THURSDAY, JUNE 30, 1910.

A TREATISE ON ANTS.

Ants: their Structure, Development, and Behaviour. By Prof. W. M. Wheeler. Pp. xxv+663. (New York: Columbia University Press; London: Macmillan and Co., Ltd., 1910.) Price 21s. net.

FROM the classic work of Huber to that of Forel our knowledge of ant life made comparatively little progress. Forel's remarkable researches, however, gave it a great impetus, and since then the students of this most fascinating department of natural history have been numerous and their discoveries most interesting.

Prof. Wheeler, who shows a most generous desire to do justice to other observers, and has himself contributed much to our knowledge, gives a bibliography which occupies no fewer than seventy pages of his work.

The most comprehensive contributions, he says,

"have been made by Forel and Emery, but important work has been done by Adlerz, Ernest André, Bates, Belt, Bethe, Brauns, von Buttel-Reepen, Ebrard, Escherich, Goeldi, Heer, J. Huber, von Ihering, Janet, Karawaiew, Lameere, Lespès, Lubbock, Mayr, Moggridge, Reichenbach, Reuter, Rothney, Santschi, and Sykes."

Yet for many years there has been no comprehensive treatise on the subject. Prof Wheeler, who promises us also a systematic monograph which will no doubt be most useful, has endeavoured, as he tells us,

"to appeal to several classes of readers—to the general reader, who is always more or less interested in ants; to the zoologist, who cannot afford to ignore their polymorphism or their symbiotic and parasitic relationships; to the entomologist, who should study the ants if only for the purpose of modifying his views on the limits of genera and species; and to the comparative psychologist, who is sure to find in them the most intricate instincts and the closest approach to intelligence among invertebrate animals."

Chapter i. the author devotes to "Ants as Dominant Insects," discussing their interest for man, the probable causes of their dominance, the comparison of human and ant societies, the analogy between the ant colony and the cellular organism, the economic importance of ants, and their great interest as objects of biological study.

He then proceeds to their external structure—the segmentation of the body; the integument; the head, thorax, and abdomen. In the third chapter he deals with their internal structure—the alimentary tract; the glandular system; the reproductive organs and poison apparatus; the circulatory system and fat body; the respiratory, and, lastly, the muscular, system.

The fourth chapter is also devoted to the internal structure, and especially that of the nervous system and sense organs. In chapter v. he takes up their development—the care of the young; the egg, larva, pupa, and perfect insect; their length of life, and resistance to noxious influences. Chapter vi. deals with polymorphism, its extent and character; the phylogenetic origin and development; Weissmann's, Spencer's, and Emery's theories; the three aspects of the problem—physiological, ethological, and psychological; and the explanation of the development of the worker.

The same subject is continued in chapter vi., and especially the origin of the worker; the relation of instinct to polymorphism; the differentiation in function as the precursor of differentiation in structure.

Chapter viii. deals with the history of myrmecology and the classification of ants; ix. with their distribution; x. with fossil ants; xi. with habits; xii. and xiii. describe the various forms and structure of nests, their characteristics, the method of construction, &c.; xiv. deals with the Ponerine ants, which the author regards as unmistakably primitive, and the ancestors of the higher and more developed groups; xv. is devoted to the driver and legionary ants; xvi. to the harvesting ants; xvii. to the relations between ants and vascular plants; xviii. to the fungus-growing ants; xix. to the relations of ants to aphides, scale insects, tree hoppers, and caterpillars; xx. to honey ants; xxi. and xxii. to ant guests and parasites, especially beetles, flies, hymenoptera, diptera, mites, and nematodes.

Interesting as these chapters are, the next are even more so. They deal with the extraordinary relations existing between ants of different species; compound nests and mixed colonies; ant parasites; slave-making ants; degeneration as the result of dependence on others—a lesson, as he justly points out, to our statesmen and electors.

In chapter xxviii. the author comes to the sensations of ants, different types of behaviour, the senses as a basis for study, touch, smell and taste, hearing and vision.

The ocelli, which occur in the earliest known fossil insects, are supposed to give an indistinct visual image of very near objects, but, as he says, this view is not yet clearly established.

In chapters xxix. and xxx., Prof. Wheeler discusses the question of instinct, and concludes with five appendices, on (*a*) methods of collecting, mounting, and studying ants; (*b*) key to the subfamilies, genera, and subgenera of the North American Formicidæ, for the identification of the workers; (*c*) a list of described North American ants; (*d*) methods of exterminating noxious ants; (*e*) literature.

Any one of these chapters would afford ample materials for review, but this would involve too great a claim on the space at my disposal.

I will only say a few words on the concluding chapters, in which Prof. Wheeler deals with the instincts of ants (chapter xxix.) and their plastic behaviour (chapter xxx.).

He accepts the old scholastic distinction between "memory" and "recollection," one being used

"in the sense of having ideas of absent objects, rather than in the sense of behaving differently to present objects because of past experience with them. The dog shows clearly that he remembers his master in the latter sense by displaying joy at the sight of him. Can we be sure that he has remembered him in the former sense during his absence; that is, that he has had a memory image of him?"

For my part, I cannot doubt this.

