THURSDAY, SEPTEMBER 26, 1912.

SCIENTIFIC PEDAGOGY.

(1) *Rationalist English Educators.* By Dr. G. E. Hodgson. Pp. 254. (London: S.P.C.K.; New York: E. S. Gorham, 1912.) Price 3*s.* 6*d.*

(2) *The Montessori Method: Scientific Pedagogy as Applied to Child Education in "The Children's Houses."* With additions and revisions by the author. By Maria Montessori. Translated from the Italian by Anne E. George. Pp. xliii + 377. (London: W. Heinemann, 1912.) Price 7*s.* 6*d.* net.

(3) *The Evolution of Educational Theory.* By Prof. John Adams. Pp. ix + 410. (London: Macmillan and Co., Ltd., 1912.) Price 10*s.* net. (The Schools of Philosophy.)

(1) PROBABLY Miss Hodgson is by temperament incapable of entering sympathetically into the point of view of those of whom she writes in this volume—Locke, the Edgeworths, and John Stuart Mill. In any case she should show a more adequate acquaintance with the Edgeworths when she writes about them. In the first line of her essay she misquotes the title of the only book of theirs she refers to, and continues so to misquote it throughout her text. A competent reader will soon discover that she has missed the message of the book in her superficial *résumé* of its contents. It is therefore scarcely necessary to examine her criticisms. The treatment of Locke is the most satisfactory performance of the three.

(2) Mdme. Montessori's work for young children in the slum districts of Rome had received widespread recognition before the translation of her chief pedagogical writing appeared. The ground had in other ways been well prepared, and now we are threatened with a regular invasion of Montessori machinery. This is not said to belittle what has been accomplished in the "Children's Houses" in Rome. The idea of a central nursery for children from three to seven in the great tenement blocks was admirable in itself, and it was made still more so by associating the parents with its management and by appointing *directrices* who should live on the spot amongst those whom they were trying to serve. As a great social experiment, there is much to learn from Mdme. Montessori's success, whether it is the little school societies themselves which we regard, or the whole social setting of the establishments which she set up.

From the point of view of scientific pedagogy, the book and the experiment are interesting because of the sources of Mdme. Montessori's inspiration. Primarily a medical woman, the author made a special study of psychiatry, and took up the education of mentally deficient children. This brought her into touch with the pioneer works of Séguin and Itard, and led her to take courses in experimental psychology. For two years she was the working director of the State orthophrenic school. Her experience and her reading had led to the collection of a great quantity of didactic *matériel,* but, as she found at Bicêtre and elsewhere, admirable *matériel* is of little use, even when used in ways that are technically accurate, unless the spirit of its inventor is present.

The idea of these "tenement nurseries" and of applying the apparatus designed for the mechanical exercise of defective neural apparatus to the education and training of young but normal children occurred to her. The volume before us is a simple and fascinating account of what has been accomplished on these lines. Obviously much more than the transference of the apparatus was involved. It had to be adapted to children in whom the power of self-direction and self-education was present. But the principle of "training the senses," &c., was preserved. It is an interesting reversal of the ordinary tendency which is to apply modified infant school methods to the defective schools, and another instance of the way in which the scientific study of the abnormal may react upon the treatment of the normal. Whether or not Dr. Montessori's methods will lead to a reversion to formal training—none the less soulless because it is derived from modern psychology—is perhaps debateable. That there is some danger of this nobody who knows the schools will be likely to deny.

(3) It is quite impossible to do justice to Prof. Adams's latest contribution to the literature of education within the limits laid down. It is the first volume of a series which is to appear under the general editorship of Sir Henry Jones—"The Schools of Philosophy." The task assigned to Prof. Adams was a supremely difficult one, and we know nobody who could have attempted it with greater chances of success. He had no predecessors in the field upon whose work he might have improved, as he necessarily abandoned the usual methods of presentation employed by historians of educational thought. Instead of a strictly chronological treatment he has given us a broad view of the development of educational concepts—of their interaction, of the recognition of their mutual implications, and of their relation to social and scientific advance. Thus many of the dangers implicit in the study of the history of education are avoided—there is no mistaking the external shell of teaching devices for the spirit and substance of the thought behind them.

It need scarcely be said that Prof. Adams's

method occasionally upsets the conventional sense of proportion. Some of the things that we had supposed really mattered are treated with indifference; a new sense of values is introduced. Whether these will bear closer examination remains to be seen, but in any case we may warmly congratulate the author on the successful completion of an arduous undertaking.

J. A. G.

ATOMIC DYNAMICS.

Prinzipien der Atomdynamik. By Prof. J. Stark. I. Teil: "Die elektrischen Quanten." Pp. x+124. (Leipzig: S. Hirzel, 1910.) Price 3.20 marks. II. Teil: "Die elementare Strahlung." Pp. xv+286. (Leipzig: S. Hirzel, 1911.) Price 7.80 marks.

IN this work Prof. Stark gives a systematic account of the experimental facts which throw light on the constitution of the atom, and develops a theory of the structure of the atom, mainly on the basis of optical phenomena. The work is divided into three parts. Part i. is intended as an introduction, and deals with our knowledge of the nature and properties of electrons, and of the energy and structure of the electromagnetic field. Little space is devoted to the description of the methods by which the experimental results were obtained, and more prominence is given to the discussion of the validity of the experiments and their value in elucidating the internal structure of the atom.

In chapter iii. the constitution of the atom on Stark's theory is described. It is assumed that electrons and positively charged entities (archions) which are endowed with mass form the constituent parts of an atom. On account of magnetic forces, the archions form a definite configuration in the atom, and cannot be separated without causing its disruption. On the other hand, the electrons which are attached to the archions can be separated without causing the atom to decay. This atomic system, which is more fully developed in part ii., is capable of explaining and systematising many of the experimental facts.

The second part is mainly concerned with electromagnetic radiation. After a discussion of the theoretical principles of radiation, the grouping of spectrum lines into series and the relations existing between the frequencies of the lines are considered. A detailed discussion of line and band spectra and similar phenomena exhibited by Röntgen rays is also given. The archion theory is then worked out more fully, and hypotheses are put forward to account for the origin of spectra. The band spectra are ascribed to the vibrations of the electrons which are attached to the archions, while the archion itself, after losing the electron attached to it, is the elementary oscillator responsible for the line spectrum. The continuous spectrum is ascribed to the vibrations of the free electrons. These by frequent collisions suffer irregular accelerations, and thus give rise to a continuous succession of frequencies. A full and interesting account of the bearing of the author's theory on such problems as the Doppler effect in canal rays, the Zeeman effect, fluorescence, and allied phenomena is given. Also the results obtained with Röntgen and γ-rays are considered in relation to the theory.

The third part, which has not yet appeared, is, according to a statement in the preface, mainly intended for the chemist. It will deal with the structure of the electromagnetic field on the surface of chemical atoms, and with the forces which hold the atoms together in chemical combinations.

A work of this nature, which aims at a discussion of the principles of atomic dynamics, must to a large extent be of a speculative character. In this connection, however, it is important to remember that the work always distinguishes very clearly between experimental facts and speculative theory. Also, the reader who does not agree with the speculations put forward in the work will find in it a very useful record of all researches which contribute to the elucidation of the internal structure of the atom. Perhaps one misses a fuller discussion of radioactive phenomena, which are intimately connected with the problems discussed in this work. Stark's book, which deals with such a fascinating subject in an interesting manner, will prove very useful as a guide to further research.

H. G.

MODERN ROAD CONSTRUCTION.

Modern Road Construction: a Practical Treatise for the Use of Engineers, Students, Members of Local Authorities, &c. By Francis Wood. Pp. xi+137; illustrated. (London: Charles Griffin and Co., Ltd., 1912.) Price 4*s.* 6*d.* net.

THE conditions relating to the maintenance of roads during the last few years have undergone so much alteration, owing to the introduction of motor vehicles, that the publication of a practical treatise on the subject is fully justified.

The book now under notice cannot fail to be of great service to those having charge of urban roads. The author, who has the supervision of the roads in the Borough of Fulham, appears to have devoted a great deal of attention to observing and recording the wear and tear of different kinds of material used; and in obtaining statistics as to their cost and endurance. The book gives,

in a concise, and not too technical a form, the leading characteristics and details of modern road construction, and the results of the traffic to which these roads are subject. The relative merits of macadam, granite sets, asphalt, and wood paving are fully dealt with.

The author considers that macadam on a good foundation, for horse-drawn vehicles, is the best, and the condition of these roads is greatly improved, both as to cleanliness and endurance, when the surface is sprayed with tar; that creosoted soft wood, such as red pine or yellow deal, gives more satisfactory results for urban traffic as regards wear than the harder woods, such as oak or jarrah; that wood paving has the advantage of being silent and not slippery; and that for motor traffic asphalt paving is the best. The relative endurance, and the time the surface will last without replacing, is given as two years for macadam laid on a good foundation; for soft creosoted wood paving laid on concrete, fifteen years; and for rock asphalt on concrete, twenty years.

Statistics are given showing the great advantage that is derived from the use of tar for spraying macadam roads, both in the prevention of dust and by increasing the length of the life of such roads, which the author calculates at 33 per cent. It is also shown that the use of motor vehicles reduces considerably the amount of refuse that has to be removed from the surface of the roads.

The book contains eleven chapters dealing with a general introduction on modern road construction; macadam roads; wear of roads; effect of traffic; tarring macadam roads; methods of using tar and bitumen; rollers and rolling; paving; cost of maintenance of roads; with appendices giving a specification for road-making; wood paving; tarring; and copies of the Road Board specification for pitch.

HISTORICAL GEODESY.

Grandeur et Figure de la Terre. By J. B. J. Delambre. Ouvrage augmenté de notes, de cartes, et publié par les soins de G. Bigourdan. Pp. viii + 402. (Paris: Gauthier-Villars, 1912.) Price 15 francs.

"LES conquêtes passent, et ces opérations restent," was the compliment with which Napoleon accepted from Delambre a copy of his "Base du Système métrique décimal." The publication of this work of the great French geodesist offers a good reason why the second half of the above remark was as true as the first. The manuscript which Delambre left unpublished at his death gave an interesting historical account of the pioneer work of the eighteenth century in investigating the size and shape of the earth, and it also reveals the value of his own share in that work. Names well known outside the world of astronomy appear in the book: Colbert gave the first order for a measure of an arc along the meridian of Paris; Robespierre signed a document expelling Lavoisier, Laplace, Coulomb, and Delambre, with others, from the Commission des Poids et Mesures. Many other French names also occur in the book to remind the world how much geodesy owed in its earliest stages to the Académie des Sciences.

The direct effect on contemporary scientific work of such a tremendous upheaval as the French Revolution is well shown in Delambre's account of the delays caused by his repeated arrests at the hands of ignorant provincials. One is tempted to wonder whether, if the metric system had been established at a time when more friendly relations existed between France and England, this country would also have adopted it. M. de Talleyrand's invitation to the British Parliament to appoint a commission of Fellows of the Royal Society to cooperate with members of l'Académie des Sciences in fixing natural and invariable units of weight and length, is still of more than academic interest.

Enough has been said of the historical side of this book. It must now be added that Delambre's accounts of the surveys of arcs in the different parts of the world are marked by very close study of all available sources of information. Where possible, the original manuscripts were studied, and by very acute criticism the faults of much of the earlier work and some of the later work were elucidated. Several investigators, notably J. Cassini, come in for pretty severe treatment; Delambre's critical remarks may still be most useful to warn the young observer as to faults to be avoided. The accounts of the journeys of some of the surveying parties are very interesting, in particular the journal of the Abbé Outhier on the Lapland survey of 1736. Curiously interesting, too, it is to see new items of knowledge gradually entering in as factors in elucidating the problem under discussion. Thus the first emergence of spherical trigonometry and the modification of results owing to the discovery of nutation, come upon the present-day reader with a curious sense of shock.

A debt of gratitude is owing to M. Bigourdan for his work in editing the manuscript. We note only one misprint; Groombridge is spelt wrongly on p. 314. The successful way in which the editing has been done may be taken as a sign of the pleasure that M. Bigourdan has felt in carrying through the undertaking.

OUR BOOKSHELF.

Norse Tales. By Edward Thomas. Pp. 159. (Oxford: The Clarendon Press, 1912.) Price 2*s*.

THIS book is a successful attempt to popularise the romance and poetry of ancient Norse literature. Though he has not quite attained the dignity and charm of style which render Sir G. Dasent's "Story of Burnt Njal" and the "Popular Tales" from the collection of Asbjorsen classics in our folk-lore literature, this presentment by Mr. Thomas offers little ground for criticism.

The collection falls into two parts:—first, stories of the gods, a rearrangement of the Prose or Younger Edda, compiled by Snorri Sturleson in the thirteenth century; secondly, an adaptation of the excellent collection of early poetry made by Gudbrand Vigfuson and F. York Powell, under the title of "Corpus Poeticum Boreale." Mr. Thomas, perhaps wisely, does not discuss at length the many problems of the Eddas. All that is certain is that the poems were collected in Iceland, that some bear internal evidence of being older than others, and that they assumed their present shape long after the time of their composition. The land in which they were originally written is still uncertain. The editors of the "Corpus Poeticum Boreale" suggest that some may have their origin in these islands, or may have been re-edited here "at a time when the Irish Church, with her fervent faith, her weird and wild imaginings, and curious half-Eastern legends, was impressing the poetic mind on one side, while the rich and splendid court of Eadgar or Canute would stimulate it on the other."

The introduction by Mr. Thomas is excellent, so far as it goes. But as the book seems to be intended for school use, it might with advantage have been extended, and a bolder attempt might have been made to prepare the student for the assimilation of much that is unfamiliar. We must, however, be thankful for what he has given us: "The Making of the Worlds, of Gods, and of Giants"; the twisting of Loki in the cave which causes earthquakes; the tale of Balder and Loki, where a note might have been added to direct the reader to Prof. Frazer's explanation of the myth; Thor, Helgi, and Sigurd—a splendid feast of poetry and romance.

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.*]

Further Researches into Induced Cell Reproduction and Cancer.

THE reviewer of Mr. H. C. Ross's book, "Further Researches into Induced Cell Reproduction and Cancer," vol. ii. (NATURE, August 15, page 601), appears to me to have been very unfortunate in saying that "The accuracy of the observations now described depends upon the accuracy of those described before, and they in turn depend upon the accuracy of an equation in which degrees of temperature, minutes of time, and cubic centimetres of solutions are added together." The accuracy of Mr. Ross's observations does not depend in any way upon the equation referred to, which is simply a formula for making a certain jelly. The reviewer would imply that the equation itself is unscientific because degrees of temperature, minutes of time and cubic centimetres of solutions are added together, and that therefore the author does not possess even an elementary knowledge of the subject. The reviewer, however, is himself obviously ignorant of the fact that such an addition is quite scientific and allowable. It is not degrees of temperature and minutes of time which are added together, but the numbers of units of these entities concerned. He might as well criticise any chemical formula, such as H_2O, because such would imply that the hydrogen is multiplied by the oxygen. As a matter of fact, Mr. H. C. Ross's equation was given on my advice, because it is the most suitable way of representing the various factors concerned in the proper concoction of the jelly. The equation represents the differential coefficient of a function of many independent variables, which is the sum of the partial differential coefficients obtained from each variable.

The other remarks of the reviewer show the same want of accuracy. Mr. Ross has proved that human leucocytes can be forced to divide in large numbers by certain agencies, as described by me in NATURE of December 14, 1911, No. 2198, p. 231, and it seems to me absurd to maintain that the facts found by him "necessitate the abandonment of every generally accepted belief with regard to mitosis." If the mode of division of human blood leucocytes had been previously determined with certainty, your reviewer's remarks might have been justified; but this is not the case. If Mr. Ross's observations cannot be reconciled with previous hypotheses (which I do not admit), so much the worse for the hypotheses. At all events the leucocytes actually do divide exactly as he has described.

During the last two and a half years Mr. Ross has been subjected to many criticisms of this nature—which criticisms remind me very strongly of the story of Galileo and his critics regarding the satellites of Jupiter. So far as I remember, it is said that the critics denied the possibility of Jupiter having satellites, but at the same time refused to look at them through Galileo's telescope. I think that if some of Mr. Ross's critics would spend as much time over his specimens as I have done they would not be so free with their *a priori* objections. RONALD ROSS.

Johnston Tropical Laboratory, University of Liverpool, August 31.

A Flower-sanctuary.

I BEG to thank Mr. Perrycoste for his letter in NATURE of September 19. The county of Somerset has for some time had a by-law similar to that of the county of Cornwall; but you will observe that the by-law does not justify the protection of any particular plant, and that the special flora of Cheddar might easily disappear without any violation of its provisions. It only applies to the uprooting or destruction of plants "in such a manner and in such quantities as to damage or disfigure any road," &c., and it is further limited by the proviso which enables persons to collect specimens in small quantities for private and scientific use. I fear that the cases in which a prosecution under such a by-law would succeed are very few, and certainly the by-law falls far short of the realisation of the wish to protect a rare flora.

EDW. FRY.

Fairland, near Bristol, September 21.

William Higgins and the Imponderable Elements.

IT is interesting to compare the semi-prophetic speculations of Oersted as so ably stated by Prof. Silvanus Thompson in NATURE of August 29 with a theory put forward by William Higgins in a book published at Dublin in 1814. This work, entitled "Experiments and Observations on the Atomic Theory and Electrical Phenomena," was primarily intended to prove that Dalton's theory had been anticipated by the author in 1789,[1] but some thirty pages in the early part of the book are devoted to a statement of his views on the "imponderable elements."

The following extracts may serve to give some idea of the nature of his surmises:—

"The ultimate particles of ponderable matter are exceedingly minute, but those of imponderable elements, such as caloric, electricity, and light, are so beyond calculation. The utmost stretch of the human mind can no more estimate the size of those particles than it can measure space and duration. However, their divisibility is limited" (p. 24).

"Every ultimate particle of a metal is surrounded with a small although dense atmosphere of caloric, together with a small portion of the electric or some other subtile fluid . . . when two atoms unite, the compound becomes surrounded with one common atmosphere of caloric and rejects a third atom of either of its constituents" (p. 13 *et seq.*).

"When two ultimate particles unite chemically their individuality is destroyed, and they form one solid atom whose capacity is less than its constituents in a detached or simple state, hence it is that caloric is liberated by chemical union. These atoms however retain a sufficient quantity of caloric to furnish them with atmospheres" (p. 20).

"The ultimate particles of different kinds of matter, whether in a solid or gaseous state, do not retain the same quantity of caloric in their respective atmospheres. This probably is occasioned by their different forces of attraction to it. Those particles which attract caloric with most force are surrounded with more of it, in a less space than those particles that attract it with a smaller force" (p. 19).

"Solids also contain a prodigious quantity of caloric, as may be shewn by deflagrating together nitre, brimstone, and crude antimony, reduced to powder, and intimately mixed" (p. 25).

"Caloric and the electric fluid are antagonistic elements, whereas light and caloric seem to be kind and almost constant associates. The light of the sun, and that produced by artificial means, are accompanied by caloric" (p. 40).

