such effects in the next generation of adults. We must accept the evidence that things which appeared inconceivable do in fact happen, and in accepting this we remove a great obstacle from the path of our inquiries, and gain a distinct step in our attempts to discover the laws which determine the production of organic form and structure.

But such experiments as those which I have mentioned only deal with one aspect of the problem. They tell us about external conditions and the effects that they are observed to produce upon the organism. They give us no definite information about the internal changes which, taken together, constitute the response of the organism to external stimuli. As Darwin wrote, there are two factors to be taken into account—the nature of the conditions and the nature of the organism, and the latter is much the more important of the two. More important because the reactions of animals and plants are manifold; but, on the whole, the changes in the conditions are few and small in amount. Morphology has not succeeded in giving us any positive knowledge of the nature of the organism; and in this matter we must turn for guidance to the physiologists, and ask of them how far recent researches have resulted in the discovery of factors competent to account for change of structure. Perhaps the first step in this inquiry is to ask whether there is any evidence of internal chemical changes analogous in their operation to the external physical and chemical changes which we have been dealing with.

There is a great deal of evidence, but it is extremely difficult to bring it to a focus and to show its relevancy to the particular problems that perplex the zoologist. Moreover, the evidence is of so many different kinds, and each kind is so technical and complex, that it would be absurd to attempt to deal with it at the end of an address that has already been drawn out to sufficient length. But perhaps I may be allowed to allude to one or two generalisations which appear to me to be most suggestive.

We shall all agree that, at the bottom, production and change of form is due to increase or diminution of the activities of groups of cells, and we are aware that in the higher animals change of structure is not altogether a local affair, but carries with it certain consequences in the nature of correlated changes in other parts of the body. If we are to make any progress in the study of morphogeny, we ought to have as exact ideas as possible as to what we mean when we speak of the activities of cells and of correlation. On these subjects physiology supplies us with ideas much more exact than those derived from morphology.

It is, perhaps, too sweeping a generalisation to assert that the life of any given animal is the expression of the sum of the activities of the enzymes contained in it, but it seems well established that the activities of cells are, if not wholly, at all events largely, the result of the actions of the various kinds of enzymes held in combination by their living protoplasm. These enzymes are highly susceptible to the influence of physical and chemical media, and it is because of this susceptibility that the organism responds to changes in the environment, as is clearly illustrated in a particular case by Tower's experiments on the production of colour changes in potato-beetles. Bayliss and Starling have shown that in lower animals, protozoa and sponges, in which no nervous system has been developed, the response of the organism to the environment is effected by purely chemical means. In protozoa, because of their small size, the question of coadaptation of function hardly comes into question; but in sponges, many of which are of large size, the mechanism of coadaptation must also be almost exclusively chemical. Thus we learn that the simplest and, by inference, the phyletically oldest mechanism of reaction and coordination is a chemical mechanism. In higher animals the necessity for rapid reaction to external and internal stimuli has led to the development of a central and peripheral nervous system, and as we ascend the scale of organisation this assumes a greater and greater importance as a co-ordinating bond between the various organs and tissues of the body. But the more primitive chemical bond persists, and is scarcely diminished in importance, but only overshadowed, by the more easily recognisable reactions due to the working of the nervous system. In higher animals we may recognise special chemical means whereby chemical coadaptations are established and maintained at a normal level or in certain circumstances altered. These are the internal secretions produced by sundry organs, whether by typical secretory glands (in which case the internal secretion is something additional and different from the external secretion), or by the so-called ductless glands, such as the thyroid, the thymus, the adrenal bodies, or by organs which cannot strictly be called glands, namely, the ovaries and testes. All these produce chemical substances which, passing into the blood or lymph, are distributed through the system, and have the peculiar property of regulating or exciting the specific functions of other organs. Not, however, of all the organs, for the different internal secretions are more or less limited and local in their effects, one affecting the activity of this and another the activity of that kind of tissue or organ. Starling proposed the name hormones for the internal secretions because of their excitatory properties (ὁρμάω, to stir up, to excite).

Hormones have been studied chiefly from the point of view of their stimulating effect on the metabolism of various organs. From the morphologist's point of view, interest chiefly attaches to the possibility of their regulating and promoting the production of form. It might be expected that they should be efficient agents in regulating form, for, if changes in structure are the result of the activities of groups of cells, and the activities of cells are the results of the activities of the enzymes which they contain, and if the activities of the enzymes are regulated by the hormones, it follows that the last-named must be the ultimate agents in the production of form. It is difficult to obtain distinct evidence of this agency, but in some cases, at least, the evidence is sufficiently clear. I will confine myself to the effects of the hormones produced by the testes and ovaries. These have been proved to be intimately connected with the development of secondary sexual characters, such, for instance, as the characteristic shape and size of the horns of the bull; the comb, wattles, spurs, plumage colour, and spurs in poultry; the swelling on the index finger of the male frog; the shape and size of the abdominal segments of crabs. These are essentially morphological characters, the results of increased local activity of cell-growth and differentiation. As they are attributable to the stimulating effect of the hormone produced by the male organ in each species, they afford at least one good instance of the production of a specific change of form as the result of an internal chemical stimulus. We get here a hint as to the nature of the chemical mechanism which excites and correlates form and function in higher organisms, and, from what has just been said, we perceive that this is the most primitive of all the animal mechanisms. I submit that this is a step towards forming a clear and concrete idea of the inner nature of the organism. There is one point, and that a very important one, upon which we are by no means clear. We do not know how far the hormones themselves are liable to change, whether by the action of external conditions or by the reciprocal action of the activities of the organs to which they are related. It is at least conceivable that agencies which produce chemical disturbances in the circulating fluids may alter the chemical constitution of the hormones, and thus produce far-reaching effects. The pathology of the thyroid gland gives some ground for belief that such changes may be produced by the action of external conditions. But, however this may be, the line of reasoning that we have followed raises the expectation that a chemical bond must exist between the functionally active organs of the body and the germ-cells. For if, in the absence of a specialised nervous system, the only possible regulating and coadapting mechanism is a chemical mechanism, and if the specific activities of a cell are dependent on the enzymes which it holds in combination, the germ-cells of any given animal must be the depository of a stock of enzymes sufficient to insure the due succession of all its developmental stages as well as of its adult structure and functions. And as the number of blastomeres increases, and the need for coordination of form and function arises, before ever the rudiments of a nervous system are differentiated, it is necessary to assume that there is also a stock of appropriate hormones to supply the chemical nexus between the different parts of the embryo. The only alternative is to suppose that they are synthesised as required in the course of development. There are grave objections to this supposition. All the evidence at our disposal goes to show that the potentialities of germ-cells are determined at the close of the maturation divisions. Following the physiological line of argument, it must be allowed that in this connection "potentiality" can mean nothing else than chemical constitution. If we admit this, we admit the validity of the theory, advanced by more than one physiologist, that heritable "characters" or "tendencies" must be identified with the enzymes carried in the germ-cells. If this be a true representation of the facts, and if the most fundamental and primitive bond between one part of an organism and another is a chemical bond, it can hardly be the case that germ-cells—which, *inter alia*, are the most primitive, in the sense of being the least differentiated, cells in the body—should be the only cells which are exempt from the chemical influences which go to make up the coordinate life of the organism. It would seem, therefore, that there is some theoretical justification for the inheritance of induced modifications, provided that these are of such a kind as to react chemically on the enzymes contained in the germ-cells.