Prof. Wheeler attempts to explain away the evidence on which good naturalists—Leuckart, Romanes, and others—have relied, and in several cases it seems to me that he does so satisfactorily. I do not myself regard the supposed case of ants dropping intentionally from ceilings on to food as definitely proved, but when Prof. Wheeler explains, or attempts to explain, it away by suggesting that "it may be a much more frequent method among ants of clearing vertical distances than has been supposed," one cannot but ask how it originated, and how it became so frequent.

The evidence, indeed, is contradictory, and difficult to reconcile. This applies not merely to the facts recorded by different observers. I have myself met with cases apparently showing intelligence, and others which seemed to imply the very reverse. Might not, however, the same be said in the case of man himself?

In conclusion, I may say that the illustrations are numerous—nearly 300—well chosen, and most of them good. Prof. Wheeler is much to be congratulated on having produced an excellent work, for which naturalists will, I am sure, be grateful.

AVEBURY.

PRACTICAL METHODS FOR THE BIO-CHEMICAL LABORATORY.

Handbuch der biochemischen Arbeitsmethoden. By Prof. Emil Abderhalden. I., Erster Band, allgemeiner Teil, erste Hälfte. Pp. iv+512. Price 18 marks. II., Zweiter Band, spezieller Teil, erste Hälfte. Pp. iv+496. Price 18 marks. (Berlin and Vienna: Urban and Schwarzenburg, 1909.)

THESE two volumes form the first consignment of a comprehensive handbook of practical methods for the biochemical laboratory, which is being written by no fewer than sixty-four contributors under the guidance of Prof. Emil Abderhalden.

The second halves of each of the present volumes are promised shortly, and the third volume within the year. When it is remembered that the editor is also engaged upon research work in the laboratory, as well as his many contributors, and is, moreover, editing an equally colossal work now appearing, one can but wonder at the rapidity of German cooking of literature of this sort.

It is a pity that the articles are not published separately, as monographs for those specially interested in the individual subjects, for this would save purchasers buying a great deal of matter which they, in most cases, do not want in order to possess a much smaller part of value to them.

As it stands the work has no general interest, and while it may be serviceable in parts as a reference laboratory book, it will scarcely prove attractive or profitable for the private purchaser.

One wonders, in looking over the table of contents of the present and contemplated volumes, why the pretence is made that it is issued in three volumes, since by the simple device of making two halves of each of these divisions it comes to be in six volumes. It might equally well have been issued in one volume of six parts, each part forming a good sized volume; or in two volumes each of three parts; or in six volumes each of one part; or there might have been another and even better alternative.

The work can only be intended for the assistance of the research worker in a biochemical laboratory, and, looking at the matter from his point of view, it is surprising that the editor has allowed the first of the present volumes to appear in his work. All that is novel or interesting to the researcher in biochemistry of the five hundred pages it contains might readily, and with great gain in interest and utility, be compressed into fifty pages. As it stands it looks like nothing more than a glorified collection of catalogues of dealers in laboratory supplies; with the names of the dealers and prices of the commodities left out, much to its disadvantage. Scores of pages are sacrificed to drawings, photographs, and descriptions of apparatus with which we all have been familiar from our youth onwards in our everyday laboratory work. The first article in the volume dealing with this kind of thing occupies 282 pages; the new matter in it could easily be put into thirty pages. If the prices and makers' names were given, it might be of some service in the laboratory; as it is, to order any of the newer apparatus which suited any particular purpose, one would have to refer from the present work to the original paper by the inventor of the apparatus, where possibly the information might be obtained.

In striking contrast with this article of 282 pages is the one succeeding it, of less than seven pages, on the ultra-microscope, written by Fr. N. Schulz, of Jena. Knowing the valuable work of this author in the particular field in question, one expected something good here; but there is nothing new. It might almost be a reprint, as are the illustrations in it, of one of the advertisements of Carl Zeiss advertising the instruments.

There follow on this all too short article a number of lengthy ones on ultimate organic analysis, ash determinations, &c. Nearly all this matter has been written many times before, is contained in all practical works on organic chemistry, and is familiar to any but the merest tyro in biochemical work. For example, illustrations with descriptions of the combustion furnace and the combustion tube and its filling are given; eighteen pages are used up in descriptions of the Kjeldahl method for determining nitrogen, and illustrations are given of most of the modifications which perverted human ingenuity and waste of genius have given rise to for carrying out that somewhat simple method of analysis. Fourteen pages in a special article go to a description of specific-gravity methods—why not instead refer the reader to an elementary work on physics?

The second of the two volumes before us will be of more service to the biological chemist whose path is touched by the articles contained therein; these articles deal with the preparation, separation, and qualitative and quantitative estimation of the important lower and higher alcohols, the carbohydrates, the fats and waxes, the phosphatides, the vegetable proteins, and the animal proteins. The volume concludes in the middle of an article by the editor on the disintegration products of the proteins, characterised by much work of a patient and laborious type. The reader is deserted in the middle of a sentence, with "möglichst" for his last word, but it may be confessed that one can wait for the next issue of the fascinating narrative with more patience than one was able to command in earlier days of reading serial literature.