Good conductors are those part of the caloric of which is capable of being readily replaced by the electric fluid. "Dry oxides are non-conductors, as their calorific atmospheres are small and strongly attached to their atoms" (p. 43).

The electric spark inflames gunpowder or alcohol owing to "caloric which is disengaged from these substances or from the air in contact with them." Wires are fused by a battery because of "a rapid dislodgement of the specific heat of the metals by the electric matter," and since a wire remains heated during the passage of a current the electric fluid "must also possess the power of urging on, during its passage, through the battery and conductors, a sufficiency of caloric to supply the waste occasioned by the ignition" (p. 26 *et seq.*).

In similar fashion he "explains" the luminosity of meteors, why the electric spark causes combustion between oxygen and hydrogen, and why earthquakes and volcanic eruptions are accompanied by thunder and lightning. The production of heat in Rumford's experiment he admits presents a difficulty, and suggests that it might be due to the displacement of some of the specific heat by electricity, which, it was well known, could be produced by friction. He precedes this by saying that "Heat evolved by friction, however unaccountable and mysterious it may appear, is not sufficient to invalidate the doctrine of the materiality of caloric, being only a solitary fact opposed to thousands that tend to establish its existence as an elementary substance" (p. 37).

He concludes this part of his work with a touch of the true Baconian philosophy:—"The theory, or rather the hypothesis, which I have advanced, on electrical phenomena . . . according to my knowledge is quite new." "So fully convinced am I, at present, of the truth of this doctrine that no vague or superficial objections will be able to stagger my creed; at the same time, I am ready to submit to convincing facts and arguments, for truth should be the sole object of every writer on philosophical subjects" (p. 45 *et seq.*).

It will be seen that his speculations, though crude, and, of course, erroneous in the light of modern theory, are none the less characterised by considerable lucidity in expression and no little ingenuity in application. In this connection we may well remember the words of Liebig: "All our views have been developed from errors." From the flashing embers of fallacy springs the Phœnix of Truth.

A. U. N.

London, W.C., September 1.

[1] See Meldrum, *Chem. News*, 1910, for a discussion of his claims on this point.

Glaciation and Striation.

PROF. COLE (NATURE, September 12, p. 37) would scarcely maintain the assumption that the stones seen in Boulder Clay were in the "englacial" distribution of the materials in closer juxtaposition than we find them in the deposit itself. The tendency of the larger stones to gravitate towards the bottom of the moving and shearing ice-mass through liquefaction and regelation is well illustrated in the Harlow "till." But Prof. Cole seems to forget that a "conglomerate with an ice-cement" would give us a glacial gravel or a "schotter" on the melting of the ice, and not a Boulder Clay. The efficiency as a graving-tool of a grain of quartz or of some harder mineral when caught between the contact-surfaces of two fragments of rock undergoing differential movement can scarcely be doubted.

As to the pre-Boulder Clay age of the "Ipswich man," the evidence of which I have examined on the spot, the attention of Mr. J. R. Moir (*ibid.*, p. 38) and others may be fairly directed to the new light thrown upon the question by the *Thorley* section.

With reference to scratches on flints, I venture to ask Sir Ray Lankester whether in plate 17 of his monograph (Phil. Trans. R.S., Series B, vol. ccii., pp. 203 ff.) he has not overlooked (1) the fact that the striations shown in Fig. 1 are on the original cortex of the flint-nodule, and therefore not necessarily connected with glaciation, and (2) the probability that the markings shown in Fig. 2 (enlarged in Figs. 3, 4, 5) are the etched-out skeletons of some spongoid fossil, by humus acids acting differentially as a solvent on the various modifications of the silica found often in the same flint-nodule? Of such differential solvent action I have a large collection of examples, in some cases showing corrosion to the extent of the complete obliteration of the lithological character of the flint as such.

A. IRVING.

Bishop's Stortford, September 17.

BIRD-MIGRATION.[1]

THIS book has been long expected, and it is certainly one worth waiting for. The author remarks "that no country in the world is more favourably situated than our own for witnessing the movements of migratory birds; that there is none in which the many phases of the phenomenon are of a more varied nature; and none in which the subject has received greater attention." To which we venture to add that no one has made so much use of these opportunities as Mr. Eagle Clarke has done, and that no contribution to the subject compares in importance with the work which is summarised in the book before us. It is, indeed, a striking fact that although the book deals almost wholly with the author's own work, it has a completeness and scope far superior to that of any other book on migration. It represents the spare-time industry of a quarter of a century, a remarkable persistence of observation under difficult conditions on lighthouses, lightships, and lone islands of the sea, a resolute courage in facing and accomplishing the dreary task of analysing the immense masses of data provided by the British Association Committee, and a remarkable restraint in dealing with a fascinating subject which has repeatedly proved itself fatally provocative of romantic treatment. It is scarcely necessary to say that the author has given us from time to time instalments of his results, but here we have a revised and unified presentation of the whole—an achievement calling for the warmest congratulation.

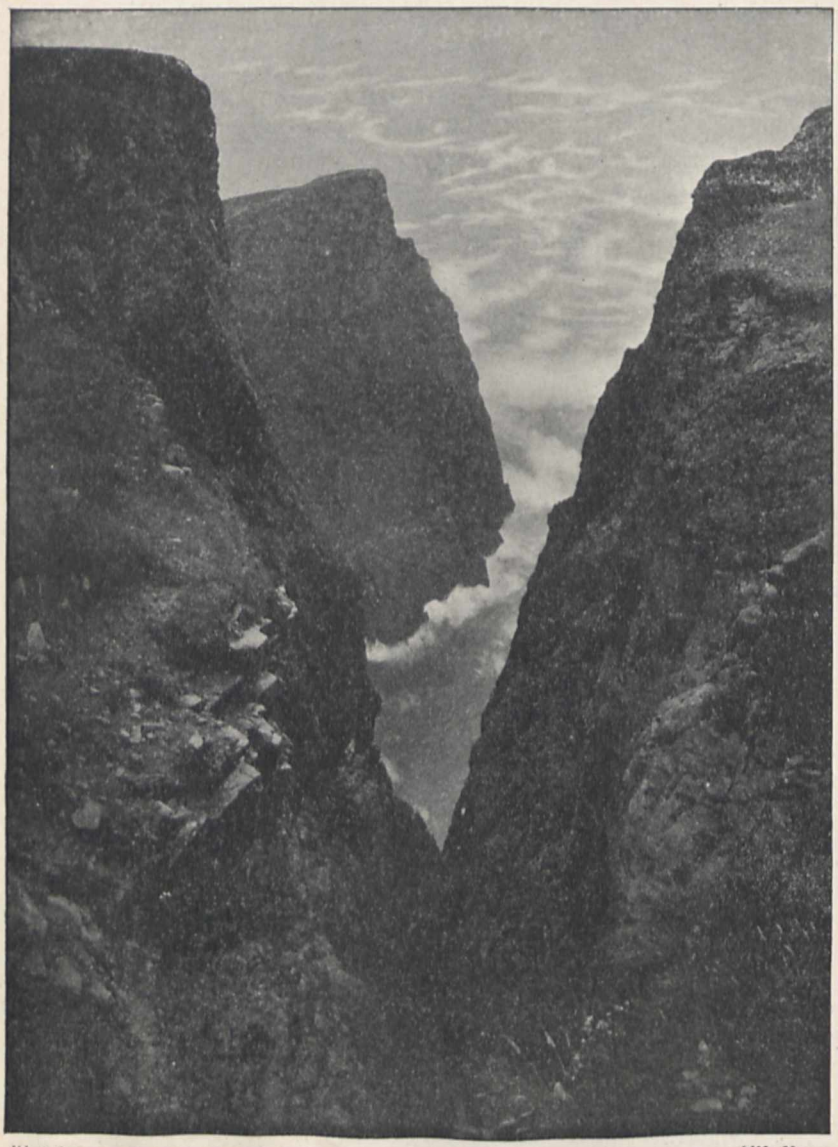

Photo.] [*W. Norrie.*

FIG. 1.—Fair Isle: a rift in the western cliffs. From "Studies in Bird Migration."

The plan of the book is simple. After a pleasant chapter on antiquated views (such as the "hibernation" theory, which lasted from Aristotle to Gilbert White and longer) and another—tantalisingly short—on some modern views, the author plunges *in medias res*. He classifies our migratory birds—summer visitors, partial migrants, winter visitors, and birds of passage—gives a summary of the movements of these several groups under their seasons, and indicates in a general way—the only possible way as yet—whence they come to us and whither they go from us. The next chapter, on "The Geographical Aspects of British Bird-Migration," is a masterly account of a very complicated subject, with rather more insistence on definite routes than we have been accustomed to from recent writers. Perhaps a more critical attitude might have been adopted towards the earlier work of Palmen and others.

The next three chapters, which are devoted to "Round the Year among British Migratory Birds," bring out very clearly the contrasts between the spring, autumn and winter movements, and there are two valuable appendices giving the dates of the arrivals and departures of the various species. The last general chapter deals with the vexed

[1] "Studies in Bird Migration." By William Eagle Clarke. Vol. i., pp. xvi+323. Vol. ii., pp. vii+346+25 plates. (London: Gurney and Jackson: Edinburgh: Oliver and Boyd, 1912.) Price 18*s.* net, 2 vols.

question of "Weather Influences," and is an admirable instance of careful scientific discussion. So much nonsense has been written on this subject that an authoritative statement is doubly welcome; and not only has Mr. Eagle Clarke had the vast data of the British Association Committee to draw upon, but he has secured the valuable cooperation of Dr. W. N. Shaw, Director of the Meteorological Office.

To those who glibly theorise on insufficient data with regard to migrants' supposed preference for "tail-winds," "beam-winds," and such like, we commend what is said on page 173: "The *direction* of the wind has in itself nothing to do with the results described. The winds and the performance, or non-performance, of the migratory movements are the effects of a common cause—namely, the particular type of weather prevailing at the time, which may be favourable or unfavourable for the flight of birds to or from our islands." Furthermore we learn that similar conditions—including wind directions—are favourable for a movement both in spring and in autumn, although the direction of the movement is, of course, exactly the opposite at one season to what it is at the other. Thus "south-easterly weather" (a large continental anticyclone to the east of our shores but extending to them, and south-easterly winds in the British area) favours migration across the North Sea in either direction (according to the season), but is unfavourable to intermigration between Britain and Iceland.

The remainder of the book may be divided into two parts. Chapters ix.–xvi. deal in detail with the migrations of eight typical birds—swallow, fieldfare, white-wagtail, song-thrush, skylark, lapwing, starling, and rook. Much of this valuable work is already well known to those who have followed the author's separate papers, but the whole has been thoroughly revised. The second volume and one chapter of the first deal with the author's observations at typical stations round the British coasts—the Eddystone Lighthouse (shown on a "bird-night" in a fine frontispiece by Marian Eagle Clarke), the Kentish Knock Lightship, Fair Isle ("the British Heligoland"), St. Kilda, the Flannan Isles, Sule Skerry (west of Orkney), Ushant (where the author was treated as a spy!), and Alderney. An account is given of the movements observed at each station, and what is known in regard to each species of bird is tersely summarised.

It must be clearly understood that this admirable piece of work is not intended as a treatise on bird-migration, summing up all that has been done by various methods in different parts of the world; it is an account of the author's personal observations and inductions. This explains what we cannot help regretting—the deliberate condensation and reserve of the second chapter, which is intended as a general introduction for the non-expert, as the majority of zoologists, for instance, must in this connection be called. But even for such as these—the most appreciative of all readers after ornithologists proper—the terseness is surely overdone. Let us illustrate. In the few lines devoted to migration in the southern hemisphere, an important point has surely been obscured in ignoring the great difference between migration in the two hemispheres, that while *many* northern summer birds go far south of the equator to "winter" in the southern summer, only a few petrels and others from the south perform a reverse journey of corresponding extent. Similarly some mention of alternative views on the origin of the migratory habit might well have been given. Again, Mr. Clarke quotes with apparent approval Mr. Chapman's opinion that the recent experimental proof of the homing power of the noddy and sooty terns dispels "the so-called mystery" of how migrants find their way, placing it on a par with "any other instinctive functional activity." But this is an obvious *non sequitur*. Nor does it help matters to describe the special sense of direction (in which Mr. Clarke firmly believes) in Prof. Newton's phrase as "inherited but unconscious experience." An interest-

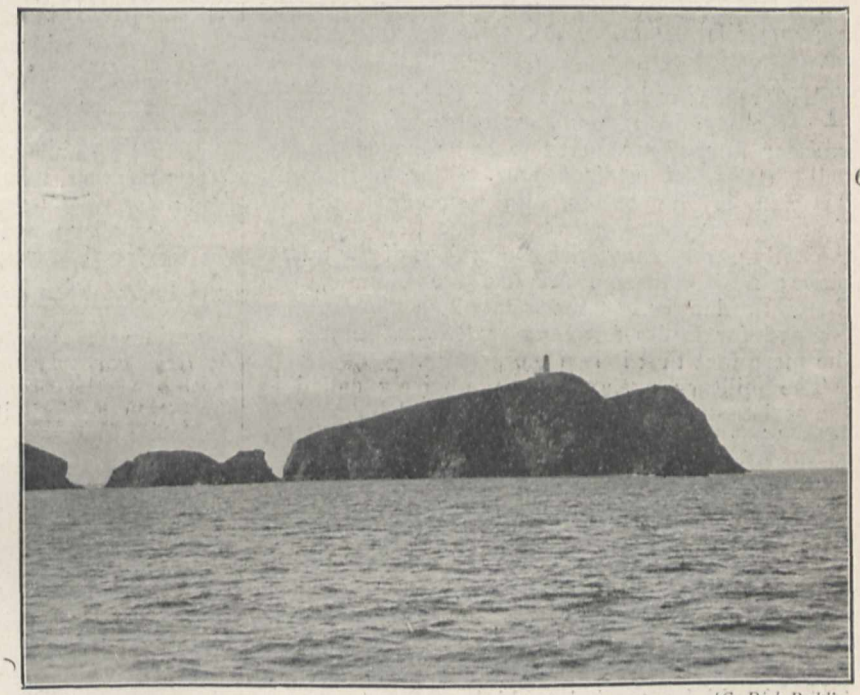

Photo.] [*C. Dick Peddie.*

FIG. 2.—Flannan Islands: Eilean Mor from the east. From "Studies in Bird Migration."

ing point in this chapter is the author's suggestion that night travelling is an adaptation to the necessity that most birds have of devoting the daytime to the seach for food.

The book is lucidly and carefully written and the author occasionally slackens his rein and reveals his power as a stylist, the description of a "bird-night" at Eddystone being perhaps the finest example. There are several good photographs of various stations, notably those of Fair Isle by Mr. W. Norrie, but the chief illustrations are maps and weather-charts—all conspicuous for clearness and simplicity. We have already referred to the admirable first frontispiece. The book is dedicated to the Duchess of Bedford, herself an ardent ornithologist, who has given the author valued assistance.

THE QUESTION OF THE BIPLANE VERSUS *THE MONOPLANE.*

THE recent order of the War Office suspending the use of monoplane flying machines for military purposes has led to the renewal, in the daily Press, of a discussion of the old riddle, "Which is the better, the monoplane or the biplane?" When Blériot crossed the Channel, the daily papers rang with the praises of the monoplane; now everyone favours the biplane, and there is a danger lest the monoplane may be condemned for faults not necessarily attributable to the mere fact that it is a monoplane.

The military authorities have wisely called in the assistance of the National Physical Laboratory in seeking an explanation of why so many of the recent accidents have occurred with monoplane machines. Even if the work placed in the hands of the Teddington department does not extend beyond overhauling and testing the machines used in the Army, the physicists ought to have sufficient scope for arriving at many important conclusions regarding essential features of aeroplane construction. For the purposes of an inquiry of the type proposed, it appears desirable that the same tests should be applied to biplanes as to monoplanes; but the value of the work will be greatly enhanced if the investigation is conducted on general lines, and not confined to the mere testing of the Army machines. It is easy enough to say that when a stay has broken it should be replaced by a stronger one, and to draw up a report which would suffice to enable any defects in existing machines to be patched up, but it is essential for real progress that the Laboratory authorities should have a free hand to assist in the evolution of a more perfect type of flying machine than either the existing monoplane or biplane.

It must not be forgotten that the terms monoplane and biplane usually imply something more than the mere difference between a "single-decker" and "double-decker" (to quote the German equivalents). The former usually has the propeller in front, the latter behind. Thus an inquiry necessarily turns on at least two points, namely, the relative advantages of the single- and double-decker, and whether the propeller is better placed in front or behind. Further subjects suggested are the gyrostatic effect of the propellers, the relative merits of rotary and oscillating engines, and so forth.

In regard to the first point, it must be remembered that even Lilienthal experimented successfully with the double-decked type; that Chanute, after trying not only "single-" and "double-decked" gliders, but also "multiple-winged machines," finally decided on the glider with two superposed surfaces as the best on which to experiment; that his experiments were continued by the Wrights, and led to their first realisation of artificial flight. One advantage of the two-surfaced arrangement is that, with an equivalent area, the wings can be made of lesser span, and thus the bending moments they have to sustain are proportionately reduced; moreover, these bending moments are much better sustained by the framework, which naturally takes the form of a latticed girder. Of course, from this point of view a triplane would even be better than a biplane, but the gain would be less important.

There would be no difficulty in constructing a "two-decker" with a propeller in front, and, from the point of view of the physicist, the position of the propeller depends largely on whether it is better for the propeller to receive the wash from the planes or for the planes to receive the wash from the propeller. One advantage of the latter plan has not, perhaps, received the attention that it deserves. It must not be forgotten that the action of the propeller sets up a rotation in the "wash" behind it, and, as Sir G. Greenhill has pointed out, so far from being negligible, the amount of this rotation is directly related to the horse-power and rate of revolution of the engine. In fact, the propeller exerts on the air a constant torque, which tends to produce angular momentum, and is equal in amount to the torque of the engine. If, then, the main planes are placed in the wash of the propeller, the rotating air on striking them will produce a difference of pressure on the two sides tending to counteract the corresponding torque on the aeroplane, and the machine will not heel over sideways to the same extent that it would if a single propeller were placed behind. For the purposes of the War Office, the propeller in front is disadvantageous, as it interferes with scouting or shooting from an aeroplane. On the other hand, we have the recommendation of a well-known engineer that the engine should be in front of the aviator, so that the latter shall not be crushed underneath the former in case of an accident.

Apart from these essential differences between monoplane and biplane, great importance attaches to an investigation into the gyrostatic couples caused by both rotary engines and propellers. At present, apart from setting up strains in the framework, which require the latter to be adequately stayed, these cause a mixing-up of the longitudinal and lateral motions of the machine which must necessarily greatly increase the danger of accidents when the machine is being navigated in gusts of wind. It is important that more

attention should be given to the question of balancing, not only of the actual propeller torque by the use of two propellers, but also of the gyrostatic couples due to both the propeller and the rotary engine. Why do not the makers try an engine rotating about a horizontal axis perpendicular to the line of flight, driving a pair of propellers rotating in opposite directions by means of bevelled cogs? The arrangement would be perfectly symmetrical, and the gyrostatic couple of the engine *might* be used to assist in lateral steering.