One further idea that suggests itself to me and I have done. Is it possible that different kinds of enzymes exercise an inhibiting influence on one another; that germ-cells are "undifferentiated" because they contain a large number of enzymes, none of which can show their activities in the presence of others, and that what we call "differentiation" consists in the segregation of the different kinds into separate cells, or perhaps, prior to cell-formation, into different parts of the fertilised ovum, giving rise to the phenomenon known to us as pre-localisation? The idea is purely speculative; but, if it could be shown to have any warrant, it would go far to assist us in getting an understanding of the laws of the production of form.

I have been wandering in territories outside my own province, and I shall certainly be told that I have lost my way. But my thesis has been that morphology, if it is to make useful progress, must come out of its reserves and explore new ground. To explore is to tread unknown paths, and one is likely to lose one's way in the unknown. To stay at home in the environment of familiar ideas is no doubt a safe course, but it does not make for advancement. Morphology, I believe, has as great a future before it as it has a past behind it, but it can only realise that future by leaving its old home, with all its comfortable furniture of well-worn rules and methods, and embarking on a journey, the first stages of which will certainly be uncomfortable, and the end is far to seek.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY A. J. HERBERTSON, M.A., PH.D., PROFESSOR OF GEOGRAPHY IN THE UNIVERSITY OF OXFORD, PRESIDENT OF THE SECTION.

GEOGRAPHY AND SOME OF ITS PRESENT NEEDS.

Geographical Progress in the Last Decade.

AT the close of a reign which has practically coincided with the first decade of a new century, it is natural to look back and summarise the progress of geography during the decade. At the beginning of a new reign it is equally natural to consider the future. Our new Sovereign is one of the most travelled of men. No monarch knows the World as he knows it; no monarch has ruled over a larger Empire or seen more of his dominions. His advice has been to wake up, to consider and to act. This involves taking existing geographical conditions into account. It will be in consonance with this advice if I pay more attention to the geography of the present and future than to that of the past, and say more about its applications than about its origins. Yet I do so with some reluctance, for the last decade has been one of the most active and interesting in the history of our science.

Among the many geographical results of work in the past decade a few may be mentioned. The measurement of new and the remeasurement of old arcs will give us better data for determining the size and shape of the Earth. Surveys of all kinds, from the simple route sketches of the traveller to the elaborate cadastral surveys of some of the more populous and settled regions have so extended our knowledge of the surface features of the Earth that a map on the scale of 1 : 1,000,000 is not merely planned, but actually partly executed. Such surveys and such maps are the indispensable basis of our science.

The progress of oceanography has also been great. The soundings of our own and other Admiralties, of scientific oceanographical expeditions, and those made for the purpose of laying cables, have given us much more detailed knowledge of the irregularities of the ocean floor. An international map of oceanic contours, due to the inspiration and munificence of the Prince of Oceanographers and of Monaco, has been issued during the decade, and so much new material has accumulated that it is now being revised. A comparison of the old and new editions of Krümmel's "Ozeanographie" shows us the immense advances in this subject.

Great progress has been made on the geographical side of meteorology and climate. The importance of this knowledge for tropical agriculture and hygiene has led to an increase of meteorological stations all over the hot belt—the results of which will be of value to the geographer. Mr. Bartholomew's "Atlas of Meteorology" appeared at the beginning, and Sir John Eliot's "Meteorological Atlas of India" at the end, of the decade. Dr. Hann's "Lehrbuch" and the new edition of his "Climatology," Messrs. Hildebrandsson and Teisserenc de Bort's great work, and the recent studies of the Upper Atmosphere, are among the landmarks of progress. The record is marred only by the closing of Ben Nevis Observatory at the moment when its work would have been most necessary. To appreciate the progress of climatology it is only necessary to compare the present number and distribution of meteorological stations with those given in Bartholomew's Atlas of 1899. I have not time to recapitulate the innumerable studies of geographical value issued by many meteorological services, observatories, and observers —public and private—but I may direct attention to the improved weather maps and to the excellent pilot charts of the North Atlantic and of the Indian Ocean published monthly by our Meteorological Office.

Lake studies have also been a feature of this decade, and none are so complete or so valuable as the Scottish Lakes Survey—a work of national importance, undertaken by private enthusiasm and generosity. We have to congratulate Sir John Murray and Mr. Pullar on the completion of a great work.

In Geology, I might note that we now possess a map of Europe on a scale of 1 : 1,500,000 prepared by international cooperation, and also one of North America on a smaller scale; both invaluable to the geographer. The thanks and congratulations of all geographers are due to Prof. Suess on the conclusion of his classical work on the Face of the Earth, the first comprehensive study of the main divisions and characteristics of its skeleton. English readers are indebted to Prof. and Miss Sollas for the brilliant English translation which they have prepared.

A new movement, inspired mainly by Prof. Flahault in France, Prof. Geddes in this country, Profs. Engler, Drude, and Schimper in Germany, has arisen among botanists, and at last we have some modern botanical geography which is really valuable to the geographer. I wish we could report similar progress in zoological geography, but that, I trust, will come in the next decade.

I pass over the various expensive arbitrations and commissions to settle boundary disputes which have in many cases been due to geographical ignorance, also the important and fascinating problems of the growth of our knowledge of the distribution of economic products and powers, existing and potential, and the new geographical problems for statesmen due to the political, economic revolutions in Japan and China.

It is quite impossible to deal with the exploration of the decade. Even in the past two years we have had Peary and Shackleton, Stein and Hedin, the Duke of the Abruzzi, and a host of others returning to tell us of unknown or little known parts of the globe. We hope to hear soon from Dr. Charcot the results of the latest investigations in the Antarctic.

Further work is being undertaken by Scott and his companions, by Bruce, Amundsen, Filchner, and others in the South or North Polar ice worlds; by Longstaff, Bruce, and others in the mountains of India and Central Asia; by Goodfellow and Ryder in New Guinea; and by many other expeditions.