The articles in this part are of unequal value and exhaustiveness; that on the phosphatides is much too short; very valuable are the three articles, on sugars by B. Tollens, that on glycogen by K. Grube, and especially that on the proteins of the vegetable world by T. B. Osborne, which is a model of what an article on practical methods for the laboratory ought to be.

Such articles as these make the work essential in a biochemical laboratory, but it is a pity that they cannot be purchased as monographs in the particular subjects. BENJAMIN MOORE.

THE LIGHT FROM THE SKY.

Meteorologische Optik. By Prof. J. M. Pernter. Section IV. Pp. i–xvii, 559–799. By Felix M. Exner. (Vienna and Leipzig: W. Braumüller, 1910.)

THIS volume is the fourth part of the late Prof. Pernter's work on meteorological optics, a notice of the earlier parts of which appeared in NATURE on April 18, 1907. It was undertaken in March, 1908, by Dr. Exner at Pernter's request, at a time when the latter's condition of health not only made it impossible that he should complete the work himself, but prevented him from giving any material assistance or advice in its preparation. The scope of the section was clearly indicated in the original plan of the work, and as regards the method of presentation Exner has successfully followed that of the preceding sections; but he had no notes to assist him, and the volume must therefore be regarded as Exner's work, except in so far as he has utilised, in some portions, Pernter's previously published papers.

In pursuance of the general scheme outlined in the previous notice above referred to, this fourth section is devoted to the discussion of those phenomena which are due to the action of the minute particles of all kinds which are always present in the atmosphere, among which must be included the gaseous molecules themselves. Thus the first two chapters deal with the colour and polarisation of sky-light, the third treats of the loss of light in passing through the atmosphere and the general brightness of daylight, while in the fourth chapter is given a brief account of what are called the phenomena of twilight, the optical effects associated with sunrise and sunset.

Of all the many interesting problems the discussion of which falls under the head of meteorological optics, that of the colour of the sky, with the associated questions as to the polarisation of sky-light, its intensity and composition, and the effects of atmospheric absorption, is perhaps the most fascinating. Less striking only because not exceptional, in the sense in which this adjective applies to the appearances dealt with in the earlier sections, even for the unscientific observer the everyday recurrence of the phenomena fails to diminish their appeal to his artistic sense and imagination. For the physicist, the satisfactory explanation of all the main features, apart from the quantitative uncertainty in the details which is an almost inevitable consequence of the complexity of the conditions, must be ranked among the triumphs of science, and constitutes one of the most beautiful applications of the wave theory of light.

The view has long correctly been held that the colour of the sky is due to the presence in the atmosphere of suspended particles, and the explanation was rendered more certain by the experiments of Brücke in 1853 and of Tyndall in 1868 on the colour and polarisation of the diffused light from artificially "clouded" media. The first exact account as to the manner in which the particles produced the effects observed was, however, given by Lord Rayleigh in 1871, in his paper on the light from the sky, its polarisation and colour. It was there shown that the presence in the atmosphere of particles of dimensions small compared with the wave-length of light would give rise to secondary radiations of intensity inversely proportional to the fourth power of the wave-length, and completely polarised in the plane at right angles to the direction of the primary radiation from the sun. In this secondary, diffused radiation, the short waves would therefore greatly preponderate, and the colour seen would be blue or violet, while the long waves would be the more readily transmitted, and the primary radiation seen through such an atmosphere would tend to be orange or red. At the same time, Rayleigh disposed of Clausius's theory that the phenomena were due to the presence in the atmosphere of small—but not small relatively to the wave-length—hollow spherical vesicles reflecting and refracting according to the ordinary laws for extended media. In a much later paper Rayleigh has given good reason for inferring that at least one-third of the scattered light is diffracted from the molecules of the air themselves (see also NATURE, March 10, 1910, p. 49).

One of the merits of Exner's discussion of the subject is the care with which he has followed out the application of Rayleigh's theory in the light of the best recorded observations. These relate to colour, polarisation, extinction coefficients, the general brightness and the distribution of brightness of the sky, &c.; indeed, the whole volume may almost be regarded as an excursus on the Rayleigh theory. In dealing with the more detailed phenomena of Arago's "positive" and "negative" polarisation, and the neutral points of Arago, Babinet, and Brewster, the author follows Soret in attempting a general explanation in which account is taken of the further action of other particles on the light already once diffracted, and of the form of the limited portion of the atmosphere from which the light reaching any individual eye can be received; but the conditions are too complicated to admit of quantitative treatment for exact comparison with observation.

The optical appearances connected with sunrise and sunset are somewhat briefly treated, reference being especially made to Kiessling's monograph "Untersuchungen über Dämmerungserscheinungen" for a more complete description of the phenomena. Some account of the observed effects due to the Krakatoa eruption and other similar disturbances is included.

Dr. Exner has followed Prof. Pernter in the careful reproduction of the best recorded and historically interesting observations of the phenomena. He has himself emphasised the impossibility of reproducing the charm of Pernter's work, dependent as it was on the latter's extensive knowledge of the literature of the subject as well as on his critical judgment. This volume will, however, be welcomed both as a fitting completion of the task undertaken by Prof. Pernter and as a valuable survey of the progress which has been made in the interpretation of the phenomena with which it deals.

THE PHILOSOPHY OF MATHEMATICS.