Another disadvantageous feature of many monoplanes, though not an essential feature of them, is that the wings are usually of considerable breadth, and, of course, are cambered. The result is that when such a machine pitches, effects may occur the nature of which will remain entirely unknown until some experimental knowledge has been obtained regarding air pressures on rotating planes. To assume that these effects are negligible, or even that they may not be the cause of accidents, is, in the circumstances, scarcely justifiable.

It will be interesting to see whether any questions of stability are considered in connection with the present inquiry. The tendency which has existed up to the present time of shelving the problem of inherent stability, and attempting to attribute accidents to other causes, is, after all, very natural. If stability could be ignored altogether, the problem of aviation would be greatly simplified, and much laborious work, both theoretical and experimental, would be saved. Those of us who have spent much time in studying the theory of stability would have been glad to give our attention to other subjects instead, had we believed that a final solution of the problem of flight was possible which should make aviation independent of stability considerations. At the present time, no experimental information exists regarding inherent stability, and a comparison of theory with practice is urgently needed. Under theoretically assumed conditions, stability, both longitudinal and lateral, is greatly affected by variations in the inclination of the flight path to the horizon, and this is a point on which experimental tests would be of particular interest. The fact that so many accidents have occurred the causes of which are unknown shows that aviators have not yet been altogether successful in their attempts to dispense with theories of, and experiments on, stability. The accounts of many accidents are strangely suggestive of what would happen under theoretical conditions if an aeroplane should be flying at an inclination to the horizon consistent with inherent instability.

As regards the monoplane and biplane, these limits are probably very different in existing machines of the two types, but there is no essential difference between the "single-" and "double-decker" in regard to stability. Many monoplanes are of the Antoinette type, and can be made laterally stable by making the tail of sufficient length; many existing biplanes do not possess sufficient auxiliary surfaces for lateral stability, though this defect is probably remedied when the planes are bent up; on the other hand, the auxiliary planes in them are as a rule more favourable to longitudinal stability. These are, however, details of construction which do not depend on whether the machine is a monoplane or biplane. It is probable that most existing aeroplanes satisfy the condition that lateral, like longitudinal, *instability* increases when rising in the air.

It is necessary to repudiate any suggestion that a so-called "theory" of stability (which is really an experimental study of the results of certain assumed hypotheses, the apparatus for which are the methods of mathematical analysis) should be applied to actual aeroplanes without first being subjected to a second experimental test performed with the actual aeroplanes or models of them. But would not even this course be better than continuing to use aeroplanes about the stability of which nothing is known? And admitting that most flights have to be performed in gusty winds, is this any reason for being satisfied with a flying machine which would not fly straight in still air? Some people appear to think so. But is it not probable that the problem of stability presented by an actual aeroplane is more complex and not less complex than that presented by a system of narrow planes moving at small angles through a resisting medium? If this be so, the complexities of the simpler problem may afford some clue to those existing in the more difficult and at present unsolved problem.

It is hoped that no suggestions made in the present article will be regarded as authoritative statements except so far as they may be confirmed by experiments conducted with the aid of mathematical or physical apparatus. If any conclusions are to be drawn from these remarks, they should be to the effect that it is far less important to try to decide whether a biplane is better than a monoplane than to investigate the relative merits of flying machines on a perfectly broad basis. It is, therefore, to be hoped that the staff of the National Physical Laboratory will not only be given a very free hand in the investigations that are placed in their hands, but that they will produce a powerful and thorough report, and—if a small criticism is permissible—give a little more attention to formulating broad general principles, and confine themselves a little less exclusively to the tabulation of minute experimental details than they have done on some previous occasions.

G. H. B.

THE INTERNATIONAL METEOROLOGICAL COMMITTEE.

WEATHER TELEGRAPHY AND MARITIME METEOROLOGY.

MEETINGS were held in London during the week ending on Friday, September 20, of two Commissions constituted by the International Meteorological Committee to deal with questions concerning international weather telegraphy on the one hand, and with those concerning mari-

time meteorology and storm warnings on the other. The Commissions were first provisionally appointed at the meeting of the International Committee held in Paris in 1907; they held meetings in London in June, 1909, and upon their report to the meeting of the International Committee held at Berlin in 1910, it was decided to recommend to the meteorological institutes of Europe to substitute a reading of the "barometric tendency" (the change of pressure in the three hours preceding the morning observation) for the reading of the wet-bulb thermometer in the international code. A scheme of storm signals for daylight, using two cones, was also recommended as an international system.

In the telegraphic reports of the morning of May 1, 1911, the change of code recommended was introduced simultaneously by all the countries of Europe, and the "barometric tendency" has now become an important feature of the daily weather message. The recommendation as to storm warnings was hampered by the fact that no agreement could be reached as to the signals that were to take the place of the cones at night.

Having regard to the various incidental questions which remained unsettled, the International Committee at Berlin decided that the two Commissions, which had consisted of only few persons, should be enlarged and become permanent. All the members of the International Committee had therefore been invited to join these Commissions, and also to nominate other persons interested in weather telegraphy and maritime meteorology respectively.

In accordance with the tradition of the International Meteorological Organisation, the administrative work of a commission rests entirely with its president; both the Commissions mentioned are under the presidency of the Director of the Meteorological Office, London, who is also president of the International Meteorological Committee, by which they were appointed. Meetings of the Commissioners were accordingly arranged to be held in London on Tuesday, Wednesday, Thursday, and Friday of the third week in September.

The Board of Education kindly lent the committee-room of the Science Museum for the meetings. The members present were:—For the Commission for weather telegraphy, General Rykatcheff, Director of the Meteorological Service of Russia; Geheimrat Hellmann, Director of the Prussian Meteorological Service, secretary of the International Committee; Prof. Grossmann, representing the Deutsche Seewarte; Prof. Palazzo, Director of the Meteorological and Geodynamic Institute of Rome; M. Angot, Director of the Central Meteorological Bureau of France; Prof. Mohn, Director of the Meteorological Service of Norway; Prof. Van Everdingen, Director of the Meteorological Service of the Netherlands; Captain Ryder, Director of the Meteorological Service of Denmark; Mr. R. G. K. Lempfert, Superintendent of the forecast division of the Meteorological Office. For the Commission for Maritime Meteorology and Storm Warnings there were, in addition, Comandatore Santi, Director of the Hydrographic Bureau of the Royal Italian Marine at Genoa; Dr. van der Stok, Superintendent of Marine Meteorology at de Bilt; and Commander Hepworth, Superintendent of the Marine Division of the Meteorological Office. His Highness the Raj Rana of Jhalawar, and Señor Duarte, chef de service of the Brazilian Meteorological Service, now being reorganised, were invited to attend the meetings of the Commissions.

The representatives of Japan, Dr. Nakamura and Dr. Okada, were prevented from coming by the death of the Emperor. Letters of regret were also received from Prof. Willis Moore, of the United States Weather Bureau; Mr. H. A. Hunt, Commonwealth meteorologist of Australia; Rev. L. Froc, of Zikawei Observatory; Mr. T. F. Claxton, of Hong Kong Observatory; and others.

As regards weather-telegraphy, the questions for discussion grouped themselves into four subjects, which may be mentioned in turn:—

(1) The first was the revision of the international code, incidental to the substitution last year of the "barometric tendency" for the reading to the wet bulb.

After a long discussion agreement was reached whereby two consecutive figure-places can be obtained in the morning groups by using only two figures for the barometric tendency, and also for the air temperature. It is suggested that for ordinary stations one of these places be assigned to the characteristic of the barometric variation in the past three hours, and the other to the direction of motion of the upper clouds; but, in order to encourage the preparation of a daily map of the circulation of the upper air over Europe, it is proposed that for those few international stations where observations of the direction and apparent velocity of clouds can be obtained, the two figures shall be assigned to those elements. For a figure-place incidentally available in the evening groups, the "characteristic of the weather in the past twenty-four hours" is suggested. Figure codes for the four new meteorological "elements" here mentioned were drawn up.

(2) Secondly, the question of the extension and proper organisation of the evening telegraphic weather service was brought forward by the Seewarte, and General Rykatcheff brought before the meeting a project of the Russian service for synchronous observations twice a day over the whole of the Russian Empire, covering 150° of longitude, in cooperation with the service of middle and western Europe.

A schedule of the present hours of observation in all parts of the globe was put forward; and in order to assist these projects it was agreed to recommend 7 a.m., 1 p.m., and 6 p.m. (G.M.T.) as "international hours" for the region between the longitude 30° W. and 30° E., and 6 a.m., 12 noon, and 6 p.m., G.M.T. (8h., 2h., 8h. of St. Petersburg time), as international hours between the longitudes 30° E. and 180° E.

(3) The form of the Iceland telegrams was the third general subject of consideration; and, with reference to that, the Director of the Danish service undertook to give effect as far as possible to any modification that was generally acceptable and that might be regarded as permanent. The opinion of the institutes upon the question will therefore be invited.

(4) The last subject of discussion, mooted by Prof. Willis Moore as a sequel to the deliberations of the recent conference on radiotelegraphy in London, was the notification, to certain centres, of observations at Greenwich noon by all vessels at sea carrying radio-telegraphic apparatus, and the issue of forecasts from the centres to the vessels. The suggestion of organising the distribution of reports by radio-telegraphy on an international plan was welcomed. Some doubt was expressed as to Greenwich noon being the most suitable international hour for the observations, as it would not fit in well with the European system, and some provision for the more general distribution of the information was mentioned as desirable. As the scheme implied legislative action by the various countries, it was decided as a first step to invite the opinions of the various institutes upon the scheme.

The Commission for Maritime Meteorology and Storm Warnings was chiefly concerned with the question of the signals to be used at night to replace the day signals already agreed upon.

Copies of a third edition of the provisional summary of the maritime weather signals at present in use in the various countries of the globe had been prepared for distribution at the meeting.

The various schemes, either at present in operation or advocated on various grounds, group themselves into (1) schemes of three lanterns in the vertical, (2) two lanterns in the vertical, and (3) one lantern only. The scheme of three lanterns was proposed by the Bureau Central Météorologique of France on behalf of the French Ministry of Marine, on the ground that a combination of two lanterns might be confused with signals already adopted in the "regulations for avoiding collisions at sea" or with harbour lights. The Board of Trade approved of these proposals, and undertook to use its good offices to get the harbour lights at two ports where confusion might arise so arranged as to obviate that difficulty. On the other hand, a scheme of two lanterns for gales in the four quadrants, with three lanterns for a hurricane, originally proposed by the Commission in 1909, and objected to first by the Seewarte, and subsequently by others, on account of the liability to confusion, had been tried by the Seewarte on the German coast, and no confusion had arisen; whereas the alternative scheme of three lanterns was pronounced unmanageable, and the hurricane signal was accordingly replaced by one red lamp for an "atmospheric disturbance."

Prof. Willis Moore, to whose initiative the work of the Commission is due, also expressed the opinion that a scheme of three lanterns is unmanageable, and therefore modified the original proposal by proposing two red lamps for a hurricane (instead of one white between two red) and one white lamp for a gale in the north-west quadrant. One red lamp is at present used in some countries to replace any day signal.

In these circumstances it was evident that there was no general agreement in favour of a single scheme of signals, and it was therefore necessary to place the recommendations for the present on the lower plane of agreeing that any combination of lamps forming a storm signal shall have the same significance in whatever country it is used.

The propositions to be submitted to the various institutes will therefore be—that, in countries which use three lanterns in the vertical for storm warnings at night, the lanterns shall not be less than two metres apart, and shall be arranged according to the approved scheme of three lanterns; that in countries which use two lanterns, the lanterns shall be not less than two metres apart, generally four metres or fifteen feet, and shall be arranged in accordance with the original proposal of the Commission, with one red lamp to signify an atmospherical disturbance without indication of the direction of the winds instead of three lamps to signify a hurricane; that in countries which use only one lamp for night signals, one red lamp shall replace any of the day signals.

It was agreed to take the opinion of the institutes on a proposal to indicate at a signal-station by a green flag or a green lamp, or otherwise, the information that no warning can be hoisted on account of telegraphic communication being interrupted or for some other cause, as is now done at Thorshavn.

It was also agreed to take the opinion of the institutes upon the desirability of adopting a scheme of international "non-local signals" indicating the position of an atmospheric disturbance, on the lines of the code used at Zikawei and elsewhere on the China coast. Another scheme of day and night signals for a similar purpose, using three cones or three lanterns to indicate the position of a tropical revolving storm, was submitted by Commander Hepworth, and will be circulated also for comments with the report.

Finally the Commission agreed, on the motion of Dr. van der Stok, to recommend the collection of extracts of data from the meteorological logs of ships of all nations for certain ocean squares on the trade routes, with a view to their publication as a contribution to the meteorology of the globe.

The proceedings of the week commenced with a reception by Mrs. Shaw at 10 Moreton Gardens on Monday, September 16. Tuesday, Wednesday, and Friday morning and afternoon, and Thursday morning, were occupied with meetings. Thursday afternoon was set free to enable the reports of proceedings to be prepared in the Meteorological Office. Instead of meeting, the delegates visited Kew Observatory by motor, and took tea in Kew Gardens. In the evening they dined together on the invitation of Dr. Shaw, the President of the International Committee, who was

honoured by the presence of the Raj Rana of Jhalawar, and was supported by Sir Norman Lockyer, Sir Charles Watson, Sir George Gibb, the Deputy-Master of Trinity House, the President of the Royal Meteorological Society, Captain Loring, R.N., Captain Sueter, R.N., Captain Clarke, Captain Thomson, C.B., Captain Lyons, R.E., Captain Henrici, R.E., and other representatives of various public offices.

The Raj Rana entertained the members of the Commission at dinner at Bailey's Hotel on Friday, September 20. Some of the delegates remaining in England were entertained for the week-end by Mr. and Mrs. Cave at Ditcham Park, Petersfield.

The reports of the proceedings at the meetings, which were read and signed at the final meetings on Friday, September 20, will now be printed and circulated to the various meteorological institutes for comments. These will be taken into consideration at the next meeting of the International Meteorological Committee, which, it is hoped, may be held in Rome in the week after Easter Week in the year 1913. The meeting will have to consider not only the reports of the Commissions which have already met, but also the important question of the application of meteorology to agriculture, which has been raised by a letter addressed to the president of the International Meteorological Committee by the president of the International Institute for Agriculture, which has its seat at Rome.

Besides the Commissions, the proceedings of which have been referred to here, it may be noted that the Commission for Radiation, under the presidency of Prof. J. Maurer, of Zürich, met in Switzerland in the first week of September; and, earlier in the year—May 27 to June 1—a largely attended meeting of the Commission for Scientific Aëronautics was held at Vienna, under the presidency of Prof. Hergesell. The Commission passed a number of resolutions, one of which, in favour of the establishment of a network of stations for daily observations with pilot balloons, has already been communicated to various Governments through diplomatic channels.

Perhaps the most noteworthy of the resolutions were those passed on the initiative of Prof. Bjerknes, formerly of Christiana, and now of Leipzig, proposing that the results of upper air observations shall be arranged according to definite steps of pressure instead of steps of height; that the heights shall be given in "dynamic" meters—that is, a step corresponding to a certain difference of gravity potential, not of geometrical height; and, thirdly, that pressures shall be recorded in millibars (C.G.S. units) instead of millimetres or inches. These important steps in the direction of arranging the material obtained from the investigation of the upper air in a form suitable for dynamical calculation are to come into effect with January, 1913, but the resolution as to pressure units is to be subject to the approval of the International Meteorological Committee. The forthcoming meeting proposed for Rome is therefore likely to be one of great importance.

SCIENTIFIC COLLECTIONS OF THE GERMAN CENTRAL AFRICA EXPEDITION OF 1907–1908.[1]

IN 1902 the Duke Adolf Friedrich visited East Africa. In 1904 he returned there and explored the region immediately to the south-east of Lake Victoria Nyanza. In 1907 he started again, this time at the head of a well-equipped scientific expedition charged with the special task of examining the volcanic regions west of the Victoria Nyanza and north of Tanganyika. The general results of this 1907–8 expedition have already been published, both in German and in English, the English version having been brought out by Cassell and Co. in 1910. The Duke, after leading his expedition through the countries of Karagwe, Ruanda (including the Kivu district), and the Virunga volcanoes, travelled past Lake Edward Nyanza to the Semliki, the Albert Nyanza, the gold-mines of Kilo, and then westwards through the Ituri Forest and down the Aruwimi to the main Congo, and so back to Germany by the Atlantic Ocean.

The volume before us is the third issued as the result of a careful examination of the immense collections made by this scientific expedition. The two previous volumes have dealt with the topography, geology, and meteorology, and with botany. Vol. iii. gives us, first, a remarkably interesting dissertation on the earth-worms or Oligochæta; on the Serphidæ, Cynipidæ, Chalcididæ, Evaniidæ, and Stephanidæ of hymenopterous insects; on the decapod crustaceans (the land-crabs, shrimps, prawns, &c.) of equatorial Africa; on the bees, the Cladocera, the molluscs (especially land-snails), the bivalves, the burrowing Hymenoptera, and wasps; the birds of the Central African lake region; the ants; the Braconidæ and beetles; the copepods of the East African lake region; the cockroaches and butterflies of Ruwenzori and the Congo Forest. The separate articles have evidently been inserted in the order in which they were written, and have thus been cited here. It would have been more convenient to the zoologist, however; if they had been arranged systematically, so that one passed on, for example, from bees and wasps to ants, or from one group of crustaceans to another, without some intervening description of a totally different group of animals.

Probably the most valuable part of the present compilation will be that on the earth-worms and the birds. Earth-worms—it has long been realised, even by those who do not specialise in any way in that study—are amongst the most interesting and certain means of estimating the relationship between the existing distribution of land and water on the earth's surface and that of past times. The article on the Oligochæta collected by the Adolf-Friedrich Scientific Expedition is accompanied by a well-written summary of the

1 "Wissenschaftliche Ergebnisse der Deutschen Zentral-Afrika-Expedition, 1907–8," unter Führung Adolf Friedrichs, Herzogs zu Mecklenburg. Band iii., Zoologie i., herausgegeben von Dr. H. Schubotz. Pp. xxiii+560+plates xi-xiv. (Leipzig: Klinkhart and Biermann, 1912.) Price 24 marks.

distribution peculiarities of the earth-worms of Africa and adjoining regions, showing, amongst other things, the intimate faunistic relationships (involving, of course, continuous land surface at one time) between Spain, Syria, and Persia, and again between Sardinia, Sicily, and Tunis; between all equatorial or tropical Africa (Senegambia to Abyssinia and Moçambique), and—it might be added in a lesser degree—Guiana and Brazil; and the very separate and peculiar character, from an earth-worm point of view, of Madagascar and the southern extremity of Africa, both of which constitute very distinct regions in the character of their earth-worms. So far as our knowledge yet extends, the most interesting and richly endowed earth-worm region in Africa is round about Ruwenzori, between the west coast of Victoria Nyanza and the north coast of Tanganyika.