One word of caution may perhaps be permitted. There is a tendency on the part of the public to confuse geographical exploration and sport. The newspaper reporter naturally lays stress on the unusual in any expedition, the accidental rather than the essential, and those of us who have to examine the work of expeditions know how some have been unduly boomed because of some adventurous element, while others have not received adequate popular recognition because all went well. The fact that all went well is in itself a proof of competent organisation. There is no excuse for us in this section if we fall into the journalist's mistake, and we shall certainly be acting against the interests of both our science and our section if we do so.

The Position of Geography in the Association.

It was not my intention in this address to raise the question of what is Geography, but various circumstances make it desirable to say a few words upon it. We are all the victims of the geographical teaching of our youth, and it is easy to understand how those who have retained unchanged the conceptions of geography they gained at school many years ago cavil at the recognition of geography as a branch of science. Moreover, the geography of the schools still colours the conceptions of some geographers who have nevertheless done much to make school geography scientific and educational. Many definitions of geography are consequently too much limited by the arbitrary but traditional division of school subjects. In schools, tradition and practical convenience have, on the whole rightly, determined the scope of the different subjects. Geography in schools is best defined as the study of the Earth as the home of Man. Its limits should not be too closely scrutinised in schools, where it should be used freely as a coordinating subject.

The present division into sections of the British Association is also largely a matter of practical convenience; but we are told that the present illogical arrangement of sections distresses some minds. No doubt there are some curious anomalies. The most glaring, perhaps, is that of combining mathematics with physics—as if mathematical methods were not used in any other subject.

There is undoubtedly a universal tendency to subdivision and an ever-increasing specialisation; but there is also an ever-growing interdependence of different parts of science. The British Association is unquestionably bound to take the latter into account as well as the former. At present this is chiefly done by joint meetings of sections: a wise course, of which this section has been one of the chief promoters. It is possible that some more systematic grouping of sections might be well advised, but such a reform should be systematic, and not piecemeal. It is one which raises the whole question of the classification of knowledge. This is so vast a problem, and one on which such divergent opinions are held, that I must apologise for venturing to put forward some tentative suggestions.

It might be found desirable to take as primary divisions the Mathematical, Physical, Biological, Anthropological, and Geographical groups. Mathematical applications might also be considered in each of the sections which use mathematical notations. In the Physical Group there should be the subdivisions Physics and Chemistry. Each would devote a certain proportion of time to its applied aspects, or these might be dealt with in sub-sections, which would include Engineering and Applied Chemistry. In the Biological Group there would be Botany, Zoology, in both cases including Palæontology and Embryology, and Applied Biology, which would be dealt with in one or other of the ways I have suggested, and would include Agriculture, Fisheries, &c. (Medicine we leave out at present.) In the Anthropological Group, in addition to the present Anthropology and Economics, there should be a section on Psychology, which might or might not be attached to Physiology, and have the Education Section as a practical appendage. In the Geographical Group there would be Geography and Geology, the practical applications of Geography and Geology being considered in joint meetings with other sections or else in sub-sections—for instance, Geography and Physics for questions of Atmospheric and Oceanic Circulation, Geography and Economics for questions of Transportation, &c.

The Need for Classification and Notation in Geomorphology, &c.

So much, then, for the classification of Geography with reference to the other sciences. I should like to say a few words about the subdivisions of geography and the vexed question of terminology.

In the scheme of the Universe it is possible to consider the Earth as a unit, with its own constitution and history. It has an individuality of its own, though for the astronomer it is only one example of a particular type of heavenly bodies. As geographers, we take it as our unit individual in the same way that an anatomist takes a man. We see that it is composed of different parts, and we try to discover what these are, of what they are composed, what their function is, what has been their history.

One fundamental division is into land, water, and air. Each has its forms and its movements. The forms are more obvious and persistent in the land. They are least so in the atmosphere, though forms exist—some of which are at times made visible by clouds, and many can be clearly discerned on isobaric charts. The land is the temporarily permanent; the water and atmosphere the persistently mobile, the latter more so than the former. The stable forms of the land help to control the distribution and movements of the waters, and to a less extent those of the atmosphere. How great the influence of the distribution of land and water is on the atmosphere may be seen in the monsoon region of eastern Asia.

The study of the land, the ocean, and the atmosphere has resulted in the growth of special branches of knowledge—Geomorphology, Oceanography, and Climatology. Each is indispensable to the geographer, each forms an essential part of the geographical whole. Much research work is and will be carried on in each by geographers who find their geographical studies hampered for the lack of it. As geographical progress is to a considerable extent conditioned by progress in these subjects, it would be legitimate to examine their needs. Time, however, will admit only a note on one of the barriers to progress in geomorphology—the lack of a good classification and notation.

Geomorphology deals with the forms of the land and their shaping. Three things have to be kept clearly in view: (1) The structure, including the composition, of the more permanent substance of the form; (2) the forces which are modifying it; and (3) the phase in the cycle of forms characteristic of such structure acted on by such forms. We may say that any form is a function of structure, process, and time. The matter is even more complicated, for we have instances, *e.g.* in antecedent drainage systems, of the conditions of a previous cycle affecting a subsequent one—a kind of heredity of forms which cannot be neglected.

The geomorphologist is seeking for a genetic classification of forms, and in the works of Betrand, Davis, de la Noë and de Margerie, Penck, Richthofen, Suess, and Supan and their pupils are being accumulated the materials for a more complete and systematic classification of forms. As you all know, the question of terms for the manifold land-forms is a difficult one, and apt to engender much more controversy than the analysis of the forms themselves. I believe that we shall find it advantageous to adopt some notation analogous to that of the chemists. I have not yet had time to work such a notation out in detail, but it might take the form of using different symbols for the three factors noted above—say, letters for different kinds of structure, Arabic figures for processes and Roman figures for the stage of a cycle the form has reached.

Take a very simple set of structures and indicate each by a letter:—

			Undisturbed	Faulted
Structure ...	homogeneous ...		A	A′
	layered	horizontal ...	B	B′
		tilted...	C	C′
		folded ...	D	D′
	mixed		E	E′

If pervious or impervious, a *p* or an *i* could be added—*e.g.* a tilted limestone with faults would be C′*p*.

Next, indicate the commoner erosion processes by Arabic numerals:—

Process ..	moving water	1
	ice	2
	wind	3
	sea	4

One process may have followed another, *e.g.* where a long period of ice erosion has been followed by water erosion we might write 2·1, where these alternate annually, say 21.

The phase of the cycle might be denoted by Roman figures. A scale of V might be adopted, and I, III, and V used for youthful, middle-aged, and old-aged, as this has been called, or early, middle, and late phases, as I prefer to term them. II and IV would denote intermediate phases.

A scarped limestone ridge in a relatively mature phase like the Cotswolds would be, if we put the process first, $1\,C^1$ III.; a highland like the Southern Uplands of Scotland would be denoted by the formula $1.\,2{\cdot}1\,E^1$ III.