Methodologisches und Philosophisches zur Elementar-Mathematik. By Dr. G. Mannoury. Pp. viii+279. (Haarlem: P. Visser Azn., 1909.) Price 8*s.* 10*d.*

THIS work is the outcome of lectures delivered by the author at the University of Amsterdam, and retains in different ways the marks of its origin. Its frequent digressions, its general discursiveness, and its rather sketchy character make it difficult to describe; and many of the topics are so controversial that where one reader will agree with the author, another, equally competent, will entirely dissent. Still, it is an honest and interesting attempt to deal, from the philosophical side, with the fundamental difficulties of mathematics, and as such deserves attention.

The first part contains five chapters dealing respectively with unity and plurality, finite and infinite numbers, the elementary laws of arithmetic applied to whole numbers, the extension of the idea of number, and, finally, the definition of irrationals. The second part is devoted to geometry, and its four chapters discuss respectively mathematical logic; elementary constructions, postulates, and theory of measurement; non-Euclidean geometries; and the notion of space from the standpoint of physiology and psychology.

A few examples must suffice to illustrate the merits and the defects of the author's procedure. Take the question of defining a unit. After pointing out, rightly enough, that there is no such thing as an objective unit directly perceived, he gives as a formal definition (p. 31):—"Units are sensation-complexes (Empfindungs-Komplexe), and a plurality (Vielheit) consists of mutually related units." Now, if there is one thing that recent mathematics has done, it is surely to clarify and make precise the notion of a unit apart from all elements of sensation. Verbal definition of a unit is a small matter, of course; the thing to be desired is the complete notion. As a matter of fact, everybody does acquire the notion more or less exactly, long before thinking about defining it; and as to the definition, a kindergarten teacher will succeed where a philosopher will fail. "These are toys; each toy is a unit among the toys"; "You are my class; each of you is a unit of the class"; such examples will convey the meaning of the term "unit" better than any formal definition. At the same time, if we must have a metaphysical example of a unit, the ego seems to be the best, for it cannot be denied, or affirmed to be a plurality, without an intrinsic contradiction in terms. If Jones makes a statement or forms an opinion, however erroneous, it is *his*, and this "he" is an irreducible entity which has a preeminent claim to be called a unit. It may be remarked that Dr. Mannoury expressly objects to this line of argument, apparently on the ground that the idea of the ego is a derivative one; this may be admitted in a sense, as a fact in the development of an individual consciousness, but it does not make the ego derivative, any more than the deciphering of hieroglyphics in recent times affects the date at which they were carved. Is not this one of those cases where psychology is appealed to where it is really irrelevant, the question being one concerning metaphysical data? We must have something *a priori* and undefined in any science; the question is, how few and how fundamental (or elementary) may we assume these data to be?

A more striking example of the same sort of thing is to be found on p. 263, where the author speaks of "the four-dimensional space-time-notion which is to be regarded as an image of the whole group of sensations." It is almost impossible to give any sense to this phraseology, consistent with either popular or mathematical usage. If it merely means that in abstract kinematics in three-dimensional space there are four independent variables (x, y, z, t), it is a very unsatisfactory way of stating a simple fact; and it is very doubtful whether kinematics is, properly, an image of sensations, any more than our sensation of the colour of homogeneous light is imaged by its wave-length.

In treating of the elementary laws of arithmetic, the author, in the text, mainly follows those who appeal to the principle of analogy or "permanence"; he does not give a detailed discussion of the elementary operations. The definition of irrationals is Dedekind's, which is wrongly attributed to Dirichlet; there is a brief account of Peano's system of shorthand, and a section on mathematical induction, with quotations from Poincaré, Couturat, and others. Dr. Mannoury is evidently dissatisfied with Poincaré's arguments, but here, as in other cases, he does not bring forward any very definite statements of his own.

In the geometrical section there are several features of interest, and this is the most readable part of the book. A fair account is given of the different types of three-dimensional geometry, of Hilbert's non-Desarguian system, and of metrical geometry based on a movable standard assumed to be rigid. But there is no discussion of a system of definitions, and the only element treated in any detail is the straight line. With regard to the different types of geometry, the author adopts the sensible attitude that it is now, and always will be, impossible to fix on one as the "actual" geometry of space, and he would probably assent to Poincaré's dictum that the science of mathematics is neither true nor false.

There is one remarkable statement made which deserves mention. Dr. Mannoury says that in December, 1818, F. K. Schweikart sent to Gauss a note asserting the existence of a geometry in which the sum of the angles of a triangle is less than two right angles, and in which the altitude of an isosceles triangle with a finite base has a finite upper limit. This goes far to demolish the claim made for Gauss that he was the first to assert the possibility of a consistent system of geometry distinct from that of Euclid. G. B. M.

THE PROTOZOA: AN IMPRESSIONIST SKETCH.

Protozoölogy. By Prof. Gary N. Galkins. Pp. 349. (New York and Philadelphia: Lea and Febiger; (London: Baillière, Tindall and Cox, 1909.) Price 15*s.* net.

TO attempt to condense our present knowledge of the Protozoa into some three hundred pages is—to anyone acquainted with the subject—to attempt the impossible. This book, however,

"does not aim at being an exhaustive treatise on the Protozoa; it aims, rather, to give an introduction to the study of modern protozoology as seen from the author's point of view."