In the article on birds, the survey of all well-known collections is somewhat incomplete, very little reference being made to the reports on the collections made by the writer of this review in Uganda and on Ruwenzori. (In his general summary of the results of the expedition, the Duke Adolf Friedrich attributes the discovery of the Okapi, not to the writer of this review, but to Lieutenant Eriksson; the true facts of the case have been so well stated in M. Jules Fraipont's monograph on the Okapi that it is not necessary to repeat them here.) Several mistakes are made in the spelling of names of non-German authorities and certain place-names. This article, however, like some which have recently appeared in the *Ibis*, emphasises the remarkable beauty and strangeness in coloration of the Central African shrikes (Malaconotus) and the tree hoopoes (Scoptelus). The most striking species of Scoptelus has been named after the Duke Adolf Friedrich.

H. H. JOHNSTON.

NOTES.

SIR W. T. THISELTON-DYER, K.C.M.G., F.R.S., has been elected an honorary fellow of the Royal Society of South Africa.

A memorial to Lord Lister is to be established at University College Hospital, where Lister was a student. A special committee has been formed under the presidency of the Duke of Bedford, president of the hospital, with Sir John Tweedy, consulting ophthalmic surgeon, as hon. treasurer of the fund. The exact nature of the tribute will be largely decided by the amount of the subscriptions received, but it has been suggested that either a bust or a tablet should be placed in both the hospital and the college. It is understood that the memorial will be local in character, and only those who have been in some way connected with University College or the hospital are being asked to subscribe.

A NEW case has just been arranged in the Geological Department of the British Museum (Natural History) to illustrate the characteristic coral of each of the successive layers or zones in the Carboniferous Limestone of the Avon Gorge, Bristol, as determined by Dr. Arthur Vaughan. The actual fossils and photographs of the cliff-sections are explained by accompanying diagrams, prepared by Mr. W. D. Lang. It appears that the successive faunas, including the corals, are not directly derived from each other on the spot, but represent a series of migrations. Dr. Vaughan has presented to the museum the whole of the collection of corals on which his well-known researches were based, and this gift has been supplemented by another from Dr. Albert Wilmore, illustrating similar researches undertaken by him in the Carboniferous Limestone of Yorkshire.

THE Geological Department of the British Museum (Natural History) has also recently received a valuable gift of Wealden fossils from the Revs. P. Teilhard and F. Pelletier, S.J., who made the collection during a four years' residence near Hastings. A large proportion of the specimens are small teeth from bone-beds which had previously been very little examined, and among them is the unique mammalian tooth described under the name of *Dipriodon valdensis* by Dr. Smith Woodward in 1911. There are numerous teeth of the dwarf crocodile Theriosuchus, which has hitherto been known only from the Purbeck Beds. The series of plant-remains is also important and will shortly be described by Prof. A. C. Seward in a communication to the Geological Society.

MR. WILLIAM H. HOGG having been appointed an inspector under the Board of Agriculture for Scotland, the post of resident manager of the Royal Agricultural Society's Experimental Farm at Woburn has become vacant. Applications for the appointment are to be made to the secretary of the society, at 16 Bedford Square, London, W.C., not later than Saturday, November 2.

PROF. KARL PEARSON has recently addressed two lectures to the medical profession. One, entitled "Eugenics and Public Health," was delivered at the York Congress of the Royal Sanitary Institute, and the other, "Darwinism, Medical Progress and Eugenics," before the West London Medico-Chirurgical Society as the "Cavendish Lecture." In both the importance of statistical training is insisted on in dealing with the data collected in the Public Health service, and also in deciding the method for their collection. Instances are given of the kind of errors which may be or have been made and can only be avoided by the application of the requisite knowledge and experience. The matter is one of urgent public importance, as social legislation of a kind that is difficult to repeal may be based on conclusions such as Prof. Pearson here criticises in his usual clear and forcible style.

A VOLUME entitled "Problems in Eugenics" (London: The Eugenics Education Society, 1912, pp. 490) contains the majority of the papers read before the recent International Congress in Eugenics, together with translations into English of those which were written in other languages. Such contributions as were sent in too late for inclusion in this volume are to be published in a supplement, which will con-

tain also reports of the discussions and of the speeches delivered at the inaugural banquet. As might be expected, a very wide range of subjects is covered. On one page we read of the inheritance of fecundity in fowls and on another of proposed temperance legislation in Norway. The comparative merits of hectine and salvarsan are set forth by one author, while another discusses the elements which go to make up a successful demagogue. History, anthropology, and experimental psychology have all been drawn on, yet nothing has been included which is not to some extent or in some manner relevant.

DURING this season's excavations of the Maumbury Rings, Dorchester, the removal of much material from the terrace thrown up during the Civil Wars (1642–43) has disclosed remains of the Roman period, including Samian and other ware of that age, with a brass coin of Constantine. Search was made for indications of tiers of seats, but without result. It must, however, be remarked that according to Valerius Maximus the Senate forbade the erection of such conveniences for public use, although Ovid records that it was Romulus who first arranged seats of turf for the spectators.

THE Bureau of American Ethnology announces a forecast of the results of a tour conducted in Argentine territory by Dr. Hrdlicka with the object of studying the remains of early man in that region. In order to ensure the verification of the necessary geological data, he was accompanied by Mr. Bailey Willis, of the U.S. Geological Survey. Unfortunately, the results of this investigation are not in harmony with claims previously made by the discoverers of certain "finds" in South America. The conclusion now reached is unfavourable to the hypothesis of the great antiquity of man in this region, more especially as to the existence of very early predecessors of the Indian in South America; nor does it sustain the theories of the evolution of man in general, or even that of an American race alone, in the southern continent. The facts collected attest only the existence of the already differentiated and relatively modern American Indian. It is not, of course, denied that early man may have existed in South America, but the position taken is that this hypothesis cannot be accepted without much additional scientific evidence. The importance of this announcement in connection with the theories advanced by Prof. Elliot Smith at the recent meeting of the British Association is sufficiently obvious.

IN a paper published in the *Archives of the Roentgen Ray*, Dr. Hall-Edwards directs attention to diffusion figures—figures obtained by dropping different coloured dyes in definite amount and regular order on absorbent paper. Very beautiful coloured geometrical figures may thus be produced, four of which are reproduced in a coloured plate, and Dr. Hall-Edwards anticipates that their study may throw some light on the production of patterns in nature.

A TECHNICAL engineering journal is a somewhat curious place in which to describe new species of mosquitoes, and yet this has been done by Dr. M. N. Tovar in the June issue of the *Revista Tecnica del Ministerio de Obras Publicas*, published at Caracas, Venezuela, in the course of an article on the biting gnats and flies of the Monagas estate, Maturin, such new species being respectively named *Psorophora blanchardi* and *Sabethoides rangeli*. In a second illustrated article in the same issue Dr. L. Alvarado describes certain prehistoric objects from Venezuela.

THE fiftieth number of "Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India" contains a preliminary report by Captain W. S. Patton upon his investigations into the etiology of Oriental sore in Cambay. The author concludes that the house-flies (Musca spp.) play no part whatever in the transmission of the disease in Cambay. Although he has failed up to the present to transmit the parasite by the bed-bug, he has "no doubt whatever that the bug *Cimex rotundatus* is the only insect transmitter of the disease" in Cambay, on the ground that the parasite only passes into its flagellate stage in the bug below a certain temperature, and that "this observation exactly coinsides with the geographical distribution of the disease in India." The problem of the transmission of this disease is therefore still without its final solution.

THE importation of tuberculosis in frozen meat forms the subject of a short note by Prof. Guido Bordoni-Uffreduzi in the *Rendiconti del R. Istituto lombardo*, xlv., 12. According to this writer something like a scare has occurred in Italy, and exaggerated statements have been circulated to the effect that 90 per cent. of the cattle in the Argentine Republic, whence the beef is obtained, are tuberculous. Prof. Uffreduzi, on the other hand, finds the Argentine cattle to be far less affected by tuberculosis than those bred in Italy; further, he refers to the circumstances (1) that the bacillus occurs rarely in the muscular parts and that only in animals obviously unfit for food; (2) that cooking destroys the bacillus; (3) that adults are not very liable to infection from tuberculosis introduced in the form of food. Hence it is concluded that the danger is more imaginary than real, and is not based on circumstantial evidence.

THE need of legislative protection for the Californian so-called valley quail (*Lophortyx californica*) forms the subject of an article by Mr. H. C. Bryant in the July number of *The Condor*. In some districts these birds show a great diminution in number, although in certain areas there is an increase. The provision of sufficient food and proper covert is stated to be necessary.

The Egyptian Gazette of August 1 contains a list of twenty-four species of Sudani mammals and ten of birds living examples of which have been recently received at the Government Zoological Gardens at Giza. The most interesting of these is a white-eared kob antelope (*Cobus leucotis*), from the swamps of the White Nile, believed to be the first example of its kind that has ever left the Sudan alive.

A NEW species of the minute annelids of the genus Achæta—so called from the absence of bristles—from Armagh is described by the Rev. H. Friend in the

September number of *The Irish Naturalist* as *A. spermatophora*. A second addition to the British fauna is recorded by Mr. N. H. Joy in *The Entomologist's Monthly Magazine* of the same date in the shape of *Orthochaetes insignis*, a beetle common in Brittany.

THE American Camp Fire Club has issued a circular letter setting forth the part played by that body in regard to legislation for the protection of the Pribilow fur-seals. It is claimed that both the recent international fur-seal treaty and the Bill establishing a five-year close season for the fur-seals are the result of action taken by the club. Be this as it may, the enactment of such a close can scarcely fail to be a source of satisfaction in this country. During the Russian occupation of the Pribilows the number of fur-seals was at one time reduced to 31,000, but when the United States came into possession of the islands, after a ten-years' close season, it had increased to nearly five millions. At the present time it is believed that the seal herd does not comprise more than 125,000 head, but it is confidently expected that at the end of the five-years' close season the number will have risen to more than a million.

THE greater part of *Naturen* for July and August is occupied by an illustrated article by Mr. K. E. Schreiner on "the oldest men," in which skulls of the Neanderthal, Spy, and other early races are figured, as well as the lower jaw of *Homo heidelbergensis*, and the skull, teeth, and femur of *Pithecanthropus*, are figured. Genealogical diagrams illustrating different views which have been expressed as to the relationship of the genus last mentioned to the Neanderthal and modern man are of interest. In one case Pithecanthropus is regarded as the direct ancestor of *Homo sapiens*, with *H. neandertaliensis* as the intermediate link; in a second Pithecanthropus and the Neanderthal race are regarded as separate lateral offshoots of the stem which gave rise to the modern races, while in a third Pithecanthropus occupies the same collateral position, but is supposed to have given rise to Neanderthal man, who is accordingly only a distinct cousin of the existing races of mankind.

UNDER the title "An American Lepidostrobus," Prof. J. M. Coulter and Dr. W. J. G. Land have described (*Botanical Gazette*, vol. 51) the first hitherto discovered American coal-measure cone showing the internal structure. Until now American palaeozoic fructifications and seeds have been known only as impressions or casts, in striking contrast to the richness of the coal-measures in Britain and France in petrified remains showing beautifully preserved structure, though the mesozoic formations have yielded a rich harvest of material to American palaeo-botanists such as is unequalled in any other country.

The well-known work of Prof. H. de Vries on the evening primrose, *Oenothera Lamarckiana*, and the various forms (mutants and hybrids) derived from it has been followed up by various cytologists in the hope of elucidating the origin and nature of these forms with reference to the nuclear phenomena. Miss Anne M. Lutz has published an extensive paper (*Biologisches Centralblatt*, 1912, No. 7) based upon the counting of the chromosomes in the dividing nuclei of various Œnotheras, especially in the forms called "triploid mutants"—in which the somatic cells have thrice instead of twice the number of chromosomes normally found in the male and female germ-cells from which the plant arose. The results obtained by Gates, Davis, Geerts, and the writer herself are discussed at length, and considerable ingenuity is shown in the explanation of the various numbers of chromosomes observed in different Œnotheras—a list is given of more than forty possible combinations and permutations in the chromosome numbers in the germ-cells, and the writer claims to have demonstrated "the harmonious relationship existing between practically all of the observed phenomena thus far reported for the germ and somatic cells of *Oenothera*."

PROF. H. E. ARMSTRONG'S lecture to the Royal Horticultural Society on "The Stimulation of Plant Growth" is printed in the current number (vol. 38, part 1) of the Society's journal. It is primarily concerned with the action of volatile activating bodies or hormones, which can pass through the membranes of plant cells and stimulate enzymes to set up chemical changes in the cell contents. In the growth of an ordinary green plant two periods may be distinguished—that in which assimilation occurs under the influence of light, and that in which growth takes place at the expense of the materials thus produced. The latter is apparently the period during which stimulation is necessary, that in which enzymes are brought into action as simplifying agents and the products of their action enter into circulation and are carried to the places where they can be used as building materials in promoting growth; probably during this period the membranes become more or less permeable to substances which do not pass them during the period of assimilation. It is pointed out that manures probably act largely as hormones; that ammonia is the most active "natural" stimulant, and that a substance (ammonia, for instance) which is a valuable hormone when used in proportions not exceeding a certain low maximum at once becomes toxic when this maximum is exceeded.

IN the Quarterly Journal of the Geological Society of London for 1912, vol. lxviii., part 2 (price 5*s*.), the president, Prof. W. W. Watts, F.R.S., reviews the important subject of the coal supply of Britain. He urges forcibly that an exploration by boring of concealed coal areas might well be undertaken by the State. The "Summary of Progress of the Geological Survey of Great Britain for 1911" (1912, price 1*s*.) shows how the Coal Measures of the Denbighshire district are being examined, and coal again attracts attention in Staffordshire, Warwickshire, and Scotland (pp. 22, 23, and 46). A second edition has been issued of the Survey's memoir on the country around Cardiff (1912, price 2*s*.), with especial reference to the growth of information as to mines. The memoir on the country around Ollerton, by G. W. Lamplugh and others (price 2*s*.), accompanies sheet

113 of the map (price 1s. 6d.). Both in the memoir and in the section on the map, the position of the concealed coalfield under Sherwood Forest is well emphasised. Perhaps in anticipation of the comprehensive publication that we expect from the International Geological Congress of 1913, Mr. E. F. Pittman has prepared a handy volume on "The Coal Resources of New South Wales" (Geol. Surv., N.S.W., 1912, price 1s.).

THE series of papers on the development of the theories of mathematical logic and the principles of mathematics, by Mr. P. E. B. Jourdain, appearing in *The Quarterly Journal of Pure and Applied Mathematics*, forms a useful contribution to mathematical literature. The sections dealing with Leibniz and Boole appeared some time ago, and we have now received the part (*Quarterly Journal*, No. 171, 1912) dealing with the work of Hugh McColl (1837–1909), Gottlob Frege (born 1848), and Giuseppe Peano. All these sections have been revised, both by the respective authors with whose work they deal and by Mr. Bertrand Russell.

A PAPER contributed to the *Atti dei Lincei*, xxi. (2), 1, by Prof. S. Salaghi bears the title "On the vulgarisation and application of mathematical physics in medicine." It constitutes a plea for the application of hydrodynamical principles to the study of the circulation of the blood, the formulæ for the purpose being the ordinary equations of hydraulics applicable to the motion of liquids in tubes, a subject which the author claims to have introduced into Italy for the first time, but which is now being investigated by Dr. Morandi under the name hæmodynamics.

A SMALL pamphlet on "Rubies," written by Mr. Noel Heaton, has been issued by the Burma Ruby Mines, Ltd. In the course of a few concise paragraphs, Mr. Heaton explains how the natural ruby may be distinguished from other red gem-stones, and especially from the reconstructed and synthetic rubies. The difference in structure between the natural and the artificially prepared stones is clearly brought out by some admirable illustrations. The pamphlet will be found invaluable by jewellers and dealers in precious stones, to whom of late years the identification of rubies has been a troublesome problem. The salient items of the pamphlet are also reprinted in the form of a chart, which may be framed and hung in a convenient position on a wall.

THE Journal of the Institution of Electrical Engineers for July contains a description of a portable instrument for the detection of combustible gases and vapours in air, devised by Messrs. A. Philip and L. J. Steele. It depends on the possibility of causing the gas or vapour to combine with the oxygen of the air by bringing the mixture into contact with a platinum spiral raised to the necessary temperature by the passage of an electric current through it. The combustion thus brought about produces heat which raises the temperature of the platinum spiral still further. The electric current passes through a second spiral identical with the first, but protected from contact with the mixture of gases. By combining the two spirals in any of the well-known ways, the difference of their electrical resistances may be made to indicate the presence of the combustion. In the instrument described, the spirals are in series with the coils of a differential relay, and the redistribution of current which results from the heating of one spiral actuates the relay and a red lamp lights up.

IN the Chemical Society's Journal Prof. Pope and Mr. C. S. Gibson give an account of their successful resolution of *sec*-bitylamine, $C_2H_5.CH(NH_6).CH_3$, a simple substance which had resisted earlier attempts to separate it into two optically-active isomerides. Although the base behaves normally, and its hydrochloride is highly dispersive, a series of sulphonic derivatives were found to produce practically constant rotations in the yellow and green regions of the spectrum. This absence of rotatory dispersion is very exceptional, though some parallel is found in substances such as ethyl tartrate, which show a maximum of specific rotatory power in the yellow or green region of the spectrum.

THE current issue of *Science Progress* contains a second article by Dr. Charles Walker on theories and problems of cancer, and a long article by Dr. F. G. Hopkins on Dr. Pavy and diabetes. Prof. Love contributes an article on tides and the rigidity of the earth, and Mr. J. N. Worthington gives a critical review of the possibilities and limitations of observations of the planet Mars, to be followed in a later article by an account of what these observations have revealed. Chemists will welcome an extremely lucid exposition, by Mr. F. W. Aston, of Sir J. J. Thomson's new method of chemical analysis, which precedes a second article by Mr. D. L. Chapman on conditions of chemical change. Dr. Desch contributes an illustrated article on the structure of metals, Mr. C. T. Gimingham discusses variations in pastures, with special reference to the "fatting" and "non-fatting" pastures of the Romney Marshes, and the "teart" lands of Somersetshire, and Mr. Allan Ferguson gives an historical account of the genesis of logarithms.

THE latest addition to the handy little subject lists issued by the Patent Office, London, W.C., is the subject list of works on horology in the library of the office. The list comprises works on the determination and division of time, dialling, clocks, watches, and other timekeepers.

OUR ASTRONOMICAL COLUMN.

COMET 1912*a* (GALE).—From observations made on September 8, 11, and 15, Dr. Ebell has calculated a set of elements and an ephemeris for comet 1912*a*. The time of perihelion is given as October 4·7088 (Berlin M.T.), and the following is an extract from the ephemeris given in the Kiel Centralstelle Circular, No. 135 :—

Ephemeris 12h. (Berlin M.T.)