This is the roughest suggestion, but it shows how we could label our cases of notes and pigeon-hole our types of forms—and prevent for the present undue quarrelling over terms.[1] No doubt there would be many discussions, for example, about the exact phase of the cycle, whether ice, in addition to water, has been an agent in shaping this or that form, and so on. But, after all, these discussions would be more profitable than quarrels as to which descriptive term, or place-name, or local usage should be adopted to distinguish it.

The use of such notations in geographical problems is not unknown. They were employed by Köppen in his classification of climate; and now, in the case of climatology, there is coming to be a general consensus of opinion as to what are the chief natural divisions, and the use of figures and letters to indicate them has been followed by several other authors. This should also be attempted for oceanography.

If any international agreement of symbols and colours could be come to for such things it would be a great gain, and I hope to bring this matter before the next International Geographical Congress.

[1] What I wish to make clear is that it is not necessary to invent a new term for every new variety of land form as soon as it is recognised. It will suffice at first to be able to label it. The notation will also stimulate the search for and recognition of new varieties.

The Need for Selecting Natural Geographical Units.

We have still to come to Geography proper, which considers land, water, and air, not merely separately but as associated together. What are the units smaller than the whole Earth with which our science has to deal?

When we fix our attention on parts of the Earth and ask what is a natural unit, we are hampered by preconceptions. We recognise species, or genera, families, or races as units—but they are abstract rather than concrete units. The reason for considering them as units is that they represent a historical continuity. They have not an actual physical continuity such as the component parts of an individual have. Concrete physical continuity in the present is what differentiates the geographical unit. Speaking for myself, I should say that every visible concrete natural unit on the Earth's surface consisting of more than one organic individual is a geographical unit. It is a common difficulty not to be able to see the wood for the trees; it is still more difficult to recognise that the wood consists of more than trees, that it is a complex of trees and other vegetation, fixed to a definite part of the solid earth and bathed in air. We may speak of a town or State as composed of people, but a complete conception of either must include the spacial connections which unite its parts. A town is not merely an association of individuals, nor is it simply a piece of land covered with streets and buildings; it is a combination of both.

It is true that in determining the greater geographical units, man need not be taken into account. We are too much influenced by the mobility of man, by his power to pass from one region to another, and we are apt to forget that his influence on his environment is negligible except when we are dealing with relatively small units. The geographer will not neglect man; he will merely be careful to prevent himself from being unduly influenced by the human factor in selecting his major units.

Some geographers and many geologists have suggested that land forms alone need be taken into account in determining these larger geographical units. Every different recognisable land form is undoubtedly a geographical unit. A vast lowland, such as that which lies to the east of the Rocky Mountains, is undoubtedly a geographical unit of great importance, but its geographical subdivisions are not necessarily orographical. The shores of the Gulf of Mexico could not be considered as geographically similar to those of the Arctic Ocean, even if they were morphologically homologous. The lowlands of the polar regions are very different from those at or near the tropics. The rhythm of their life is different, and this difference is revealed in the differences of vegetation.

I wish to lay great stress on the significance of vegetation to the geographer for the purposes of regional classification. I do not wish to employ a biological terminology nor to raise false analogies between the individual organism and the larger units of which it is a part, but I think we should do well to consider what may be called the life or movement going on in our units as well as their form. We must consider the seasonal changes of its atmospheric and of its water movements, as well as the parts of the Earth's crust which they move over and even slightly modify. For this purpose a study of climatic regions is as necessary as a study of morphological regions, and the best guides to the climatic regions are the vegetation ones.

By vegetation I mean not the flora, the historically related elements, but the vegetable coating, the space-related elements. Vegetation in this sense is a geographical phenomenon of fundamental importance. It indicates quality—quality of atmosphere and quality of soil. It is a visible synthesis of the climatic and edaphic elements. Hence the vast lowlands of relatively uniform land features are properly divided into regions according to vegetation—tundra, pine forest, deciduous forest, warm evergreen forest, steppe, and scrub. Such differences of vegetation are full of significance even in mountainous areas.

The search after geographical unity—after general features common to recognisable divisions of the Earth's surface, the analysis of these, their classification into types, the comparisons between different examples of the types—seem to me among the first duties of a geographer.

Two sets of studies and maps are essential—topographical and vegetational—the first dealing with the superficial topography and its surface irregularities, the latter relating to the quality of climate and soil.

Much has been said in recent years—more particularly from this Presidential chair—on the need for trustworthy topographical maps. Without such maps no others can be made. But when they are being made it would be very easy to have a general vegetational map compiled. Such maps are even more fundamental than geological maps, and they can be constructed more rapidly and cheaply. Every settled country, and more particularly every partially settled country, will find them invaluable if there is to be any intelligent and systematic utilisation of the products of the country. Possessing both sets of maps, the geographer can proceed with his task.

This task, I am assuming, is to study environments, to examine the forms and qualities of the Earth's surface, and to recognise, define, and classify the different kinds of natural units into which it can be divided. For these we have not as yet even names. It may seem absurd that there should be this want of terms in a subject which is associated in the minds of most people with a superfluity of names. I have elsewhere suggested the use of the terms major natural region, natural region, district, and locality to represent different grades of geographical units, and have also attempted to map the seventy or eighty major natural regions into which the Earth's surface is divided, and to classify them into about twenty types. These tentative divisions will necessarily become more accurate as research proceeds, and the minor natural regions into which each major natural region should be divided will be definitely recognised, described, and classified. Before this can be done, however, the study of geomorphology and of plant formations must be carried far beyond the present limits.

The value of systematic and exhaustive studies of environment such as those I suggest can hardly be exaggerated. Without them all attempts to estimate the significance of the environment must be superficial guess-work. No doubt it is possible to exaggerate the importance of the environmental factor, but it is equally possible to undervalue it. The truly scientific plan is to analyse and to evaluate it. Problems of the history of human development, as well as those of the future of human settlements, cannot be solved without this. For the biologist, the historian, the economist, the statesman, this work should be carried out as soon and as thoroughly as is possible in the present state of our knowledge.

A beginning of systematic geographical studies has also been made at the opposite end of the scale in local geographical monographs. Dr. H. R. Mill, one of the pioneers of geography in this country and one of my most distinguished predecessors in this chair, has given us in his study of south-west Sussex an admirable example of the geographical monograph proper, which takes into account the whole of the geographical factors involved. He has employed quantitative methods so far as these could be applied, and in doing so has made a great step in advance. Quantitative determinations are at least as essential in geographical research as the consideration of the time factor. At Oxford we are continuing Dr. Mill's work. We require our diploma students to select some district shown on a sheet of this map for detailed study by means of map measurements, an examination of statistics and literature which throw light on the geographical conditions, and, above all, by field work in the selected district. Every year we are accumulating more of these district monographs, which ought, in their turn, to be used for compiling regional monographs dealing with the larger natural areas. In recent years excellent examples of such regional monographs have come from France and from Germany.