It would therefore be unfair to draw comparisons with Doflein's recent masterpiece on the subject which appeared almost simultaneously.

As we differ fundamentally from the author in many matters of interpretation—both as regards general principles and detailed facts—we can here consider only a few points which a perusal of the work has suggested.

With regard to the tentative classification of the Protozoa which is adopted, we can only say that it is, perhaps, as good as any which has so far been advocated. With our present knowledge, it is not possible, we believe, to arrive at a satisfactory classification of the whole group. At present there must be many tadpoles among our fish. It may be noted, however, that the author does not accept Hartmann's group "Binucleata"—for trypanosomes and their allies and Hæmosporidia—and in this we heartily agree with him. It may be noted, further, that the Spirochæts are classified (with some reservation) among the Mastigophora; the Mycetozoa are ranked under the Rhizopoda; the Opalinidæ are placed among the holotrichous Ciliata; and the Mastigamœbæ are placed, in the order Monadida, with the Mastigophora. Though these groupings are usual, they are none the less, we believe, unjustifiable in the light of recent work.

In dealing with the trypanosomes, the author adheres to Schaudinn's much-debated work, because he finds

"the schematic figures and categorical descriptions of Schaudinn's original contribution are still the most convincing of all such attempts to describe the nuclear changes."

The life-cycle of Paramecium is described as a "typical" one. With this we cannot agree, because we consider the Ciliophora to be very different from all other organisms. Moreover, we regret to find no allusion to the recent important work of Enriques and others in this connection.

A remarkable account of autogamy in *Amoeba limax* is given, apparently from the author's own (unpublished?) observations, though no indication of this is given. Autogamy is again alleged to take place in *Amoeba proteus,* though this has not been by any means proved. It is disappointing to find no reference, in this connection, to Prandtl's important work on Cryptodifflugia ("Allogromia").

It seems to us that undue prominence has been given to many very questionable organisms, such as "*Cytorrhyctes variolae,*" the "Negri bodies," &c. (described, by the way, under "Parasitic Rhizopoda"), whilst many important life-histories, *e.g.* Opalina, Mastigella, Trichosphærium, Stylorhynchus, &c., receive little more than passing mention.

The remarkable form Aggregata is mentioned only in the classification, where it is placed among the cephaline gregarines! One can only suppose that this is an oversight; and we regret to see that the very doubtful work of Dallinger and Drysdale has found its way into yet another text-book.

Throughout the book, generic names are often written in ordinary type, without a capital letter, although in many cases the customary convention is adopted—frequently in the same paragraph. We think this is to be deplored, more especially so because medical men—to whom, on account of the large amount of space devoted to parasitic forms, the book will specially appeal—are at present particularly prone to write zoological names incorrectly. In addition, the author's apparent dislike of diphthongs causes him to adopt the spellings not only Paramecium (correctly), but also Ameba, Actinospherium, Spirocheta, &c., and even Jenia (for Joenia).

These criticisms are, however, of minor points. The chief value of the book lies in the fact that it gives us a unified picture of the many problems of protozoology as they present themselves to a worker who has devoted many years of original research to his subject. Without doubt, the book will be welcomed by many, because there exists no other modern work in English which attempts to deal with the present state of protozoology within the compass of a single volume. C. CLIFFORD DOBELL.

BEE-KEEPING IN AMERICA.

How to Keep Bees for Profit. By Dr. D. E. Lyon. Pp. xii+329. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1910.) Price 6*s.* 6*d.* net.

THIS is a book on bee-keeping in the United States. The author is a well-known bee-keeper, and an entertaining writer; he has a happy way of briefly explaining the chief operations of the apiary in a personal style that does not weary the reader. Dr. Lyon tells us that many years ago he acquired the "bee fever," "from which he has never recovered, and never expects to recover." The chief symptoms of this affection, enthusiasm and optimism, pervade his book, but he is careful not to exaggerate the profits of bee-keeping; the methods and appliances he describes are all well known and well tried, though some of them are unsuited to bee-keeping in England.

The clipping of queens' wings to prevent swarms absconding is recommended, but this practice is seldom employed in England, chiefly because the queen is likely to perish in the grass unless the bee-keeper happens to be present at the moment of swarming to find her and put her back into the hive.

The author, in saying (p. 52) that "it has not been definitely determined whether in laying an infertile egg from which springs the drone, the queen lays it through choice, or is compelled to owing to the increased size of the drone cell," seems to be unacquainted with the fact that a queen will sometimes lay large numbers of fertile eggs in drone cells.

Among the enemies of the honey-bee that the American apiarist has to contend with are skunks, "who seem to have a fondness for bees, and the little rascals will, in the shadow of night, scratch on the alighting board of a hive to lure the sentinels out for investigation, only to be gobbled up by their odoriferous enemies." "In warm climates the dragonflies kill a large number of virgin queens, when in flight, and in certain sections they are so numerous that commercial queen-rearing is well-nigh an impossibility."

Dr. Lyon finds he is less liable to be stung in a white cotton suit than when he wears dark woollen clothes, and wonders whether it is because the bees detect the animal scent in the woollen goods or have a natural aversion to black.