	R.A.	Decl. S.		R.A.	Decl. S.
	h. m.	° ′		h. m.	° ′
Sept. 27 ..	15 7·3	11 14·8	Sept. 30	15 16·3	7 19·3
,, 28 ...	15 10·5	9 55·2	Oct. 1 ...	15 19·0	6 3·0
,, 29 ...	15 13·4	8 36·7	,, 2 ...	15 21·6	4 48·0

The calculated magnitude for the whole of this period is 5·0, and as the comet sets at about 7 p.m. it is only possible, in these latitudes, to see it low down in the south-west, immediately after sunset. But as the southern declination is decreasing the conditions will become more favourable; also as the comet nears the sun it may brighten intrinsically. Consequently, at the beginning of October, it may become visible about an hour after sunset at an altitude of about 10° above the south-western horizon.

REPORTED METEORIC FALL IN FRANCE.—According to a message transmitted by Reuter's Agency a large and brilliant meteorite fell at two o'clock on Friday morning (September 20), in the department of the Aube, Central France. The report states that the meteorite exploded with such great violence as to shake the neighbouring houses and to cause the residents to believe that an earthquake was occurring.

THE GALACTIC DISTRIBUTION OF CERTAIN STELLAR TYPES.—In a paper appearing in No. 4600 of the *Astronomische Nachrichten*, Dr. Hertzsprung publishes some interesting results concerning the distribution of certain special types of celestial objects in relation to the galaxy.

The seven types considered are shown in the following table, together with the coordinates of the pole of the plane in which each type principally gathers :—

Type	No. of objects	Coordinates, for 1900, of the pole of the favoured plane			
		Galactic Long.	Lat.	α	δ
Helium stars Oe_5–B_9	1402	179·2	+83·0	182·1	+27·0
Eclipsing variables	150	234·0	+87·3	188·2	+25·8
c and *ac* stars	98	243·9	+88·1	189·1	+26·3
Type V., Oa 0–Oe 0	87	300·0	+88·7	190·7	+26·9
Gaseous nebulæ	130	4·2	+87·6	192·7	+28·1
Type IV., N	228	352·6	+86·2	194·2	+27·4
δ Cephei variables	60	348·9	+84·6	195·9	+26·8

The data providing these results were taken from vol. lvi. of the Harvard Annals, and Pickering's value, $\alpha = 190°$, $\delta = +28°$ (1900), for the position of the galactic pole was used. As will be seen from the results, the type V. stars chiefly lie in a plane nearly coincident with that of the galaxy, while the mean pole for the six other types is practically the same. It should be remarked that the helium stars and those of the fifth type show a tendency to cluster in various galactic longitudes. Thus 72 per cent. of the helium stars lie within 90° of galactic longitude 248°, and 69 per cent. of the fifth type stars lie within 90° of long. 305°, the two positions 248° and 305° being, respectively, the places of greatest density.

RADIO-ACTIVE ELEMENTS IN CELESTIAL BODIES.—Having secured excellent spectrograms of the chromosphere during the Spanish eclipse of 1905, Dr. S. A. Mitchell has compared his (unpublished) wave-lengths with those of Exner and Haschek's radium spectrum, and finds himself unable to confirm Prof. Dyson's suggestion that radium may be present in the chromosphere. As previously noted in these columns, the chromospheric spectrum is probably adequately explained by the presence of other elements. Dr. Mitchell finds no sufficient evidence for the presence of radium emanation and uranium in the chromosphere, and deduces that we must wait for better photographs with greater dispersion than those of Nova Geminorum (2) obtained by Dr. Giebeler before seriously contemplating the presence of these radio-active substances in novæ (*Astronomische Nachrichten*, No. 4600).

THE PHYSICAL CHEMISTRY OF THE LOAF.

THE question of strength in wheaten flour has of late years repeatedly engaged the attention of chemists. Recent researches, more particularly those of Prof. T. B. Wood, have established that strength, or, in other words, the capacity of the flour to give a bold, well-risen loaf, depends in the main on the influence of the electrolytes naturally present on the gluten. The difficulties of the problem have hitherto prevented a more quantitative study of the electrolytes present in flour, but a recent paper from the Carlsberg Laboratory, Copenhagen, by Jessen-Hansen, perhaps marks a first step in this direction. Use is made by him of Sörensen's methods of determining small amounts of acidity, either colorimetrically or by determinations of electrical conductivity, to study the degree of acidity, or, as it is usually termed, the "hydrogen ion concentration" of a number of doughs made in the usual way.

In particular, the effect of the addition of different quantities of acid to the dough was examined, and the acidity compared with the result obtained on baking. The conclusion is drawn that there is a certain optimum concentration of hydrogen ions, in presence of which the best results are obtained on baking; this concentration is rather higher than that of dough prepared from natural flour and distilled water. It differs only slightly according to the quality of the flour, being somewhat higher for the superior grades and rather lower for the lower kinds; it also differs slightly in flour milled from different parts of the berry, being highest for the so-called patents. The optimum concentration corresponds approximately to a hydrogen ion concentration of 10^{-5} normal, pure distilled water being about 10^{-7} normal. It will be obvious that doughs made in this country with the hard alkaline service water must diverge a good deal from this concentration.

Dr. Jessen-Hansen seeks to explain the effect of the various flour improvers which have been brought forward during the last year or so, as due to their increasing the hydrogen ion concentration and not to any subtle working of the improver, as the patentee would sometimes have us believe. Nothing is said, however, to indicate in what way the optimum acidity may be supposed to condition the subtle changes in the gluten which produce a good loaf. It is perhaps significant that the acidity also corresponds to the optimum acidity for protein coagulation.

E. F. A.

AGRICULTURE IN INDIA.[1]

IN his report on the condition of agriculture in India, Mr. Coventry is able to state that the progress recorded in earlier reports has been well maintained, and the beneficent and productive character of the Department's undertakings made much more apparent. Sustained efforts are being made in the cotton tracts to improve the quality and increase the quantity of the staple. In Madras, the improvements have taken two lines—the separation and selection of the best indigenous variety and the introduction of the exotic Cambodia. Similar improvements are also noted in the Central Provinces and Bombay. The well-known work of Mr. and Mrs. Howard on the improvement of Indian wheats is being carried on, and has entered a new phase by the establishment of seed farms where the new varieties can be grown on the large scale for distribution

[1] Report on the Progress of Agriculture in India. (Calcutta, 1912.) Memoirs of the Department of Agriculture in India. (Pusa.) *The Agricultural Journal of India.* (Pusa.)

to the growers. The sugar industry, however, is in a critical condition, the native product failing to compete with sugar from the West, but it is hoped that the industry can be remodelled on scientific lines.

Turning to the memoirs published recently from Pusa, Mr. and Mrs. Howard have succeeded in crossing rust-resistant wheat from northern Europe with some of the native wheats. It was not possible to do this at Pusa, on account of the impossibility of getting the rust-resisting parents to flower in time for crossing to be done and for the resulting grain to ripen before the hot weather set in. The difficulty was overcome by sending the Indian parents to Cambridge for spring sowing, and by carrying out the actual hybridisation work in England. In this way crosses were made between various Indian types and American club and other rust-resistant wheats that promise to be very useful.

In the chemical department Mr. Annett has begun an important study of the date-palm sugar industry, which has hitherto been entirely worked by native methods, involving considerable losses. There can be no doubt of the value of this kind of work; success in putting native industries on a sound foundation would be an achievement of which any department might be proud. The saltpetre industry has already been investigated by Dr. Leather, and we may hope for further good results. Dr. Leather also reports further work on the water requirements of crops.

The Entomological Department has proceeded on its usual lines. Progress has been made with inquiries into the life-histories and habits of injurious insects, amongst the more important being the rhinoceros beetle, the surface and painted grasshoppers, potato bug, lucerne Hvpera, small cabbage caterpillar, termites, &c. Steady progress has been made in the preparation and issue of coloured plates illustrative of insect pests of crops, and these have been distributed to various institutions. Useful work has also been done on sericulture.

The Bacteriological Department is now in full work, and may be expected shortly to turn out useful results; whilst the mycologist, the agriculturist, and the cotton specialist are all able to report good work done.

THE BRITISH ASSOCIATION AT DUNDEE.

SECTION F.

ECONOMIC SCIENCE AND STATISTICS.

FROM THE OPENING ADDRESS BY SIR HENRY H. CUNYNGHAME, K.C.B., PRESIDENT OF THE SECTION.

HAVING endeavoured to the best of my ability to protest against the idea that economics is not a science, but a mere collection of copybook aphorisms that may be used at random like quack medicines, I should like, with your leave, to endeavour to establish its claim to come among the exact sciences by the surest test that can be applied—namely its capability of being demonstrated by means of geometry and mathematics.

Everyone in this room is no doubt acquainted with the machine known as a barograph or registering barometer. It is constructed as follows: A vertical cylinder covered with white paper revolves once in a week. A light arm is hinged on to a series of hollow elastic circular chambers, from which the air has been pumped out. As the pressure of the atmosphere varies, the air chambers dilate and contract, carrying the arm with them. The arm carries a pen which marks with a dot on the paper the height of the barometer at any time. As the paper moves the dot is drawn out into a line, which gives a continuous record of barometric variations. This diagram is a picture of one of the records.

Now, a little consideration will show what a useful diagram we have here. If we were to attempt to give the information contained in it in words we should have to say something like this. On Monday at 0 a.m. the barometer stood at 28·8 in.; during the morning of Monday it rose until about 2 p.m., when it remained stationary for three hours. It again steadily rose in the evening, until at midnight it stood at 29·9 in. (Fig. 1). On Tuesday it still continued to rise until midday, when it again experienced a fall, &c. Or, if the same results were put into arithmetical form, we should have quite a column of figures.

But this diagram shows us the height of the barometer at any time, and all its fluctuations. Its

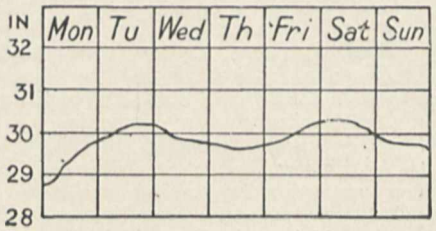

FIG. 1.

life-history for the week and the law of its variations are obvious at a glance, in a way which no words could convey to us. So great are the advantages of this method that barographs are printed in many of the newspapers.

But the use of such curves is not confined to the registration of atmospheric pressure or temperature. They may be used for all purposes. Thus, for example, we might have a curve indicating the variation in successive years of the number of marriages per head of the population.

Line 1 (Fig. 2) shows the proportion of marriages to population from 1870 to 1910. The advantages of this synoptic view are obvious. But they become more obvious still when we add other curves. For instance, line 4 shows the price of wheat in various

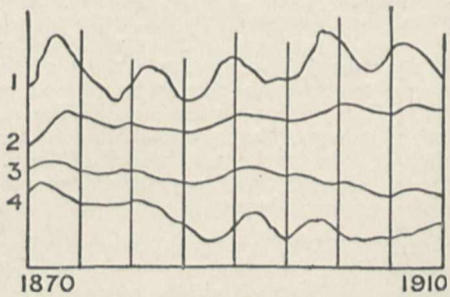

FIG. 2.

years, line 3 the price of coal, line 2 the average of money wages, and line 1 the number of marriages per head of the population. A simple inspection shows that these curves rise and fall sympathetically, and proves beyond doubt that the facts they represent are causally connected.

How eloquently this diagram represents on a space that in a printed book may be three inches square, a series of relations which would take three or four pages to describe even imperfectly in words. And would any description in words enable us to follow the changes like this diagram? The diagram, in fact, plays the part that maps play in geography, and when duly appreciated becomes as valuable as maps of countries.

We may use similar diagrams in the exposition of economic facts. It was, however, reserved for Cournot to show that the use of curves might go further still. Not only might they be used to display statistical facts, but they might also be used to solve problems. I will endeavour to illustrate this very ingenious and interesting development.

It is a well-known fact that in certain departments of industry the cost of making an article increases in proportion to the number produced. The growth of corn is a familiar example of this principle. The principle depends on two facts: (1) that corn can be grown in some places with a less expenditure of capital and labour than in others; and (2) that the quantity of the more favourable land is limited. Whence it follows that growers will first have recourse to the most fertile land; afterwards to that which is

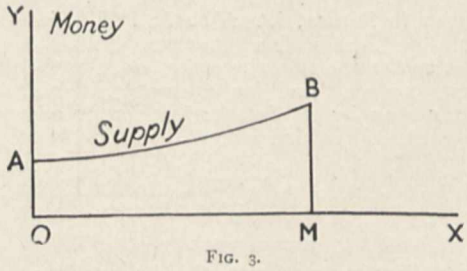

FIG. 3.

less fertile. If we were acquainted exactly with the economics of corn-growing we could represent this state of things in any country at any given time by a curve like a barograph.

Along the line OX (Fig. 3), instead of the progressive days of the week, we should mark off successive quantities of corn, and the vertical height of the curve above any given quality would represent the price per quarter of production of that part which was produced at greatest expense. Thus, the cost of production of the first and most easily grown quarter would be, say 18*s*., and of the next 18*s*. 1*d*., and so on. And it would be evident that the total cost of the whole of the wheat grown would be obtained by adding all these prices together, that is to say, by the area of the curve OMBA; for an area is but the sum

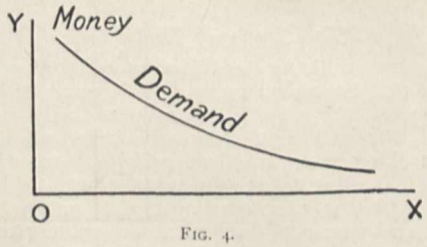

FIG. 4.

of all its constituent parallel lines, just as the total of a bill for goods is an addition of all its items.

Let us now dismiss this corn-growing graph from our minds and turn to another side of the question. Let us consider the various prices which consumers would give for various quantities of corn if they could get these and no more. I do not mean the market prices of the quantities, but what might be called the famine prices, which they would give rather than not have the corn. If we draw a corn-consumers' graph it will obviously be a descending curve, for the more they can get the less they will value successive portions. In fact, if the supply of corn were unlimited the surplus would be used first to feed animals, then to consume as fuel, then as manure, and at last have to be destroyed as a nuisance.

The curve would be of the form shown in Fig. 4.

The contemplation of these curves of corn will no doubt suggest the question whether if we had them we could tell what the market price would be. For it seems obvious that if we know all the conditions, both of demand and supply, we ought to be able to foretell the market price. This is the case and can be easily done. All that is necessary is to superpose the curves, as is done in Fig. 5.

We then see at once that PM must represent the market price of corn per quarter at a given epoch, and OM the quantity produced in a standard time. For if more than OM were grown it could only be sold at a loss; if less the growing of corn would produce an abnormal profit, which would soon cause an expansion, so as to bring the quantity grown and sold up to the maximum that could be profitably produced.

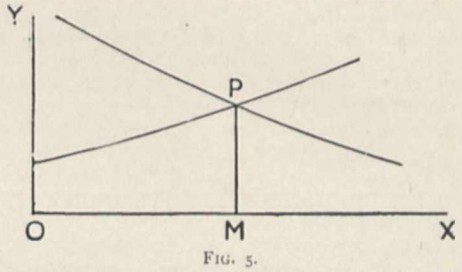

FIG. 5.

These diagrams have therefore done more than present a state of facts; they have solved a problem, just as could be done by a pair of algebraic equations.

Moreover, other illustrations can be derived from Fig. 5. By drawing the series of lines shown in Fig. 6 meanings can be given to various parts of the diagram. The area NPMO represents the total price paid for the corn; the area APMO represents the total cost of growing; the area APN, which is the difference between them, represents the surplus profit obtained from the use of the better lands, or, in other words, rent; the area BPMO represents the total enjoyment the consumer derives from the corn, expressed in terms of money; and since NPMO is the

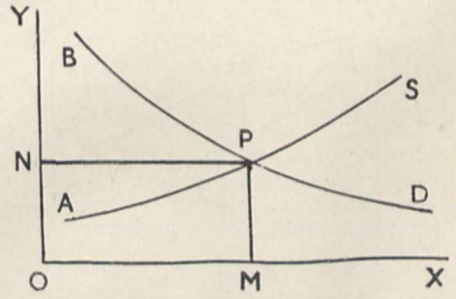

FIG. 6.

price he pays for it, BNP is the surplus enjoyment he gets by obtaining corn for less than he would have given for it had there been a famine.

Let us go a little further. Suppose that a tax were laid on corn, and that all corn grown in a country were subject to an excise duty like that now levied on the manufacture of spirits. Suppose the duty were 5*s*. a quarter, and to simplify the problem suppose no corn came in from the outside. Then the curve APS (Fig. 7) would be pushed upwards all along its length by 5*s*., and assume a position A′P′S′. And notice that the price would rise, not by 5*s*., but by some amount rather less than 5*s*. For M′P′−MP must always be less than the upward movement of the curve APS. Again, the rent would be decreased, for the area

N'P'A' is less than NPA. The amount grown would decrease from OM to OM'. The proceeds of the tax would be OM' times five shillings, and the consumers' surplus of enjoyment would have considerably diminished. This is all obvious enough if you look at the curves. But I want to ask whether, without a curve, you could have got all that so quickly by logical cogitation? I agree it could have been done by hard thought, but what a help the diagram has been in thinking it out. It is like drawing a genealogical tree when you are thinking out some complex problems of family relationship. A simple inspection of the figure also shows that an *ad valorem* tax on rent would not increase price or diminish production.

Again, what is a monopoly? A monopoly is simply

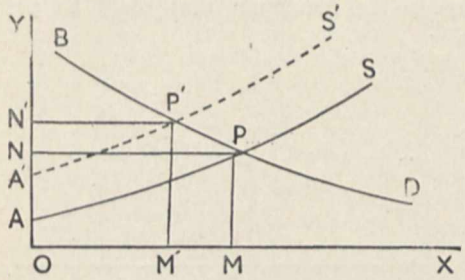

FIG. 7.

a power of stopping production at a point short of that which it would reach under conditions of free production, sale, and distribution. You can stop production by means of statutes regulating quantities produced, or by combinations to limit production, or to limit the supply of labour produced, or by statutes regulating the employment of capital, or by statutes fixing minima of wages, or in various other ways. If you exercise the power, then the state of things shown in Fig. 8 comes into play. The quantity produced is reduced to OM'. The price rises from PM to P'M', the surplus producers' profit (including rent) rises from ANP to AQP'N'. So that profits, interest, and wages increase, but the consumers' surplus enjoyment goes down from NPB to N'P'B. The limitation of output plays a far larger part in the regu-

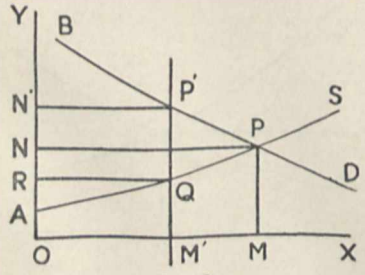

FIG. 8.

lation of prices than is commonly supposed. Those who are engaged in the manipulation of the meat trade, and the bread trade, and the petroleum industry, the supply of machinery or other articles, do not usually advertise the means they have taken to limit supply, nor do trade unions publicly descant upon the means they adopt to limit the labour of adults or apprentices. It is no part of our business here to discuss the necessity or the legitimate limits of such limitations. All that I am here to do is to show how useful diagrams are in explaining their effects.