The geomorphologist and the sociologist have also busied themselves with particular aspects of selected localities. Prof. W. M. Davis, of Harvard, has published geomorphological monographs which are invaluable as models of what such work should be. In a number of cases he has passed beyond mere morphology and has directed attention to the organic responses associated with each land form. Some of the monographs published under the supervision of the late Prof. Ratzel, of Leipzig, bring out very clearly the relation between organic and inorganic distributions, and some of the monographs of the Le Play school incidentally do the same.

. . . . .

The Double Character of Geographical Research.

To carry on geographical research, whether on the larger or the smaller units, there is at present a double need—in the first place, of collecting new information, and, in the second place, of working up the material which is continually being accumulated.

The Need for the Systematic Collection of Data.

The first task—that of collecting new information—is no small one. In many cases it must be undertaken on a scale that can be financed only by Governments. The Ordnance and Geological Surveys of our own and other countries are examples of Government departments carrying on this work. We need more of them. The presidents of the Botanical and Anthropological Sections are, I understand, directing the attention of the Association to the urgent necessity for complete Botanical and Anthropological Surveys of the kingdom. All geographers will warmly support their appeal, for the material which would be collected through such surveys is essential to our geographical investigations.

Another urgent need is a Hydrographical Department, which would cooperate with Dr. Mill's rainfall organisation. It would be one of the tasks of this department to extend and coordinate the observations on river and lake discharge, which are so important from an economic or health point of view that various public bodies have had to make such investigations for the drainage areas which they control. Such research work as that done by Dr. Strahan for the Exe and Medway would be of the greatest value to such a department, which ought to prepare a whether by government departments or by private We shall see how serious the absence of such a department is if we consider how our water supply is limited, and how much of it is not used to the best advantage. We must know its average quantity and the extreme variations of supply. We must also know what water is already assigned to the uses of persons and corporations, and what water is still available. We shall have to differentiate between water for the personal use of man and animals, and water for industrial purposes. The actualities and the potentialities can be ascertained, and should be recorded and mapped.

The Need for the Application of Geographical Methods to already Collected Data.

In the second direction of research—that of treating from the geographical standpoint the data accumulated, whether by Government departments or by private initiative—work has as yet hardly been begun.

The topographical work of the Ordnance Survey is the basis of all geographical work in our country. The Survey has issued many excellent maps, none more so than the recently published half-inch contoured and hill-shaded maps with colours "in layers." Its maps are not all above criticism; for instance, few can be obtained for the whole kingdom having precisely the same symbols. It has not undertaken some of the work that should have been done by a national cartographic service—for instance, the lake survey. Nor has it yet done what the Geological Survey has done—published descriptive accounts of the facts represented on each sheet of the map. From every point of view these are great defects; but in making these criticisms we must not forget (1) that the Treasury is not always willing to find the necessary money, and (2) that the Ordnance Survey was primarily made for military purposes, and that the latest map it has issued has been prepared for military reasons. It has been carried out by men who were soldiers first and topographers after, and did not necessarily possess geographical interests.

The ideal geographical map, with its accompanying geographical memoir, can be produced only by those who have had a geographical training. Dr. Mill, in the monograph already referred to, has shown us how to prepare systematised descriptions of the one-inch map sheets issued by the Ordnance Survey.

The preparation of such monographs would seem to fall within the province of the Ordnance Survey. If this is impossible, the American plan might be adopted. There the Geological Survey, which is also a topographical one, is glad to obtain the services of professors and lecturers who are willing to undertake work in the field during vacations. It should not be difficult to arrange similar cooperation between the universities and the Ordnance Survey in this country. At present the Schools of Geography at Oxford and at the London School of Economics are the only university departments which have paid attention to the preparation of such monographs, but other universities will probably fall into line. Both the universities and the Ordnance Survey would gain by such cooperation. The chief obstacle is the expense of publication. This might reasonably be made a charge on the Ordnance Survey, on condition that each monograph published were approved by a small committee on which both the universities and the Ordnance Survey were represented.

The Geological Survey has in recent years issued better and cheaper one-inch maps, and more attention has been given to morphological conditions in the accompanying monographs; but it is necessary to protest against the very high prices which are now being asked for the older hand-coloured maps. The new quarter-inch map is a great improvement on the old one, but we want "drift" as well as "solid" editions of all the sheets. The geographer wants even more than these a map showing the quality of the solid rock, and not merely its age. He has long been asking for a map which would indicate the distribution of clay, limestone, sandstone, &c., and when it is prepared on the quarter-inch, or better on the half-inch, scale the study of geomorphology and of geography will receive a very great stimulus and assistance.

The information which many other Government departments are accumulating would also become much more valuable if it were discussed geographically. Much excellent geographical work is done by the Admiralty and the War Office. The Meteorological Office collects statistics of the weather conditions from a limited number of stations; but its work is supplemented by private societies which are not well enough off to discuss the observations they publish with the detail which these observations deserve. The Board of Agriculture and Fisheries has detailed statistical information as to crops and live stock for the geographer to work up. From the Board of Trade he would obtain industrial and commercial data, and from the Local Government Board vital and other demographic statistics. At present most of the information of these departments is only published in statistical tables.

Statistics are all very well, but they are usually published in a tabular form, which is the least intelligible of all. Statistics should be mapped, and not merely be set out in columns of figures. Many dull Blue-books would be more interesting and more widely used if their facts were properly mapped. I say *properly* mapped, because most examples of so-called statistical maps are merely crude diagrams, and are often actually misleading. It requires a knowledge of geography in addition to an understanding of statistical methods to prepare intelligible statistical maps. If Mr. Bosse's maps of the population of England and Wales in Bartholomew's Survey Atlas are compared with the ordinary ones, the difference between a geographical map and a cartographic diagram will be easily appreciated.

The coming census, and to a certain extent the census of production, and probably the new land valuation, will give more valuable raw material for geographical treatment. If these are published merely in tabular form they will not be studied by any but a few experts. Give a geographer with a proper staff the task of mapping them in a truly geographical way, and they will be eagerly examined even by the man in the street, who cannot fail to learn from them. The representation of the true state of the country in a clear, graphic, and intelligible form is a patriotic piece of work which the Government should undertake. It would add relatively little to the cost of the census, and it would infinitely increase its value.

The Need of Reorganising the Geographical Factor in Imperial Problems.