On pp. 12 and 13 we are unfortunately informed that the eggs of workers, drones, and queens hatch respectively in twenty-one, twenty-four, and sixteen days, instead of that these are the periods taken by these bees to develop from the time the egg is laid; but this will no doubt be put right in a second edition, which is likely to be wanted before long by the great nation across the ocean, in whose favoured country the bee-keeping industry has grown to great importance.

Very attractive features of the book are its handy size, clear, large type, and beautiful photographs. Bee-keepers, both prospective and actual, will appreciate this evident effort of printers and publishers to give them their best. F. W. L. SLADEN.

OUR BOOK SHELF.

Ektropismus oder die physikalische Theorie des Lebens. By Felix Auerbach. Pp. v+99. (Leipzig: W. Engelmann, 1910.) Price 2.60 marks.

EACH fresh theory of life which is put forward by thinkers will doubtless find a certain number of adherents, even if, as in the present instance, it is unsupported by anything in the nature of experimental evidence. This sort of evidence is just the kind which it is so difficult to obtain, and new theories lead one but very little nearer to the solution of the great problem. Auerbach's brochure contains nothing really new, and he clothes his ideas in a considerable amount of verbiage. No one can doubt that life with its characters of growth and development is a form of energy, but the psychical aspects of life have always been a stumbling-block in the full acceptance of a purely physical theory. Ectropism, the term selected by the author, is not entirely a physical theory; he tells us that ectropism is neither materialism nor idealism, neither formalism nor phenomenalism; it is certainly not monism, but, in a certain sense, it is dualistic. From this one learns what ectropism is not, and one could wish that the rest of the book, which tells us what it is, was equally explicit. We must, however, leave those of our readers who are interested in speculations of this nature to unravel it for themselves.

A Text-book of Physical Chemistry, Theory and Practice. By Dr. Arthur W. Ewell. Pp. ix+370. (Philadelphia: P. Blakiston, Son and Co., 1909.) Price 2.25 dollars net.

TEXT-BOOKS of physical chemistry are generally written by chemists, which is natural enough, since the subject is much more widely studied by chemists than by physicists. It is therefore a pleasant change to come across a text-book of physical chemistry written by a physicist. As one might expect, the treatment is less descriptive and more mathematical, with greater precision in the definition of physical magnitudes and greater strictness in the deductions. The work under review is an excellent example of this type, being brief, pointed, and consistent. It is not exactly a book which the young chemist without previous knowledge of the subject would be likely to read with profit, but it can be warmly recommended to those who, either by hearing a course of lectures, or by the perusal of one of the more chemical text-books, have attained some acquaintance with the subject-matter and desire to systematise their knowledge.

The value of the book is greatly enhanced by the inclusion of questions and mathematical exercises on the subjects discussed. The directions for practical work err occasionally on the side of conciseness, but should in any case prove useful to the student who cannot always have a demonstrator by his side.

Vorträge und Aufsätze über Entwickelungsmechanik der Organismen. Edited by Prof. W. Roux. Heft x., Über die gestaltliche Anpassung der Blutgefässe. By Prof. Dr. Albert Oppel. Pp. ix+182. (Leipzig: W. Engelmann, 1910.) Price 4.40 marks.

THIS is a useful and interesting contribution to the study of development, dealing, as its name indicates, with the blood-vessels, and the way in which they are adapted to the needs of the organs or tissues they supply and to the changes which these undergo. This adaptation is divided into three periods, the first during which inherited characters determine the course of development; the third is the period of full functional life during which the changes are the result of functional stimuli; the second or intervening period is that in which both factors come into play. The changes dealt with in detail are not merely those dependent on quantity of the blood supply; but the various coats of the blood-vessels, especially the muscular coat, with its nerves, undergo alterations in consonance with the needs of the tissues. An important section deals with the collateral circulation, and another, by no means the least interesting, with the recent remarkable results which have attended attempts to transplant organs from one animal to another. The value of the book is increased by a copious bibliography.

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.*]

The Descent of a Sphere in a Viscous Liquid.

STOKES's formula for the terminal velocity of a sphere descending in a viscous liquid under the action of gravity has been recently tested by Prof. John Zeleny and Mr. L. A. Keehan ("British Association Report," 1909, p. 407), and they found that the values of the velocity furnished by it were considerably larger than those which they obtained from their experiments. Since Stokes's formula is obtained on the hypothesis of no slipping, it furnishes an *inferior* limit to the velocity, and consequently the discrepancy between theory and observation cannot be explained on any hypothesis that slipping takes place.

I think that a possible explanation is the following. The equation determining the current function contains the term $d\psi/dt$, the origin being some *fixed* point in the line of motion of the sphere; and if the motion be referred to the centre of the sphere as a moving origin, $d\psi/dt$ must not be put equal to zero when the motion is steady, but must be replaced by $Vd\psi/dz$, where V is the constant velocity of the sphere. The retention of this term creates no difficulty so far as the integration of the differential equation for ψ is concerned, but the solution is quite different from that given by Stokes.

A. B. BASSET.

Fledborough Hall, Holyport, Berks, June 20.

Popular Biological Misconceptions.