The monopoly controller seeks, of course, to make the area AQP'N' a maximum, arranging his price just in the way a milliner would do who had to cut the biggest square she could out of a remnant of material. How much reduction of output and increase of price will the market bear? is the question that all monopolists present to themselves.

I could go on with these curves through a great variety of questions. They become especially interesting where applied to show the effects of tariffs upon export and import trade, but I must forbear.

My principal object has not been to introduce to the notice of the audience a subject already known to many of them, but rather to use it as an illustration of the truth that national economics is subject to laws —laws which, though complicated, are as exact and unfailing as the laws of physics, chemistry, or engineering, and which, if neglected by political engineers, will as certainly bring the State to ruin as the miscalculation of a mechanical engineer in designing a boiler, or of a civil engineer in designing a bridge. Whence, then, instead of consigning economics to Saturn, let us study it, not in a metaphysical or Aristotelian manner, using question-begging epithets, or, on the other hand, in the manner of some moderns, as, for example, Ruskin, by replacing reason by sentiment; but let us approach it in the spirit of positive science.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY PROF. G. ELLIOT SMITH, M.A., M.D., CH.M., F.R.S., PRESIDENT OF THE SECTION.[1]

The Evolution of Man.

AT the outset it is fitting that I should express our sense of the loss this section has sustained in the death of Mr. Andrew Lang. Meeting as we do so near to his home at St. Andrews, it was hoped at one time that his versatile scholarship and literary skill would have been available to add lustre to our deliberations. But early last winter we learned with deep regret that the state of his health would not permit him to accept the presidency of the section. In associating ourselves with those who are deploring the loss literature and history have sustained, we realise that our science also is the poorer to-day through the death of one of its most brilliant expositors.

The Scope of Evolution.

In a recent address Lord Morley referred to "evolution" as "the most overworked word in all the language of the day"; nevertheless, he was constrained to admit that, even when discussing such a theme as history and modern politics, "we cannot do without it." But to us in this section, concerned as we are with the problems of man's nature and the gradual emergence of human structure, customs, and institutions, the facts of evolution form the very fabric the threads of which we are endeavouring to disentangle; and in such studies ideas of evolution find more obvious expression than most of us can detect in modern politics. In such circumstances we are peculiarly liable to the risk of "overworking" not only the word evolution, but also the application of the idea of evolution to the material of our investigations.

My predecessor in the office of president of this section last year uttered a protest against the tendency, to which British anthropologists of the present generation seem to be peculiarly prone, to read evolutionary ideas into many events in man's history and the spread of his knowledge and culture in which careful in-

[1] This report represents the address as it was delivered at the meeting; it is a somewhat condensed and rearranged form of that appearing in the Association's Reports.

vestigation can detect no indubitable trace of any such influences having been at work.

I need offer no apology for repeating and emphasising some of the points brought forward in Dr. Rivers's deeply instructive address; for his lucid and convincing account of the circumstances that had compelled him to change his attitude toward the main problems of the history of human society in Melanesia first brought home to me the fact, which I had not clearly realised until then, that in my own experience, working in a very different domain of anthropology on the opposite side of the world, I had passed through phases precisely analogous to those described so graphically by Dr. Rivers. He told us that in his first attempts to trace out "the evolution of custom and institution" he started from the assumption that "where similarities are found in different parts of the world they are due to independent origin and development, which in turn is ascribed to the fundamental similarity of the workings of the human mind all over the world, so that, given similar conditions, similar customs and institutions will come into existence and develop on the same lines." But as he became more familiar with the materials of his research he found that such an attitude would not admit of an adequate explanation of the facts, and he was forced to confess that he "had ignored considerations arising from racial mixture and the blending of cultures."

I recall these statements to your recollection now, not merely for the purpose of emphasising the far-reaching significance of an address which is certain to be looked back upon as one of the most distinctive and influential utterances from this presidential chair, nor yet with the object of telling you how, in the course of my investigations upon the history of the people in the Nile Valley,[2] I also started out to search for evidences of evolution, but gradually came to realise that the facts of racial admixture and the blending of cultures were far more obtrusive and significant. My intention is rather to investigate the domain of anthropology in which unequivocal evolutionary factors have played a definite rôle; I refer to the study of man's genealogy, and the forces that determined the precise line of development his ancestors pursued and ultimately fashioned man himself.

I suppose it is inevitable in these days that one trained in biological ways of thought should approach the problems of anthropology with the idea of independent development as his guiding principle; but the conviction must be reached sooner or later, by everyone who conscientiously, and with an open mind, seeks to answer most of the questions relating to man's history and achievements—certainly the chapters in that history which come within the scope of the last sixty centuries—that evolution yields a surprisingly small contribution to the solution of the difficulties which present themselves. Most of the factors that call for investigation concerning the history of man and his works are unquestionably the direct effects of migrations and the intermingling of races and cultures.

But I would not have you misunderstand my meaning. Nothing could be further from my intention than to question the reality of evolution, as understood by Charles Darwin, and the tremendous influence it is still exerting upon mankind. In respect of certain perils man may, perhaps, have protected himself from "the general operation of that process of natural selection and survival of the fittest which, up to his appearance, had been the law of the living world" (Sir Ray Lankester); but it has been demonstrated quite definitely that man, in virtue of these very heightened powers, which, to some observers, seem to have secured him an immunity from what Sir Ray Lankester calls "nature's inexorable discipline of death," is constantly exposing himself to new conditions that favour the operations of natural selection, as well as other forms of "selection" which his increased powers of intelligent choice and his subjection to the influences of fashion expose him.

It is not, however, with such contentious matters as the precise mode of operation of evolution at the present day that I propose to deal; nor yet with the discussion of when and how the races of mankind became specialised and differentiated the one from the other. It is the much older story of the origin of man himself and the first glimmerings of human characteristics amidst even the remotest of his ancestors to which I invite you to give some consideration to-day.

In a recently published book[3] the statement is made that "the uncertainties as to man's pedigree and antiquity are still great, and it is undeniably difficult to discover the factors in his emergence and ascent." There is undoubtedly the widest divergence of opinion as to the precise pedigree; nevertheless, there seems to me to be ample evidence now available to justify us sketching the genealogy of man and confidently drawing up his pedigree as far back as Eocene times—a matter of a million years or so—with at least as much certainty of detail and completeness as in the case of any other recent mammal; and if all the factors in his emergence are not yet known, there is one unquestionable, tangible factor that we can seize hold of and examine—the steady and uniform development of the brain along a well-defined course throughout the primates right up to man—which must give us the fundamental reason for "man's emergence and ascent," whatever other factors may contribute toward that consummation.

What I propose to attempt is to put into serial order those vertebrates which we have reason to believe are the nearest relatives to man's ancestors now available for examination, and to determine what outstanding changes in the structure of the cerebral hemispheres have taken place at each upward step that may help to explain the gradual acquirement of the distinctively human mental faculties, which, by immeasurably increasing the power of adaptation to varying circumstances and modifying the process of sexual selection, have made man what he is at present.

The links in the chain of our ancestry supplied by palæontology are few, and of doubtful value, if considered apart from the illumination of comparative anatomy.

Psychologists have formulated certain definite phases through which the evolution of intelligence must have passed in the process of gradual building-up of the structure of the mind. The brain in a sense is the incarnation of this mental structure; and it seemed to me that it would be instructive, and perhaps useful, to employ the facts of the evolution of the brain as the cement to unite into one comprehensive story the accumulations of knowledge concerning the essential facts of man's pedigree, and the factors that have contributed to his emergence, which have been gathered by workers in such diverse departments of knowledge as zoology and comparative anatomy, geology and palæontology, and physiology and psychology.

For it was the evolution of the brain and the ability to profit by experience, which such perfecting of the cerebral mechanism made possible, that led to the emergence of mammals, as I attempted to demonstrate in opening the discussion on the origin of mammals at the Portsmouth meeting last year[4]; and from

[2] "The Ancient Egyptians," Harpers, 1911.

[3] J. A. Thomson and P. Geddes, "Evolution," 1912, p. 102.

[4] Discussion on the "Origin of Mammals" at the meetings of Section D (Brit. Assoc. Reports, 1911, p. 424).

the mammalia, by a continuation of this process of building-up the cerebral cortex, or, if you prefer it, the structure of the mind, was eventually formed that living creature which has attained the most extensive powers of profiting by individual experience.

The study of the brain and mind, therefore, should have been the first care of the investigator of human origins. Charles Darwin, with his usual perspicuity, fully realised this; but since his time the rôle of intelligence and its instruments has been almost wholly ignored in these discussions; or when invoked at all wholly irrelevant aspects of the problems have been considered.

There can be no doubt that this neglect of the evidence which the comparative anatomy of the brain supplies is in large measure due to the discredit cast upon this branch of knowledge by the singularly futile pretensions of some of the foremost anatomists who opposed Darwin's views in the discussions which took place at the meetings of the British Association and elsewhere more than forty years ago.

Many of you no doubt are familiar with Charles Kingsley's delightful ridicule of these learned discussions in the pages of "Water Babies." The controversy excited by Sir Richard Owen's contention that the great distinctive feature of the human brain was the possession of a structure that used to be called the hippocampus minor was not unjustly the mark of his scathing satire.

"The professor had even got up at the British Association and declared that apes had hippopotamus majors in their brains, just as men have. Which was a shocking thing to say; for, if it were so, what would become of the faith, hope, and charity of immortal millions? You may think that there are other more important differences between you and an ape, such as being able to speak, and make machines, and know right from wrong, and say your prayers, and other little matters of that kind; but that is only a child's fancy, my dear. Nothing is to be depended upon but the great hippopotamus test. If you have a hippopotamus major in your brain you are no ape, though you had four hands, no feet, and were more apeish than the apes of all aperies. Always remember that the one true, certain, final, and all-important difference between you and an ape is that you have a hippopotamus major in your brain and it has none. If a hippopotamus was discovered in an ape's brain, why, it would not be one, you know, but something else."

The measure of the futility of the contention thus held up to scorn can be more justly realised now; for some years ago I discovered that the feature referred to in Kingsley's burlesque phrase, "hippopotamus major," which Owen claimed to be distinctive of the human brain, and Huxley maintained was present also in apes, is quite a primitive characteristic, and the common property of the mammalia in general.

This illustration of the nature of the discussions which distracted attention from the real problems, although the most notorious one, is unfortunately characteristic of the state of affairs that prevailed when prejudice blinded men's eyes to the obvious facts that were calling so urgently for calm investigation.

Man's Pedigree.

No one who is familiar with the anatomy of man and the apes can refuse to admit that no hypothesis other than that of close kinship affords a reasonable or credible explanation of the extraordinarily exact identity of structure that obtains in most parts of the bodies of man and the gorilla. To deny the validity of this evidence of near kinship is tantamount to a confession of the utter uselessness of the facts of comparative anatomy as indications of genetic relationships, and a reversion to the obscurantism of the dark ages of biology. But if anyone still harbours an honest doubt in the face of this overwhelming testimony from mere structure, the reactions of the blood will confirm the teaching of anatomy; and the susceptibility of the anthropoid apes to the infection of human diseases, from which other apes and mammals in general are immune, should complete and clinch the proof for all who are willing to be convinced.

Nor can anyone who, with an open mind, applies similar tests to the gibbon refuse to admit that it is a true, if very primitive, anthropoid ape, nearly related to the common ancestor of man, the gorilla, and the chimpanzee. Moreover, its structure reveals indubitable evidence of its derivation from some primitive Old World or catarrhine monkey akin to the ancestor of the langur, the sacred monkey of India. It is equally certain that the catarrhine apes were derived from some primitive platyrrhine ape, the other, less modified, descendants of which we recognise in the South American monkeys of the present day; and that the common ancestor of all these primates was a lemuroid nearly akin to the curious litle spectral tarsier, which still haunts the forests of Borneo, Java, and the neighbouring islands, and awakens in the minds of the peoples of those lands a superstitious dread—a sort of instinctive horror at the sight of the ghost-like representative of their first primate ancestor.

This much of man's pedigree will, I think, be admitted by the great majority of zoologists who are familiar with the facts; but I believe we can push the line of ancestry still further back, beyond the most primitive primate into Haeckel's suborder Menotyphla, which most zoologists regard as constituting two families of insectivora. I need not stop to give the evidence for this opinion, for most of the data and arguments in support of it have recently been summarised most excellently by Dr. W. K. Gregory.[5]

This group includes the Oriental tree-shrews and the African jumping-shrews. The latter (Macroscelididæ), living in the original South African home of the mammalia, present extraordinarily primitive features linking them by close bonds of affinity to the marsupials. The tree-shrews (Tupaiidæ), however, which range from India to Java, while presenting very definite evidence of kinship to their humble African cousins, also display in the structure of their bodies positive evidence of relationship to the stem of the aristocratic primate phylum.

Quite apart from the striking similarities produced by identical habits and habitats, there are many structural identities in the tree-shrews and lemuroids, not directly associated with such habits, which can be interpreted only as evidences of affinity.

The Neopallium and its Relation to the Ability of Learning by Experience.

Having now sketched the broad lines of man's pedigree right back to the most primitive mammals, let us next consider what were the outstanding factors that determined the course of his ancestors' progressive evolution.

The class mammalia, to which man belongs, is distinguished in structure from all other vertebrates mainly by the size and high development of the brain, and, as regards the behaviour of its members, by the fact that they are able, in immeasurably greater degree than all other animals, not excluding even birds, to profit by individual experience. The behaviour of most, or perhaps it would be more correct to say all, animals, however complex and nicely adapted to their

[5] "The Orders of Mammals," Bull. Amer. Mus. Nat. Hist., vol. xxvii., 1910, p. 321.

circumstances it may seem, is essentially instinctive; and the main problem we have to solve, in attempting to explain the emergence of the distinctive attributes of the creature which in greater measure than any other has succeeded in subordinating its instincts to reason, is the means by which it has become possible for the effects of individual experience to be brought to bear upon conduct.

The ability to learn by experience necessarily implies the development, somewhere in the brain, of a something which can act not only as a receptive organ for impressions of the senses and a means for securing that their influence will find expression in modifying behaviour, but also serve in a sense as a recording apparatus for storing such impressions, so that they may be revived in memory at some future time in association with other impressions received simultaneously, the state of consciousness they evoked, and the response they called forth.

Such an organ of associative memory is actually found in the brain of mammals. It is the cortical area to which eleven years ago I applied the term "neopallium."[6] Into it pathways lead from all the sense organs; and each of its territories, which receives a definite kind of impression, visual, acoustic, tactile, or any other, is linked by the most intimate bonds with all the others. In spite of the disapproval of the psychologists, we can indeed regard this neopallium as fulfilling all the conditions of the *sensorium commune*, which Aristotle and many generations of philosophers have sought for twenty centuries; for it is unquestionably a "unitary organ the physical processes of which might be regarded as corresponding to the unity of consciousness" (Wm. MacDougall).

Nothing that happens in this area in the course of its enormous expansion and differentiation in the higher mammals materially affects this fundamental purpose of the neopallium, which continues to remain a unifying organ that acts as a whole, though each part is favourably placed to receive and transmit to the rest its special quota to the sum-total of what we may call the materials of conscious life.

The consciousness which resides, so to speak, in this neopallium, and is fed by the continual stream of sensory impressions pouring into it and awakening memories of past sensations, can express itself directly in the behaviour of the animal through the intermediation of a part of the neopallium itself, the so-called motor area, which is not only kept in intimate relation with the muscles, tendons, and skin by sensory impressions, but controls the voluntary responses of the muscles of the opposite side of the body.

The Differentiation of Mammals and the Effects of Specialisation.

The possession of this higher type of brain enormously widened the scope for the conscious and intelligent adaptation of the animal to varying surroundings; and in the exercise of this newly acquired ability to learn from individual experience, and so appreciate the possibilities of fresh sources of food supply and new modes of life, the way was opened for an infinite series of adaptations to varying environments, entailing structural modifications in which the enhanced plasticity of the new type of animal found expression.

Nature tried innumerable experiments with the new type of brain almost as soon as the humble Therapsid-like mammal felt the impetus of its new-found power of adaptation. In turn, the Prototherian and Metatherian types of brain were tried before the more adaptable scheme of the Eutherian brain was evolved.

[6] "The Natural Subdivision of the Cerebral Hemisphere," *Journ. Anat. and Phys.*, vol. xxxv., 1901, p. 431; Arris and Gale Lectures on the Evolution of the Brain, *Lancet*, January 15, 1910, p. 153.

The new breed of intelligent creatures rapidly spread from their South African home throughout the whole world, and exploited every mode of livelihood. The power of adaptation to the particular kind of life each group chose to pursue soon came to be expressed in a bewildering variety of specialisations in structure, some for living on the earth or burrowing in it, others for living in trees or even for flight; others, again, for an aquatic existence. Some mammals became fleet of foot, and developed limbs specially adapted to enhance their powers of rapid movement. They attained an early pre-eminence, and were able to grow to large dimensions in the slow-moving world at the dawn of the age of mammals. Others developed limbs specially adapted for swift attack and habits of stealth, successfully to prey upon their defenceless relatives.

Most of these groups attained the immediate success that often follows upon early specialisation; but they also paid the inevitable penalty. They became definitely committed to one particular kind of life; and in so doing they had sacrificed their primitive simplicity and plasticity of structure, and in great measure their adaptability to new conditions. The retention of primitive characters, which so many writers upon biological subjects, and especially upon anthropology, assume to be a sign of degradation, is not really an indication of lowliness. We should rather look upon high specialisation of limbs and the narrowing of the manner of living to one particular groove as confessions of weakness, the renunciation of the wider life for one that is sharply circumscribed.

The stock from which man eventually emerged played a very humble rôle for long ages after many other mammalian orders had waxed great and strong. But the race is not always to the swift, and the lowly group of mammals which took advantage of its insignificance to develop its powers evenly and very gradually, without sacrificing in narrow specialisation any of its possibilities of future achievement, eventually gave birth to the dominant and most intelligent of all living creatures.

The tree-shrews are small squirrel-like animals which feed on "insects and fruit, which they usually seek in trees, but also occasionally on the ground. When feeding they often sit on their haunches, holding the food, after the manner of squirrels, in their forepaws."[7] They are of "lively disposition and great agility."[8] These vivacious, large-brained little insectivores, linked by manifold bonds of relationship to some of the lowliest and most primitive mammals, present in the structure of their skull, teeth, and limbs undoubted evidence of a kinship, remote though none the less sure, with their compatriots the Malaysian lemurs; and it is singularly fortunate for us in this inquiry that side by side there should have been preserved from the remote Eocene times, and possibly earlier still, these insectivores, which had almost become primates, and a little primitive lemuroid, the spectral tarsier, which had only just assumed the characters of the primate stock, when nature fixed their types and preserved them throughout the ages, with relatively slight change, for us to study at the present day.

Thus we are able to investigate the influence of an arboreal mode of life in stimulating the progressive development of a primitive mammal, and to appreciate precisely what changes were necessary to convert the lively, agile Ptilocercus-like ancestor of the primates into a real primate.