With such quantitative information geographically treated and with a fuller analysis of the major natural regions it ought to be possible to go a step further and to attempt to map the economic value of different regions at the present day. Such maps would necessarily be only approximations at first. Out of them might grow other maps prophetic of economic possibilities. Prophecy in the scientific sense is an important outcome of geographical as well as of other scientific research. The test of geographical laws, as of others, is the pragmatic one. Prophecy is commonly but unduly derided. Mendeléeff's periodic law involved prophecies which have been splendidly verified. We no longer sneer at the weather prophet. Efficient action is based on knowledge of cause and consequence, and proves that a true forecast of the various factors has been made. Is it too much to look forward to the time when the geographical prospector, the geographer who can estimate potential geographical values, will be as common as and more trustworthy than the mining prospector?

The day will undoubtedly come when every Government will have its Geographical-Statistical Department dealing with its own and other countries—an Information Bureau for the administration corresponding to the Department of Special Inquiries at the Board of Education. At present there is no geographical staff to deal geographically with economic matters or with administrative matters. Yet the recognition of and proper estimation of the geographical factor is going to be more and more important as the uttermost ends of the Earth are bound together by visible steel lines and steel vessels or invisible impulses which require no artificial path or vessel as their vehicle.

The development of geographical research along these lines in our own country could give us an Intelligence Department of the kind, which is much needed. If this were also done by other States within the Empire, an Imperial Intelligence Department would gradually develop. Thinking in continents, to borrow an apt phrase of Mr. Mackinder's, might then become part of the necessary equipment of a statesman instead of merely an after-dinner aspiration. The country which first gives this training to its statesmen will have an immeasurable advantage in the struggle for existence.

The Need for the adequate Endowment of Geography at the Universities.

Our universities will naturally be the places where the men fit to constitute such an Intelligence Department will be trained. It is encouraging, therefore, to see that they are taking up a new attitude towards geography, and that the Civil Service Commissioners, by making it a subject for the highest Civil Service examinations, are doing much to strengthen the hands of the universities. When the British Association last met in Sheffield geography was the most despised of school subjects, and it was quite unknown in the universities. It owed its first recognition as a subject of university status to the stimulus and generous financial support of the Royal Geographical Society and the brilliant teaching of Mr. Mackinder at Oxford. Ten years ago Schools of Geography were struggling into existence at Oxford and Cambridge, under the auspices of the Royal Geographical Society. A single decade has seen the example of Oxford and Cambridge followed by nearly every university in Great Britain, the University of Sheffield among them. In Dr. Rudmose Brown it has secured a scientifically trained traveller and explorer of exceptionally wide experience, who will doubtless build up a Department of Geography worthy of this great industrial capital. The difficulty, however, in all universities is to find the funds necessary for the endowment, equipment, and working expenses of a Geographical Department of the first rank. Such a department requires expensive instruments and apparatus, and, since the geographer has to take the whole World as his subject, it must spend largely on collecting, storing, and utilising raw material of the kind I have spoken of. Moreover, a professor of geography should have seen much of the World before he is appointed, and it ought to be an important part of his professional duties to travel frequently and far. I have never been able to settle to my own satisfaction the maximum income which a department of geography might usefully spend, but I have had considerable experience of working a department the income of which was not very far above the minimum. Until now the Oxford School of Geography has been obliged to content itself with three rooms and to make these suffice, not merely for lecture-rooms and laboratories, but also for housing its large and valuable collection of maps and other materials. This collection is far beyond anything which any other university in this country possesses, but it shrinks into insignificance beside that of a rich and adequately supported Geographical Department like that of the University of Berlin. This fortunate department has an income of about 6000*l.* a year, and an institute built specially for its requirements at a cost of more than 150,000*l.*, excluding the site. In Oxford we are most grateful to the generosity of Mr. Bailey, of Johannesburg, which will enable the School of Geography to add to its accommodation by renting for five years a private house, in which there will temporarily be room for our students and for our collections, especially those relating to the geography of the Empire. But even then we can never hope to do what we might if we had a building specially designed for geographical teaching and research. Again, Lord Brassey and Mr. Douglas Freshfield, a former President of this Section, have each generously offered 500*l.* towards the endowment of a professorship if other support is forthcoming. All this is matter for congratulation, but I need hardly point out that a professor with only a precarious working income for his department is a person in a far from enviable position. There is at present no permanent working income guaranteed to any Geographical Department in the country, and so long as this is the case the work of all these departments will be hampered and the training of a succession of competent men retarded. I do not think that I can conclude this brief address better than by appealing to those princes of industry who have made this great city of Sheffield what it is to provide for the Geographical Department of the University on a scale which shall make it at once a model and a stimulus to every other university in the country and to all benefactors of universities.

IONISATION OF GASES AND CHEMICAL CHANGE.[1]

THE term "catalytic" was introduced by Berzelius to describe a number of chemical actions which would only take place in the presence of a third substance, which itself was apparently unchanged throughout the reaction. The first cases of such actions were investigated by Sir Humphry Davy in 1817. He showed that many mixtures of gases were caused to unite in the presence of finely divided platinum at temperatures far below those at which union ordinarily took place. Some years afterwards Faraday investigated similar actions, and attempted to explain them by a supposed condensation of the gases on the surface of the metal.

Thirty years ago Prof. H. B. Dixon investigated the behaviour of carbon monoxide and oxygen when they were dried as completely as possible, and he discovered that in these circumstances electric sparks caused no explosion. Some years before Wanklyn had discovered that purified chlorine did not act on sodium, but he did not identify the impurity, now known to be a trace of water, which causes the vigorous action which takes place in ordinary circumstances.

In 1882 Cowper investigated the action of dried chlorine on several metals, and found that the removal of moisture in many cases inhibited the reaction.

In the following year, working in Prof. Dixon's laboratory at Balliol College, I found that purified carbon could be heated to redness in dried oxygen, and that sulphur and phosphorus could be distilled in the same gas without burning. In the investigations which followed, some thirty simple reactions have been tried by myself and others. It has been shown that hydrogen and chlorine can be exposed to light without explosion, ammonia and hydrogen chloride mixed without union, sulphur trioxide can be crystallised on lime, ammonium chloride and mercurous chloride give undissociated vapours, hydrogen and oxygen can be exposed to a red heat without explosion, and lastly, in 1907, nitrogen trioxide was obtained as an undissociated gas for the first time by carefully drying the liquid and evaporating into a dried atmosphere.

The amount of water necessary to carry on these chemical reactions is extremely small, certainly less than 1 mg. in 300,000 litres. There is no accepted explanation of its catalytic effect, and in the same way the catalytic power of platinum is still a mystery. Dr. Armstrong's theory, that only water which is capable of conducting an electric current is capable of bringing about these chemical actions, seems to be supported by the fact that water can be formed in heated tubes containing very pure hydrogen and oxygen without the explosive combination of the gases taking place. That great purity does affect the chemical activity of water was proved by an experiment shown during the lecture. Two tubes, one containing water of a very high degree of purity and the other containing ordinary distilled water, were placed side by side in the lantern. Into each was filtered some liquid sodium amalgam, and while vigorous effervescence was seen in the less pure water, the very pure specimen was apparently without action for some minutes, and even at the end of the lecture its action had not attained the same vigour as that in the other tube.