THE object of science is to increase the knowledge of mankind in general, and not merely that of the workers in science. The methods of science may be only understood by the workers in each particular branch, but the conclusions are for all, and should be made accessible to all. The methods by which Newton established the law of gravitation can only be understood by good mathematicians, but the results can be put into words that can be understood by any educated man. I think most will agree that students of science should, so far as possible, make known their discoveries in such a way as to be understood by the layman.

In making these remarks I have biology in mind. Nothing is known of biology outside the ranks of biologists. Even Darwin's theory of evolution is most imperfectly understood by the ordinarily educated man. Probably working biologists have no idea how much it is misunderstood. When the late Lord Salisbury at Oxford said that there was nothing except pure chance to ensure the transmission of an advantageous variation, he left out of consideration the survival of the fittest, an integral part of the theory. Sir Oliver Lodge, in "Man and the Universe" (p. 38), speaking of the persistence of favourable variations, says, "given their appearance, their development by struggle, inheritance, and survival can be explained; but that they arose spontaneously, by random change, without a purpose, is an assertion that cannot be justified." This passage shows that the writer has not fully grasped the elements of the theory; the changes take place in every direction, but all variations except those in favourable directions are wiped out in the struggle for existence; such, at any rate, is the theory. When we consider that Darwin's theories are not fully grasped by scholars, it is hardly to be wondered at that the ordinarily educated man has but the vaguest ideas of biology, ideas made still more vague by the ordinarily educated writers in the daily, weekly, and monthly Press. To the ordinary man the word Darwinism means the theory that his ancestors were monkeys; he will have heard the words "survival of the fittest" used as a catch phrase, but he will have no idea of their meaning; "struggle for existence" will have no biological sense for him; "selection" he will think has something to do with sex. Biologists may say either that I am exaggerating or that the educated men of my acquaintance must be singularly few: but I can assure them that such misconceptions are shared by very many men who have been educated at our public schools and universities, which is generally (though perhaps erroneously) considered the criterion of a good education. It is quite common to come across persons who say that Darwinism is discredited by new discoveries, especially by Mendelism; they have no other idea of the meaning of Mendelism, and, seeing that their notion of Darwinism is no more than I have stated above, they arrive at conclusions that would rather astonish the average biologist.

I think it is the duty of biologists to educate the uneducated in biological matters, to tell them how matters really stand, and to tell them how far old theories are, or are not, modified by new views; but we should be educated by first-class masters, and not by second-hand popular writers. This has been done for a long time for astronomy, and, to a certain extent, for physics; it is very desirable that it should be done also for biology.

C. C.

Anomalous Reading of Hygrometer.

ON June 11 I observed a case of the wet-bulb thermometer reading higher than the dry bulb, which cannot be attributed to a falling temperature, as this anomalous condition continued for more than two hours, during the greater part of which the temperature was slowly rising. A gradually dispersing fog prevailed at the time, and the dry bulb was at first covered with precipitated moisture, but after being wiped dry it continued to read lower than the wet bulb, without any further visible deposition of moisture. This, however, may only imply that evaporation was proceeding too rapidly to allow of the fog particles aggregating into visible drops. This evaporation might account for the temperature of the dry bulb being as low as that of the wet bulb, but not lower. As thermal equilibrium will be attained by each thermometer when its rate of heat-loss is equal to its rate of heat-gain, and as the only loss of heat is by evaporation, which at most can only lower the dry-bulb reading to that of the wet, it is necessary to suppose that the wet bulb absorbs heat more rapidly than the dry. This may be accounted for by the greater thermal diffusivity of the wet bulb with its saturated muslin covering.

Experiments made by Prof. A. W. Porter at University College, London, show clearly that, in the case of steam pipes of small diameter, the effect of a lagging of badly conducting material is to *promote* the transference of heat from the interior to the exterior, and it is evident that if the external temperature be higher than the internal, the effect will be reversed, and, further, that it will be increased if the covering is not a bad conductor. We have such a covering on the wet-bulb thermometer, and as owing to evaporation the temperature of the thermometers will be lower than that of their surroundings, the direction of heat transfer will be inwards, and its rate more rapid in the "lagged" wet bulb than in the bare dry bulb. We should accordingly expect the former to come to a state of thermal equilibrium at a higher temperature than the latter.

J. ROWLAND.

St. Beuno's College, St. Asaph, June 20.

Pwdre Ser.

DOUBTLESS many of your readers will suggest that Pwdre Ser may, in some cases at least, be the jelly-like plasmodium of *Spumaria alba*, D.C., a common British myxomycete. The size, colour, time, and places where found agree well with Prof. McKenny Hughes's description, but how it should be connected with meteors this identification, if correct, would in no way explain.

AGNES FRY.

Failand House, Failand, near Bristol.

THE article on "Pwdre Ser" in your issue of June 23 has brought to my remembrance a tale of a shooting star which fell upon a connection of mine many years ago. The man was working in the field, when a mass of jelly fell upon him. I discredited the story at the time; but this article seems to lend weight to the story. I believe the man was unhurt. The occurrence happened in Wales.

ROWLAND A. EARP.

Preston Brook, near Warrington, June 27.