In the forerunners of the mammalia the cerebral hemisphere was predominantly olfactory in function; and even when the true mammal emerged, and all the

[7] Flower and Lydekker, "Mammals, Living and Extinct," 1891 . 618

[8] W. K. Gregory, *op. cit.*, p. 269, and pp. 279, 280.

other senses received due representation in the neopallium, the animal's behaviour was still influenced to a much greater extent by smell impressions than by those of the other senses.

This was due not only to the fact that the sense of smell had already installed its instruments in, and taken firm possession of, the cerebral hemisphere long before the advent in this dominant part of the brain of any adequate representation of the other senses, but also, and chiefly, because to a small land-grubbing animal the guidance of smell impressions, whether in the search for food or as a means of recognition of friends or enemies, was much more serviceable than all the other senses. Thus the small creature's mental life was lived essentially in an atmosphere of odours, and every object in the outside world was judged primarily and predominantly by its smell; the senses of touch, vision, and hearing were merely auxiliary to the compelling influence of smell.

Once such a creature left the solid earth and took to an arboreal life all this was changed, for away from the ground the guidance of the olfactory sense lost much of its usefulness. Life amidst the branches of trees limits the usefulness of olfactory organs, but it is favourable to the high development of vision, touch, and hearing. Moreover, it demands an agility and quickness of movement that necessitates an efficient motor cortex to control and co-ordinate such actions as an arboreal mode of life demands (and secures, by the survival only of those so fitted), and also a well-developed muscular sensibility to enable such acts to be carried out with precision and quickness. In the struggle for existence, therefore, all arboreal mammals, such as the tree-shrews, suffer a marked diminution of their olfactory apparatus, and develop a considerable neopallium, in which relatively large areas are given up to visual, tactile, acoustic, kinæsthetic, and motor functions, as well as to the purpose of providing a mechanism for mutually blending in consciousness the effects of the impressions pouring in through the avenues of these senses.

Thus a more equable balance of the representation of the senses is brought about in the large brain of the arboreal animal; and its mode of life encourages and makes indispensable the acquisition of agility. Moreover, these modifications do not interfere with the primitive characters of limb and body. These small arboreal creatures were thus free to develop their brains and maintain all the plasticity of a generalised structure, which eventually enabled them to go far in the process of adaptation to almost any circumstances that presented themselves.

Amongst the members of this group, as in all the other mammalian phyla, the potency of the forces of natural selection was immensely enhanced by the fact that the inquisitiveness of an animal which can learn by experience, *i.e.*, is endowed with intelligence, was leading these plastic insectivores into all kinds of situations which were favourable for the operation of selection. Various members of the group became specialised in different ways. Of such specialised strains the one of chief interest to us is that in which the sense of vision became especially sharpened.

The Origin of Primates.

Towards the close of the Cretaceous period some small arboreal shrew-like creature took another step in advance, which was fraught with the most far-reaching consequences; for it marked the birth of the primates and the definite branching off from the other mammals of the line of man's ancestry.

A noteworthy further reduction in the size of the olfactory parts of the brain, such as is seen in that of Tarsius,[9] quite emancipated the creature from the dominating influence of olfactory impressions, the sway of which was already shaken, but not quite overcome, when its tupaioid ancestor took to an arboreal life. This change was associated with an enormous development of the visual cortex in the neopallium, which not only increased in extent so as far to exceed that of Tupaia, but also became more highly specialised in structure. Thus, in the primitive primate, vision entirely usurped the controlling place once occupied by smell; but the significance of this change is not to be measured merely as the substitution of one sense for another. The visual area of cortex, unlike the olfactory, is part of the neopallium, and when its importance thus became enhanced the whole of the neopallium felt the influence of the changed conditions. The sense of touch also shared in the effects, for tactile impressions and the related kinæsthetic sensibility, the importance of which to an agile tree-living animal is obvious, assist vision in the conscious appreciation of the nature and the various properties of the things seen, and in learning to perform agile actions which are guided by vision.

An arboreal life also added to the importance of the sense of hearing; and the cortical representation of this sense exhibits a noteworthy increase in the primates, the significance of which it would be difficult to exaggerate in the later stages, when the simian are giving place to the distinctively human characteristics.

The high specialisation of the sense of sight awakened in the creature the curiosity to examine the objects around it with closer minuteness, and supplied guidance to the hands in executing more precise and more skilled movements than the tree-shrew attempts. Such habits not only tended to develop the motor cortex itself, trained the tactile and kinæsthetic senses, and linked up their cortical areas in bonds of more intimate associations with the visual cortex, but they stimulated the process of specialisation within or alongside the motor cortex of a mechanism for regulating the action of that cortex itself—an organ of attention which co-ordinated the activities of the whole neopallium so as the more efficiently to regulate the various centres controlling the muscles of the whole body. In this way not only is the guidance of all the senses secured, but the way is opened for all the muscles of the body to act harmoniously so as to permit the concentration of their action for the performance at one moment of some delicate and finely adjusted movement.

In some such way as this there was evolved from the motor area itself, in the form of an outgrowth placed at first immediately in front of it, a formation, which attains much larger dimensions and a more pronounced specialisation of structure in the primates than in any other order; it is the germ of that great prefrontal area of the human brain which is said to be "concerned with attention and the general orderly co-ordination of psychic processes,"[10] and as such is, in far greater measure than any other part of the brain, deserving of being regarded as the seat of the higher mental faculties and the crowning glory and distinction of the human fabric.

[By means of lantern slides representing Dr. Scharff's convincing elucidation of the modifications of the land connections during Tertiary times, a demonstration was given of the wanderings of the primates, which the facts of palæontology and comparative anatomy demand; the object being to direct attention to the fact

[9] "On the Morphology of the Brain in the Mammalia, with Special Reference to that of the Lemurs, Recent and Extinct," Trans. Linn. Soc. Lond., second series; *Zoology*, vol. viii., Part 1, February, 1903.

[10] J. S. Bolton "The Functions of the Frontal Lobes," *Brain*, 1903.

that at each stage in the migrations of man's ancestors, menotyphlous, prosimian, platyrrhine, catarrhine and anthropoid, the unprogressive members remained somewhere in the neighbourhood of the home of their immediate ancestors, and that those which wandered into new surroundings had to struggle for their footing, and as the result of this striving attained a higher rank.

Other slides were shown to demonstrate the fact that in this series of primates there was a steady development of the brain—expansion and differentiation of the visual, tactile and auditory centres, and development of the meeting territory between them; a marked growth and specialisation of the motor centres, and the power of skilled movements, especially of the hands and fingers; and a regular expansion of the prefrontal area—along the lines marked out once for all when the first primate was formed from some menotyphlous progenitor.]

Thus the outstanding feature in the gradual evolution of the primate brain is a steady growth and differentiation of precisely those cortical areas which took on an enhanced importance in the earliest primates.

So far in this address I have been delving into the extremely remote, rather than the nearer, ancestry of man, because I believe the germs of his intellectual preeminence were sown at the very dawn of the Tertiary period, when the first anaptomorphid began to rely upon vision rather than smell as its guiding sense. In all the succeeding ages since that remote time the fuller cultivation of the means of profiting by experience, which the tarsioid had adopted, led to the steady upward progression of the primates. From time to time many individuals, finding themselves amidst surroundings which were thoroughly congenial and called for no effort, lagged behind; and in Tarsius and the lemurs, the New World monkeys, the Old World monkeys, and the anthropoids, not to mention the extinct forms, we find preserved a series of these laggards which have turned aside from the highway which led to man's estate.

The primates at first were a small and humble folk, who led a quite unobtrusive and safe life in the branches of trees, taking small part in the fierce competition for size and supremacy that was being waged upon the earth beneath them by their carnivorous, ungulate, and other brethren. But all the time they were cultivating that equable development of all their senses and limbs, and that special development of the more intellectually useful faculties of the mind which, in the long run, were to make them the progenitors of the dominant mammal—the mammal which was to obtain the supremacy over all others, while still retaining much of the primitive structure of limb that his competitors had sacrificed. It is important, then, to keep in mind that the retention of primitive characters is often to be looked upon as a token that their possessor has not been compelled to turn aside from the straight path and adopt protective specialisations, but has been able to preserve some of his primitiveness and the plasticity associated with it, precisely because he has not succumbed or fallen away in the struggle for supremacy. It is the wider triumph of the individual who specialises late, after benefiting by the many-sided experience of early life, over him who in youth becomes tied to one narrow calling.

In many respects man retains more of the primitive characteristics, for example, in his hands, than his nearest simian relatives; and in the supreme race of mankind many traits, such as abundance of hair, persist to suggest pithecoid affinities, which have been lost by the more specialised negro and other races. Those anthropologists who use the retention of primitive features in the Nordic European as an argument to exalt the negro to equality with him are neglecting the clear teaching of comparative anatomy, that the persistence of primitive traits is often a sign of strength rather than of weakness. This factor runs through the history of the whole animal kingdom.[11] Man is the ultimate product of that line of ancestry which was never compelled to turn aside and adopt protective specialisation either of structure or mode of life, which would be fatal to its plasticity and power of further development.

Having now examined the nature of the factors that have made a primate from an insectivore and have transformed a tarsioid prosimian into an ape, let us turn next to consider how man himself was fashioned.

The Origin of Man.

It is the last stage in the evolution of man that has always excited chief interest and has been the subject of much speculation, as the addresses of my predecessors in this presidency bear ample witness.

These discussions usually resolve themselves into the consideration of such questions as whether it was the growth of the brain, the acquisition of the power of speech, or the assumption of the erect attitude that came first and made the ape into a human being. The case for the erect attitude was ably put before the Association in the address delivered to this section by Dr. Munro in 1893. He argued that the liberation of the hands and the cultivation of their skill lay at the root of man's mental supremacy.

If the erect attitude is to explain all, why did not the gibbon become a man in Miocene times? The whole of my argument has aimed at demonstrating that the steady growth and specialisation of the brain has been the fundamental factor in leading man's ancestors step by step right upward from the lowly insectivore status, nay, further, through every earlier phase in the evolution of mammals—for man's brain represents the consummation of precisely those factors which throughout the vertebrata have brought their possessors to the crest of the wave of progress. But such advances as the assumption of the erect attitude are brought about simply because the brain has made skilled movements of the hands possible and of definite use in the struggle for existence: yet once such a stage has been attained the very act of liberating the hands for the performance of more delicate movements opens the way for a further advance in brain development to make the most of the more favourable conditions and the greater potentialities of the hands.

It is a fact beyond dispute that the divergent specialisation of the human limbs, one pair for progression, and the other for prehension and the more delicately adjusted skilled action, has played a large part in preparing the way for the emergence of the distinctively human characteristics; but it would be a fatal mistake unduly to magnify the influence of these developments. The most primitive living primate, the spectral tarsier, frequently assumes the erect attitude, and uses its hands for prehension rather than progression in many of its acts, and many other lemurs, such as the Indrisinæ of Madagascar, can and do walk erect.

In the remote Oligocene, a catarrhine ape, nearly akin to the ancestors of the Indian sacred monkey, Semnopithecus, became definitely specialised in structure in adaptation for the assumption of the erect attitude; and this type of early anthropoid has persisted with relatively slight modifications in the gibbon of the present day. But if the earliest gibbons were already able to walk upright, how is it, one might ask, that they did not begin to use their hands, thus freed from the work of progression on the earth, for skilled work, and at once before men? The

[11] "The Brain in the Edentata," Trans. Linn. Soc., 1899.

obvious reason is that the brain had not yet attained a sufficiently high stage of development to provide a sufficient amount of useful skilled work, apart from the tree-climbing, for these competent hands to do.

The ape is tied down absolutely to his experience, and has only a very limited ability to anticipate the results even of relatively simple actions, because so large a proportion of his neopallium is under the dominating influence of the senses.

Without a fuller appreciation of the consequences of its actions than the gibbon is capable of, the animal is not competent to make the fullest use of the skill it undoubtedly possesses. What is implied in acquiring this fuller appreciation of the meaning of events taking place around the animal? The state of consciousness awakened by a simple sensory stimulation is not merely an appreciation of the physical properties of the object that supplies the stimulus: the object simply serves to bring to consciousness the results of experience of similar or contrasted stimulations in the past, as well as the feelings aroused by or associated with them, and the acts such feelings excited. This mental enrichment of a mere sensation so that it acquires a very precise and complex meaning is possible only because the individual has this extensive experience to fall back upon; and the faculty of acquiring such experience implies the possession of large neopallial areas for recording, so to speak, these sensation-factors and the feelings associated with them. The "meaning" which each creature can attach to a sensory impression presumably depends, not on its experience only, but more especially upon the neopallial provision in its brain for recording the fruits of such experience.

Judged by this standard, the human brain bears ample witness, in the expansion of the great temporo-parietal area, which so obviously has been evolved from the regions into which visual, auditory, and tactile impulses are poured, to the perfection of the physical counterpart of the enrichment of mental structure, which is the fundamental characteristic of the human mind.

The second factor that came into operation in the evolution of the human brain is merely the culmination of a process which has been steadily advancing throughout the primates: I refer to the high state of perfection of the cortical regulation of skilled movements, many of which are acquired by each individual in response to a compelling instinct that forces every normal human being to work out his own salvation by perpetually striving to acquire such manual dexterity.

This brings us to the consideration of the nature of the factors that have led to the wide differentiation of man from the gorilla. Why is it that these two primates, structurally so similar and derived simultaneously from common parents, should have become separated by such an enormous chasm, so far as their mental abilities are concerned?

There can be no doubt that this process of differentiation is of the same nature as those which led one branch of the Eocene tarsioids to become monkeys while the other remained prosimiæ; advanced one group of primitive monkeys to the catarrhine status, while the rest remained platyrrhine: and converted one division of the Old World apes into anthropoids, while the others retained their old status. Put into this form as an obvious truism, the conclusion is suggested that the changes which have taken place in the brain to convert an ape into man are of the same nature as, and may be looked upon merely as a continuation of, those processes of evolution which we have been examining in the lowlier members of the primate series. It was not the adoption of the erect attitude or the invention of articulate language that made man from an ape, but the gradual perfecting of the brain and the slow upbuilding of the mental structure, of which erectness of carriage and speech are some of the incidental manifestations.

The ability to perform skilled movements is conducive to a marked enrichment of the mind's structure and the high development of the neopallium, which is the material expression of that enrichment. There are several reasons why this should be so. The mere process of learning to execute any act of skill necessarily involves the cultivation, not only of the muscles which produce the movement, and the cortical area which excites the actions of these muscles, but in even greater measure the sensory mechanisms in the neopallium which are receiving impressions from the skin, the muscles, and the eyes, to control the movements at the moment, and incidentally are educating these cortical areas, stimulating their growth, and enriching the mental structure with new elements of experience. Out of the experience gained in constantly performing acts of skill, the knowledge of cause and effect is eventually acquired. Thus the high specialisation of the motor area, which made complicated actions possible, and the great expansion of the temporo-parietal area, which enabled the ape-man to realise the "meaning" of events occurring around it, reacted one upon the other, so that the creature came to understand that a particular act would entail certain consequences. In other words, it gradually acquired the faculty of shaping its conduct in anticipation of results.

Long ages ago, possibly in the Miocene, the ancestors common to man, the gorilla, and the chimpanzee became separated into groups, and the different conditions to which they became exposed after they parted company were in the main responsible for the contrasts in their fate. In one group the distinctively primate process of growth and specialisation of the brain, which had been going on in their ancestors for many thousands, even millions, of years, reached a stage when the more venturesome members of the group, stimulated perhaps by some local failure of the customary food, or maybe led forth by a curiosity bred of their growing realisation of the possibilities of the unknown world beyond the trees which hitherto had been their home, were impelled to issue forth from their forests, and seek new sources of food and new surroundings on hill and plain, wherever they could obtain the sustenance they needed. The other group, perhaps because they happened to be more favourably situated or attuned to their surroundings, living in a land of plenty which encouraged indolence in habit and stagnation of effort and growth, were free from this glorious unrest, and remained apes, continuing to lead very much the same kind of life (as gorillas and chimpanzees) as their ancestors had been living since the Miocene or even earlier times. That both of these unenterprising relatives of man happen to live in the forests of tropical Africa has always seemed to me to be a strong argument in favour of Darwin's view that Africa was the original home of the first creatures definitely committed to the human career; for while man was evolved amidst the strife with adverse conditions, the ancestors of the gorilla and chimpanzee gave up the struggle for mental supremacy simply because they were satisfied with their circumstances; and it is more likely than not that they did not change their habitat.

The erect attitude, infinitely more ancient than man himself, is not the real cause of man's emergence from the simian stage; but it is one of the factors

made use of by the expanding brain as a prop still further to extend its growing dominion, and by fixing and establishing in a more decided way this erectness it liberated the hand to become the chief instrument of man's further progress.

In learning to execute movements of a degree of delicacy and precision to which no ape could ever attain, and the primitive ape-man could only attempt once his arm was completely emancipated from the necessity of being an instrument of progression, that cortical area which seemed to serve for the phenomena of attention became enhanced in importance. Hence the prefrontal region, where the activities of the cortex as a whole are, as it were, focussed and regulated, began to grow until eventually it became the most distinctive characteristic of the human brain, gradually filling out the front of the cranium and producing the distinctively human forehead. In the diminutive prefrontal area of Pithecanthropus,[12] and to a less marked degree, Neanderthal man,[13] we see illustrations of lower human types, bearing the impress of their lowly state in receding foreheads and great brow ridges. However large the brain may be in *Homo primigenius*, his small prefrontal region, if we accept Boule and Anthony's statements, is sufficient evidence of his lowly state of intelligence and reason for his failure in the competition with the rest of mankind.

The growth in intelligence and in the powers of discrimination no doubt led to a definite cultivation of the æsthetic sense, which, operating through sexual selection, brought about a gradual refinement of the features, added grace to the general build of the body, and demolished the greater part of its hairy covering. It also led to an intensification of the sexual distinctions, especially by developing in the female localised deposits of fatty tissue, not found in the apes, which produced profound alterations in the general form of the body.

Right-handedness.

To one who considers what precisely it means to fix the attention and attempt the performance of some delicately adjusted and precise action it must be evident that one hand only can be usefully employed in executing the consciously skilled part in any given movement. The other hand, like the rest of the muscles of the whole body, can be only auxiliary to it, assisting, under the influence of attention, either passively or actively, in steadying the body or helping the dominant hand. Moreover, it is clear that if one hand is constantly employed for doing the more skilled work, it will learn to perform it more precisely and more successfully than either would if both were trained, in spite of what ambidextral enthusiasts may say. Hence it happened that when nature was fashioning man the forces of natural selection made one hand more apt to perform skilled movements than the other. Why precisely it was the right hand that was chosen in the majority of mankind we do not know, though scores of anatomists and others are ready with explanations. But probably some slight mechanical advantage in the circumstances of the limb, or perhaps even some factor affecting the motor area of the left side of the brain that controls its movements, may have inclined the balance in favour of the right arm; and the forces of heredity have continued to perpetuate a tendency long ago imprinted in man's structure when first he became human.