In 1893 Sir J. J. Thomson (*Phil. Mag.*, xxxvi., 321) showed that if the combination of atoms in a molecule is electrical in its nature, the presence of liquid drops of water, or drops of any liquid of high specific inductive capacity, would be sufficient to cause a loosening of the tie between the atoms, and this might result in chemical combination of the partially freed atoms to form new molecules. He showed in the same paper that drying a gas very completely stopped the passage of a current of 1200 volts. In the same year I was able in the same way to prevent the passage of discharge from an induction coil, a discharge which would traverse a spark gap of three times the distance in undried gas.

Shortly after the discovery of Röntgen rays, it was found that they would ionise a gas through which they passed. At the time it was thought that this ionisation was similar to that taking place in electrolysis. If this were so the rays would probably cause chemical union to take place even in a dried gas, and accordingly Prof. Dixon and I undertook some experiments on the subject, which were published in a joint paper (Chem. Soc. Jour., 1896). The results were negative; no chemical action could be detected. Since that time the ionisation of gases has been shown to be of quite a different nature. The negative ion has been shown to be a particle of the mass of about 1/1500th that of the hydrogen atom, and the positive ion is the residue. Since the ionisation of gases is different from that in electrolysis, the retention of this term is much to be deprecated. It is suggested that the term ionisation should be retained for electrolytic dissociation, and for the different process which takes place in gases under the action of Röntgen rays, &c., a new name, electromerism, should be adopted. The electron would thus be the negative electromer.

It is probable that electrolysis and true ionisation may take place in gases, as in the decomposition of steam by electric sparks of a particular length. An experiment recently devised seems to show that in mercury vapour, which ordinarily consists of atoms, something of the nature of ionisation without electrolysis can take place. If oxygen be admitted to the interior of a mercury lamp from which the current has just been cut off, a considerable quantity of mercuric oxide is produced, although the temperature of the lamp (about 150°) is far lower than would suffice to bring about the union of ordinary mercury vapour with oxygen.

In order to test further the question as to whether electromerism can bring about chemical change, I have investigated the action of radium bromide on very pure and dry hydrogen and oxygen. The gases were sealed up with some radium bromide contained in an open silica tube. The containing vessel was provided with a vacuum gauge, by means of which the combination of 1/5000th

[1] Discourse delivered at the Royal Institution on Friday, March 11, by Dr. H. Brereton Baker, F.R.S.

part of the gases could be easily detected. No action whatever was observed, although the substances were left in contact for two months. A further experiment showed that, as was to be expected, very dry air undergoes electromerism when subjected to the action of radium. Two more tubes were then set up, similar to the first, containing mixtures of carbon monoxide and oxygen, one very dry and the other containing traces of moisture, and although the radium bromide was in contact with them for more than three months, not the slightest contraction could be observed. In these cases, therefore, electromerism produces no chemical change.

There was, however, a possibility that electromerism might bring about a chemical action in a mixture of gases which was under conditions which were nearly, but not quite, suitable for chemical action to take place. The gaseous mixtures mentioned only combine, even when moist, at a red heat. Since the experiments were done at 20°, they only show that electromerism does not produce chemical action in gases which are otherwise unable to combine.

There remained the possibility that if gases were just on the point of combining, increasing the electromerism might accelerate the rate of action. I sought for a case of simple chemical union which would proceed at a manageable temperature, and at a rate which could be measured. Of those tried, the reaction between hydrogen and nitrous oxide was found to be the most suitable. The gases used were as pure as possible, but dried only by passing through phosphorus pentoxide tubes. They were found to combine with great uniformity when heated in clean Jena glass tubes to 530°. An electric resistance furnace was used, consisting of a wide silica tube which formed the heated chamber. It is known that many substances when heated produce electromers in a gas; lime is fairly efficient, thoria more so, and, of course, radium bromide most of all. In the first experiment two tubes of the same Jena glass, containing the hydrogen and nitrous oxide mixture, were heated side by side. One contained some lime, and in order to make the conditions as similar as possible an equal quantity of powdered Jena glass was introduced into the other. As soon as the requisite temperature was reached, the action proceeded rapidly in the tube containing lime, the rate in the first five minutes being five times the rate of combination in the tube containing only powdered glass. After fifteen minutes the second tube had caught up the first, and the rates of union were equal up to the completion of the action. With thoria the effect was still more marked, the rate increasing to twenty times the rate in the tube containing the glass. Finally, about 2 mg. of radium bromide was heated in the mixture of gases. As soon as the combining temperature was reached, the gases in the radium bromide tube exploded.

From these three experiments it is seen that, as the amount of electromerism was increased, there was a rapid increase in chemical action.

I have recently been able to show that if the union of carbon monoxide and oxygen takes place in a strong electric field, which has the effect of removing electromers, the chemical action is diminished. Similar experiments are in progress with the mixture of hydrogen and chlorine, combining under the influence of light.

The next experiment tried illustrates one way in which the electromerism of a gas may bring about chemical change. Hydrogen sulphide and sulphur dioxide can be mixed at the ordinary temperature in presence of traces of moisture, but in presence of liquid water decomposition takes place into sulphur and water. The gases were dried before mixing by calcium chloride, which leaves about 4 mg. of water vapour per litre in the gas. After mixing, a small open silica tube containing about 2 mg. of dried radium bromide was introduced. After six hours no apparent change had taken place in the gas; there was no deposit of sulphur on the sides of the jar, and it seemed at first as if no action had been produced. On opening the jar, however, an inrush of air was noticed, and the contents were almost odourless. On heating the radium tube a large quantity of water was driven off, and a copious sublimate of sulphur was seen. The whole of the gaseous contents of the jar had condensed in the small tube containing the radium bromide. The explanation of this action of radium bromide is probably simple. Water vapour condenses on the electromers emitted, liquid drops are formed, and in them the chemical action takes place.[1]

Prof. Townsend has recently published an account of some experiments in which he has shown that there is a very marked decrease in the mobility of negative electromers in the presence of an amount of water vapour represented by a pressure of 1/10th mm. The air, in his experiments, was subjected to the action of Röntgen rays.

It is concluded that water in a form approaching to that of a drop is condensed on the electron even when a very small quantity is present. If this deposition of water molecules on electromers goes on when the amount of water present is still smaller, the theory of Sir J. J. Thomson affords a satisfactory explanation of the influence of moisture on chemical change, since some electromers are always present in ordinary gases.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE *Lancet* states that the University of Bristol is to receive the sum of 1000*l.* from the estate of the late Miss J. L. Woodward for the foundation of a scholarship in music or botany, to be known as the "Vincent Stuckey Lean Scholarship."