The fact that a certain proportion of mankind is left-handed, and that such a tendency is transmitted to some only of the descendants of a left-handed person, might perhaps suggest that one half of mankind was originally left-handed and the other right-handed, and that the former condition was recessive in the Mendelian sense, or that some infinitesimal advantage may have accrued to the right-handed part of the original community, which in time of stress spared them in preference to left-handed individuals; but the whole problem of why right-handedness should be much more common than left-handedness is still quite obscure. The superiority of one hand is as old as mankind, and is one of the factors incidental to the evolution of man.

It is easily comprehensible why one hand should become more expert than the other, as I have attempted to show; and the fact remains that it is the right hand, controlled by the left cerebral hemisphere, which is specially favoured in this respect. This heightened educability of the (left) motor centre (for the right hand) has an important influence upon the adjoining areas of the left motor cortex. When the ape-man attained a sufficient degree of intelligence to wish to communicate with his fellows other than by mere instinctive emotional cries and grimaces, such as all social groups of animals employ, the more cunning right hand would naturally play an important part in such gestures and signs; and, although the muscles of both sides of the face would be called into action in such movements of the features as were intended to convey information to another (and not merely to express the personal feelings of the individual), such bilateral movements would certainly be controlled by the left side of the brain, because it was already more highly educated.

The Origin of Speech.

[This argument was elaborated to explain the origin of speech. The increasing ability to perform actions demanding skill and delicacy received a great impetus when the hands were liberated for the exclusive cultivation of such skill: this perfection of cerebral control over muscular actions made it possible for the ape-man to learn to imitate the sounds around him, for the act of learning is a training not only of the motor centres and the muscles concerned, but also of the attention, and the benefits that accrued from educating the hands added to the power of controlling other muscles, such as those concerned with articulate speech.

The usefulness of such power of imitating sounds could be fully realised in primitive man, not only because he had developed the parts of the brain which made the acquisition of such skill possible, but also because he had acquired, in virtue of the development of other cortical areas, the ability to realise the significance and learn the meaning of the sounds heard.]

I do not propose to discuss the tremendous impetus that the invention of speech must have given to human progress and intellectual development, in enabling the knowledge acquired by each individual to become the property of the community and be handed on to future generations, as well as by supplying in words the very symbols and the indispensable elements of the higher mental processes.

We are apt to forget the immensity of the heritage that has come down to us from former generations of man, until we begin dimly to realise that for the vast majority of mankind almost the sum-total of their mental activities consists of imitation or acquiring and using the common stock of beliefs. For this accumulation of knowledge and its transmission to our generation we are almost wholly indebted to the use of speech. In our forgetfulness of these facts

[12] Eug. Dubois, "Remarks upon the Brain-cast of Pithecanthropus," Proc. Fourth Internat. Cong. Zool., August, 1898, published Camb., 1899, p. 81.

[13] Boule and Anthony, "L'encéphale de l'homme fossile de la Chapelle-aux-Saints," *L'Anthropologie*, tome xxii., No. 2, 1911, p. 50.

we marvel at the apparent dulness of early man in being content to use the most roughly chipped flints for many thousands of years before he learned to polish them, and eventually to employ materials better suited for the manufacture of implements and weapons. But when we consider how slowly and laboriously primitive man acquired new ideas, and how such ideas—even those which seem childishly simple and obvious to us—were treasured as priceless possessions and handed on from tribe to tribe, it becomes increasingly difficult to believe in the possibility of the independent evolution of similar customs and inventions of any degree of complexity.

The hypothesis of the "fundamental similarity of the working of the human mind" is no more potent to explain the identity of customs in widely different parts of the world, the distribution of megalithic monuments, or the first appearance of metals in America, than it is to destroy our belief that one man, and one only, originally conceived the idea of the mechanical use to which steam could be applied, or that the electric battery was not independently evolved in each of the countries where it is now in use.

In these discursive remarks I have attempted to deal with old problems in the light of newly acquired evidence; to emphasise the undoubted fact that the evolution of the primates and the emergence of the distinctively human type of intelligence are to be explained primarily by a steady growth and specialisation of certain parts of the brain; that such a development could have occurred only in the mammalia, because they are the only plastic class of animals with a true organ of intelligence; that an arboreal mode of life started man's ancestors on the way to pre-eminence, for it gave them the agility, and the specialisation of the higher parts of the brain incidental to such a life gave them the seeing eye, and in course of time also the understanding ear; and that all the rest followed in the train of this high development of vision working on a brain which controlled ever-increasingly agile limbs.

If, in pursuing these objects, I may have seemed to wander far from the beaten paths of anthropology, as it is usually understood in this section, and perhaps encroached upon the domains of the Zoological Section, my aim has been to demonstrate that the solution of these problems of human origins, which have frequently engaged the attention of the Anthropological Section, is not to be sought merely in comparisons of man and the anthropoid apes. Man has emerged not by the sudden intrusion of some new element into the ape's physical structure or the fabric of his mind, but by the culmination of those processes which have been operating in the same way in a long line of ancestors ever since the beginning of the Tertiary period.

If I have made this general conception clear to you, however clumsily I have marshalled the evidence and with whatever crudities of psychological statement it may be marred, I shall feel that this address has served some useful purpose.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Among the honorary degrees to be conferred by the University of Leeds on October 3, in connection with the visit of the Iron and Steel Institute, are:—LL.D. on the president of the institute, Mr. Arthur Cooper, and degrees of D.Sc. on Sir Robert Hadfield, past-president, Mr. J. E. Stead, and M. Adolph Greiner, vice-presidents, and the president of the Society of German Ironmasters.

Among the public lectures to be delivered in connection with the opening of the new session at University College, London, we notice the following:—*Faculty of Arts.*—October 3, amulets, Prof. Flinders Petrie; October 4, the philosophy of Shadworth Hodgson, Prof. G. Dawes Hicks; October 5, general phonetics, D. Jones; October 9, introduction to comparative psychology, Carveth Read. *Faculty of Science.*—October 4, Joseph Dalton Hooker, Prof. F. W. Oliver. *Faculty of Engineering.*—October 9, the sources of energy available to man, Prof. J. A. Fleming.

In connection with the Faculty of Engineering of the East London College, one of the constituent colleges of the University of London, a special course of lectures on the management of public electric supply undertakings has been arranged. The lectures will be given by Mr. A. Hugh Seabrook, and will commence on Monday evening, October 14. It is hoped by this means to arouse the interest of electrical engineers and others in the practical working of modern electrical undertakings. The principal of the college will be pleased to provide particulars of the fees for these lectures, and also of other special courses in connection with the engineering faculty of the college.

It is unusual to find astronomy and meteorology among the subjects of courses of lectures arranged by a local education committee. We are glad to see that the Manchester Education Committee is an exception to the rule, and that such lectures are being given at the Municipal School of Technology. Mr. W. C. Jenkins is delivering a course of twenty-six lectures on descriptive astronomy in the Godlee Observatory, of which he is curator, dealing with the descriptive and popular aspect of astronomy; a course of twelve lectures on elementary meteorology, supplementary to those on descriptive astronomy, demonstrations to be given at the Meteorological Station, established in the garden adjacent to the Municipal Secondary School; and a course of twenty-six lectures on astronomical observations and the use of the Nautical Almanack for students familiar with the elements of astronomy.

The Newcastle Section, the Society of Chemical Industry, and the Armstrong College are this winter arranging courses of evening lectures on special chapters in applied chemistry, which, it is anticipated, will prove specially interesting to those chemists and engineers already engaged in the industries. To inaugurate the scheme a special fund is being raised, which has already received liberal support from the principal manufacturers in the district. Two courses of five lectures each have been arranged for this winter, for which the committee has secured the services of well-known specialists. The first course is one on coal-gas manufacture and the carbonisation of coal, by Dr. Harold G. Colman, of London, and the second on metallography, by Dr. Desch, of Glasgow University. The first course will commence on October 16, and continue at fortnightly intervals; the second course is to commence on January 28, 1913.

The East Ham Technical College begins its seventh session this month. Being situated in a district largely devoted to chemical industries, it endeavours to provide instruction suitable to the locality. The chemical department, which has been reconstructed during the vacation, comprises two lecture rooms, an inorganic laboratory, with bench accommodation for sixty-four students, an organic laboratory of similar dimensions, specially arranged for technological work, two smaller organic laboratories, and a research laboratory. A metallurgical subdepartment has been recently

equipped. Practical and theoretical courses in pure chemistry extend over five years, and a college certificate is granted; there are also complete courses in gas engineering, gas supply and distribution, coal-tar distillation, chemical engineering, soap manufacture, painters' oils, colours and varnishes, oils, fats and waxes, metallurgy, and sugar manufacture, all of which are largely attended by students who are engaged either in the laboratories or on the plant in the respective industries.

MORE accommodation has for some time been urgently needed in the departments of bacteriology and public health of King's College (University of London). This has now been provided, with the sanction and approval of the University, by the removal of these departments with their staffs to 62 Chandos Street, Strand, W.C. (Charing Cross Medical School Buildings), where an excellent suite of laboratories is at present vacant owing to the transference of the Charing Cross Medical School's preliminary and intermediate medical studies to King's College. The laboratories at Chandos Street are being altered and refitted, and the accommodation there provided will comprise a large class laboratory, research laboratory, professors' laboratory, and lecturer's laboratory for each department, bacteriology and public health respectively; a photomicrographic laboratory, preparation and animal rooms; a large theatre, office, and library for the joint use of the two departments. There will be the regular courses of instruction in bacteriology, clinical pathology, and photomicrography, and for the diploma of public health. Research and investigation work for public bodies and others will also be carried on as before. The new laboratories will be opened on or about October 1. The laboratories vacated at King's College by this removal will be utilised for increasing the accommodation for the preliminary and intermediate medical studies.

THE volume of announcements of the Northampton Polytechnic Institute, London, E.C., for the session 1912–13 shows that the equipment of the institute has been steadily extended since last year, but there is no large item like a new generating station to report on this occasion. In the mechanical engineering department the equipment for experimental work in aëronautics has been considerably augmented and a new steam power plant has been laid down, which will enable students to experiment on the efficiency of steam plant from the coal and water to the brake of the engine with measuring appliances at every stage. In the evening classes in the electrical engineering department the heavy electrical engineering work now so well known is being continued. An important departure has been made in radio-telegraphy by the extension of the single course previously given to additional courses. The courses and classes in telegraphy and telephony have been remodelled to suit the changed conditions in the public services. In the mechanical engineering department the courses in aëronautical engineering have been further developed, especially on the experimental side. The new equipment referred to above will form a prominent feature of the laboratory instruction. The extensive work of this department in automobile and other branches of engineering is being continued. In technical optics and in technical chemistry the courses have been brought quite up-to-date, but there is no development that calls for special remark. The half-time trade courses in technical chemistry and in horology inaugurated last session are being further developed. In these classes the students, all of whom are engaged in commercial workshops, are in attendance from 9 a.m. to 1 p.m., and spend the afternoons in their employers' workshops. The experiment appears to meet the needs of the particular trades mentioned, and if it continues to be as successful as in the past year it will probably be extended to other trades.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 16.—M. A. Grandidier in the chair.—H. **Deslandres:** The relations of the prominences with the filaments and *alignements* of the upper layers of the solar atmosphere. Further details on the character of the *alignements* and the filaments (long dark flocculi, absorption markings of Hale and Evershed). The *alignements* are subdivided into two classes, those with dark and with bright lines. The properties of the latter are consistent with the assumption of a circulation current of the upper atmosphere.—A. **Lacroix:** The mineralogical constitution of the volcanoes of the Island of Reunion. The essential characteristic of the mineralogy of Reunion is the production in the same volcano, and at the expense of the same magma, of well-characterised types of sub-alkaline and alkaline rocks. These have hitherto been regarded as necessarily of independent origin.—Fred **Vlès:** Remarks on the form of the sun and moon.—Paul **Gaubert:** The influence of the velocity of attack of calcite by acids on the form of the corrosion figures of this mineral. An account of experiments with calcite and dolomite when attacked with dilute solutions of hydrochloric, acetic, formic and nitric acids.—Walter T. **Swingle:** The slow artificial ripening of the Deglet-nour date. The Algerian date was introduced into the United States (Arizona and California) in 1900, but the fruit did not ripen properly on the tree. It has been proved that the dates may be ripened in twenty-four hours by incubation at a temperature of 43° to 49° C. It has now been found that in presence of moisture the fruit can be slowly ripened at the ordinary temperature.—M. **Foëx** and P. **Berthault:** A disease of maize in Cochin China. The disease, the effects of which are described in detail, is due to a fungus of the genus Dothiorella.—E. C. **Teodoresco:** The influence of temperature on nuclease. Nuclease from the plants studied only completely lost its diastatic properties after having been heated to about 90° C. The maximum diastatic action is at about 34° C.—Alphonse **Berget:** An arrangement of apparatus designed for the relative measurement of the acceleration of gravity.—De Montessus de **Ballore:** Earthquakes and sunspots.

CAPE TOWN.

Royal Society of South Africa, August 21.—Dr. J. K. E. Halm in the chair.—A. G. **Howard:** The blizzard of June 9–12, 1902. In continuation of the paper by Mr. Stewart, read in November, 1904, before the South African Association for the Advancement of Science, the writer of the present paper brings to notice a series of synoptic charts of the weather conditions from June 8 to 13, 1902, inclusive.—J. **Hewitt** and J. H. **Power:** A list of South African Lacertilia, Ophidia, and Batrachia in the McGregor Museum, Kimberley, with field notes on various species. The paper is offered primarily as a contribution to our knowledge of the fauna of the Kimberley district. The present-day fauna of that neighbourhood is shown to be composite, a new element having been introduced along with timber from Bechuanaland. The faunistic lists

are accompanied with field notes, and in the case of some of the Batrachia the authors have been able to give a short account of the larval metamorphosis.—Dr. **Dreyer**: The salivary and mouth glands of the Nudibranchiata.—W. T. **Saxton**: The leaf-spots of *Richardia albo-maculata*, Hook. The author describes the structure and development of the white streaks characteristic of the leaves of two species of Richardia, and discusses their origin.—Dr. R. **Marloth**: Some new or little known South African succulents.

BOOKS RECEIVED.

Parallel Paths: a Study in Biology, Ethics, and Art. By T. W. Rolleston. Pp. xv+299. (London: Duckworth and Co.) 2*s*. 6*d*. net.

Compendio Elemental de Zoologia. By A. Gallardo. Pp. 360. (Buenos Aires: Angel Estrada y Cia.)

Handbook of Fungus Diseases of the Potato in Australia and their Treatment. By D. McAlpine. Pp. iii+215+1 map. (Melbourne: J. Kemp.)

Gravitation. By F. Harris. Pp. xi+107. (London: Longmans and Co.) 2*s*. 6*d*. net.

Proceedings of the Aristotelian Society. New Series. Vol. xii. Pp. 345. (London: Williams and Norgate.) 10*s*. 6*d*. net.

Butterflies and Moths at Home and Abroad. By H. Rowland-Brown. Pp. 271+21 plates. (London: T. F. Unwin.) 7*s*. 6*d*. net.

China. Ergebnisse eigener Reisen und darauf gegründeter Studien. By F. v. Richthofen. Dritter Band, Das südliche China. Edited by E. Tiessen. Pp. xxxi+817+5 plates. Fünfter Band, enthaltend die abschliessende palæontologische Bearbeitung der Sammlungen F. von Richthofens, die Untersuchung weiterer Fossiler Reste aus den von ihm bereisten Provinzen sowie den Entwurf einer erdgeschichtlichen Uebersicht China's. By Dr. F. Frech. Pp. xii+289+31 plates.

Atlas von China. Orographische und geologische Karten von F. von Richthofen, zu des Verfassers Werk—China: Ergebnisse eigener Reisen und darauf gegründeter Studien. Zweite Abtheilung. Das südliche China (zum dritten Textband gehörig). By Dr. M. Groll. Pp. 12+plates 27–54. (Berlin: D. Reimer.) Band III. and V., 32 marks; Atlas, 52 marks.

Modern Research in Organic Chemistry. By F. G. Pope. Pp. xii+324. (London: Methuen and Co., Ltd.) 7*s*. 6*d*.

A Second Year Course of Organic Chemistry for Technical Institutes. By F. B. Thole. Pp. vii+186. (London: Methuen and Co., Ltd.) 2*s*. 6*d*.

Chrysanthemums. By T. Stevenson, with chapters by C. H. Payne and C. E. Shea. Pp. xiii+112+8 coloured plates. (London and Edinburgh: T. C. and E. C. Jack.) 1*s*. 6*d*. net.

Heredity and Eugenics. By W. E. Castle, J. M. Coulter, and others. Pp. vii+315. (Chicago: The University of Chicago Press; Cambridge University Press.) 10*s*. net.

Papers and Proceedings, Sixth Annual Meeting, American Sociological Society, held at Washington, D.C. December 27–30, 1911. Vol. vi. Pp. v+101. (Chicago, Ill.: The University of Chicago Press; Cambridge University Press.) 6*s*. net.

Theories of Solutions. By S. Arrhenius. Pp. xx+247. (New Haven: Yale University Press; London: H. Frowde.) 12*s*. 6*d*. net.

The Elementary Geography. By F. D. Herbertson. Vol. v., pp. vi+152+4 maps. Vol. vi., pp. vi+186+4 maps. (London: H. Frowde.) 1*s*. 6*d*. and 1*s*. 9*d*.

Transactions of the American Institute of Chemical Engineers. Vol. iv., 1911. Pp. iv+514. (New York: D. van Nostrand Co.; London: E. and F. N. Spon, Ltd.) 30*s*. net.

Practical Geometry and Graphics. By E. L. Bates and F. Charlesworth. Pp. viii+621. (London: B. T. Batsford.) 4*s*. net.

Practical Mathematics. By E. L. Bates and F. Charlesworth. Pp. viii+513. (London: B. T. Batsford.) 3*s*. net.

Wild Life in the West Highlands. By C. H. Alston. Pp. x+271. (Glasgow: J. MacLehose and Sons.) 6*s*. net.

Scientific Method: its Philosophy and its Practice. By F. W. Westaway. Pp. xix+439. (London: Blackie and Son, Ltd.) 6*s*.

South African Geology. By Prof. E. H. L. Schwarz. Pp. vi+200. (London: Blackie and Son, Ltd.) 3*s*. 6*d*. net.

Anales de Psicologia. Volumen ii. By A. Florentino and others. Pp. 360. (Buenos Aires: *La Semana Médica*. Imp. de Obras de e. Spinelli.)

The Concrete Institute. Transactions and Notes. Vol. iv. Part ii. (London: The Concrete Institute.)

Photography of To-day. By H. Chapman Jones. Pp. 342. (London: Seeley, Service and Co., Ltd.) 5*s*. net.

The Humble-bee: its Life-history and How to Domesticate it. With Descriptions of all the British Species of Bombus and Psithynus. By F. W. L. Sladen. Pp. xiii+283. (London: Macmillan and Co., Ltd.) 10*s*. net.

La Tecnica delle Correnti Alternate. By Prof. G. Sartori. Volume Primo. Seconda edizione ampliata. Pp. xiv+558. (Milano: U. Hoepli.)

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