IT is proposed that the Congress of the Universities of the Empire shall be held in London in June, 1912, and a meeting of the Vice-Chancellors of the British universities is to take place in November next with the object of drawing up a provisional scheme of subjects to be discussed at the congress, which scheme will then be submitted to the overseas universities for suggestions.

AN Institute of Colonial Medicine has been established in connection with the faculty of medicine of the University of Paris. The first session will begin on October 13 and end at the close of the year. The following courses of instruction are announced:—Technical bacteriology and hæmatology, by Prof. Roger; parasitology, by Prof. Blanchard; surgery in tropical countries, by Dr. Morestin; ophthalmic affections, by Dr. Lapersonne; general epidemiology, by Prof. Chantemesse; tropical pathology and tropical hygiene, by Dr. Wurtz; and dermatology, by Prof. Gaucher in collaboration with Dr. Jeanselme.

ATTENTION has been directed here from time to time to the movement in this country to establish universities in China. We learn from the *Times* of September 13 that the success of the proposed Hong Kong University seems assured. Sir Frederick Lugard, the Governor of Hong Kong, has taken a prominent part in demonstrating the advantages likely to accrue from the undertaking, and he has been generously assisted by large contributions from the leading Chinese and others in the colony. Sir Hormusji Mody has offered to erect the buildings, whatever their cost (estimated at about 30,000*l.*), in accordance with the approved plans. Dr. Ho Kai, C.M.G., has given 18,000*l.*; Mr. J. H. Scott, senior partner of Messrs. Butterfield and Swire, has announced a gift of 40,000*l.* on behalf of his own and allied firms; and the Central Government at Peking has sent a substantial contribution. The bare minimum sum required has now been practically raised, and Sir Frederick Lugard and his helpers are appealing to the British public for the amount required to make the University worthy of British prestige. It may be pointed out that though there is no antagonism between them, there is no connection between this scheme and that associated with Oxford and Cambridge for the establishment of a university at Hankau, on the Yangtsze.

THE annual meeting of the Institution of Mining Engineers was held at the University College, Nottingham, last week. In welcoming the members, Sir Joseph Bright, chairman of the council of the college, said they hoped in the near future to establish a chair of mining

[1] I have invariably noticed that water collects in tubes containing radium preparations exposed to undried air. The salts are not at all deliquescent, the crystals appearing quite sharp-edged under the microscope. I found that 10 mg. of radium bromide exposed to an atmosphere saturated at 0° for two days caused a deposition of water on its surface weighing 1·5 mg.

engineering at the college. A paper was read at the meeting by Prof. H. Louis on the Mining School at Bochum, Westphalia, in the course of which he said that in Germany there are schools devoted to the better education of miners and the elementary training of colliery officials. The course lasts two years, and the men attend for eight hours weekly for a year and a half, and for ten hours weekly during the last six months. It cannot, he said, be imagined that the Germans would have continued those institutions for nearly a century had they not found that it paid them to do so. Surely it is high time to abandon our insular policy of not profiting by the experience of our neighbours in matters of such vital importance. In Prof. Louis's opinion it would be easy enough for the various British coalfields to form miners' funds like that raised in Westphalia for the same purpose. Future legislation should, he suggested, enact that in any coalfield where a large majority—say two-thirds—of the producers decide to take advantage of its provisions power shall be given to constitute a fund, and a levy upon the entire output of the field should thus be legalised, the fund to be administered and applied very much as the Westphalian miners' fund has been.

AN examination of the calendars, prospectuses, and announcements of the London polytechnic institutions for the session which is now commencing serves to show how well the metropolitan area is provided with facilities for technical and scientific instruction. The encouragement which is extended by the authorities to the plan of giving a distinguishing character to the curricula of certain of these colleges is well brought out by an inspection of the announcements in connection with the winter's work at the Northampton Institute. We can only give a few examples. The classes in submarine cable work are being continued, and more advanced classes are projected in radio-telegraphy. The success of the pioneer courses in aëronautics given last winter has been so marked that the subject is being developed. The instruction in electroplating is being brought more into line with the actual requirements of the trade, and arrangements have been made to extend the advanced work in sight-testing and physiological optics. The South-Western Polytechnic at Chelsea continues to provide courses of study suited for a great variety of technological purposes, and also for university students. We notice from the calendar of the day work at this college that students are informed that those who enter for technical instruction should have received previously a sound English education, and should have acquired an elementary knowledge of mathematics and, if possible, of physics and chemistry. The courses are arranged to occupy three years. On entering the student states whether he wishes to be trained as a mechanical or electrical engineer, or as a consulting or industrial chemist. In any of these cases he has mapped out a complete course of study. Students who have completed a three years' course should be in a position to obtain situations in important industrial firms. Birkbeck College, too, continues its excellent work. The new calendar has again to point out that the usefulness of the college is curtailed by its limited accommodation, and its pressing need is for increased space. More spacious college buildings, with additional class-rooms and larger laboratories better adapted to modern requirements, would give a great stimulus to the work of the college and add to its public utility. We notice that 1293 students attended its classes last winter, and that about a quarter of them were women.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 12.—M. Bouchard in the chair.—J. **Guillaume** and J. **Merlin**: Occultation of η Geminorum by Venus, July 26, 1910, observed at Lyons. As the planet was only 9° above the horizon, the images observed were unsteady. The data are given in full, and calculations made of the diameter of Venus.—Carl **Störmer**: Theorems on the general equations of motion of a corpuscle in a magnetic and electric field superposed.—Paul **Floquet**: A comparison of the different methods of measuring the dielectric constant. Paraffin extracted from ozokerite has been shown by M. Malclès to possess no residual charge and to be without any appreciable conductivity. This paraffin has been utilised for comparing at the same instant the values of the dielectric constant obtained by two different static methods. The results agreed within 1 per cent., and a similar concordance was obtained for measurements based on the relative velocities in air and in paraffin of Hertzian waves.—Philippe **de Vilmorin**: Researches on Mendelian heredity.—J. **Athanasin** and J. **Dragoin**: The association of elastic and contractile elements in muscle.—E. **Roubaud**: The evolution of instinct in Vespides. Remarks on the social wasps of Africa, genus Belonogaster.—Joseph **Roussel**: The existence of three horizons of calcium phosphate in Algeria and Tunis.

GÖTTINGEN.

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

February 26.—R. **König**: Conformal representation of the surface of a solid angle.—B. **Dürken**: The behaviour of the nervous system after extirpation of the limb-rudiments in the frog.—O. **Berg**: The Thomson effect in copper, iron, and platinum.

March 12.—Kurt **Wegener**: Aërological results obtained at the Samoa Observatory in 1909.

April 30.—R. **Fuchs**: Linear homogeneous differential equations of the second order with four essentially singular points.

CONTENTS.