THE FRESH-WATER LOCHS OF SCOTLAND.[1]

A PATHETIC interest is associated with this great work. A bathymetrical survey of the Scotch fresh-water lochs, which had been already attempted in a few instances, was in vain pressed upon the Government in 1883 by the Royal Societies of London and Edinburgh, and was undertaken in 1897 by Sir J. Murray and Mr. F. P. Pullar, a young Scotchman who added to a deep interest in meteorological and hydrographical problems much practical skill as an engineer. Considerable progress had been made when, on February 15, 1901, Mr. Pullar was drowned in Airthing Loch, near his own home. The ice had broken, immersing a number of people; he rescued three, and perished in an heroic, though vain, attempt to save a fourth. As a memorial, the bereaved father, Mr. L. Pullar, devoted a sum of 10,000*l*. to the completion of the task, so that the book will be an enduring memorial to one who died to save others.

A staff was organised, and the work resumed in the spring of 1902. By the end of 1906 all the Scottish lochs of any importance, 562 in number, had been surveyed, and altogether more than 60,000 soundings had been taken. Biological and physical work was continued during the next three years; but from time to time the maps, with some of the results, enriched the pages of the *Geographical Journal*, and these, together with much new material, are now collected into the present work. The first two volumes contain the text, with various illustrations, from which we are able to reproduce two of the smaller size; the remaining four volumes the tinted maps, which—though it adds considerably to bulk and cost—are wisely mounted on linen.

The first volume deals with general scientific questions. Prof. Chrystal discusses seiches; for these abnormal oscillations in the water-level—first noted in the Lake of Geneva, and first seriously studied there by Prof. Forel—can be observed on the Scottish lochs, though on a much smaller scale. They are mainly due, as Prof. Chrystal shows, to variations in barometric pressure, though winds or heavy local rains or floods may be among the causes. Mr. E. M. Wedderburn writes on temperatures. In that respect the bottom water of a deep loch such as Loch Ness varies little throughout the year, and is sometimes hardly less than 2° F. below the mean temperature of the year, but conduction produces considerable intermixture in the upper layers of water. This indirectly affects the distribution of plant and animal life, and presents some interesting problems, which must be left without further notice. Mr. G. West gives the results of studies of the phanerogams and higher cryptogams in seven Scotch lake areas. This flora, like that of the mountains, has been much affected, directly or indirectly, by the Glacial epoch, but the vertical range of the plants, strictly aquatic in habit, depends on a number of factors—such as the amount of humic or other acids in the waters, the surrounding rocks, and the altitude. A full discussion of these and summaries of the results form a contribution which will be of permanent value to the botanist. Dr. Caspari gives a useful summary of information about the chemical composition of lake waters, and has also examined about seven hundred samples of bottom deposits from these lochs, of which, however, the mineralogical aspect is fairly uniform, as might be expected from the generally similar geological conditions. Mr. John Hewitt writes on the distinctive characters of the fresh-water plankton, Dr. W. A. Cunnington on the nature and origin of fresh-water organisms, Dr. C. Wesenberg-Lund on various limnological problems, and Mr. James Murray on the biology of the Scottish lochs. According to the last-named, the following peculiarities are noteworthy:—a richness in species of Desmids (only approached by the lakes of Ireland), a conspicuous Arctic element in the Crustacea, the local distribution of many of the one and some of the other, and, lastly, the absence or rarity of certain species common to the general European plankton.

FIG. 1.—Loch Maree, the Islands in the Middle Distance. From "Bathymetrical Survey of the Scottish Fresh-water Lochs."

As a prelude to the second volume, which is occupied by a detailed description of the several lake-basins, grouped according to their drainage, Drs. B. N. Peach and J. Horne contribute to the first one an article on the relation of the lochs to the general geology of Scotland, ending with a sketch of its mountain regions and valley systems, and of its history during the Glacial epoch. In their opinion, the ice attained its maximum during the earlier part of this, when it buried the whole region in a vast sheet, which, as they tell us, was met on the bed of the North Sea by another one from Scandinavia, and thus diverted northwards and southwards. In the later part of this epoch, probably after a warmer interlude, valley glaciers, which occasionally became confluent, radiated from the several mountain groups, and to their action, according to the authors, the lake-basins are mainly to be attributed. In regard to this subject, though it may be thought presumptuous, we venture to remark that both the map illustrating the maximum extent of the ice and some statements about the erosive action of the latter involve difficulties of which it would have been better to warn the ordinary reader.

The maps and sections, which occupy the remaining four volumes of the work, will, however, supply

[1] Bathymetrical Survey of the Scottish Fresh-water Lochs, conducted under the Direction of Sir John Murray, K.C.B., F.R.S., and Laurence Pullar, during the Years 1897 to 1908. Report on the Scientific Results. 2 vols. of text with illustrations, and 4 mainly of maps. (Edinburgh: *Challenger* Office, 1910.) Price 5*l*. 5*s*. the set.

him with materials from which he may form his own conclusions. In two of the four, the intervals between the contour lines are differently tinted, both above and below water; in the other two, this is done only for the latter. Sections show the relation of depth to length, not only on an exaggerated scale, but also (which is of great value) on a true one. Most of the Scotch lakes occupy actual rock basins, but this fact of itself is not conclusive evidence of their origin. Many tarns in mountain districts are probably due to the erosive action of ice, but no one would attribute the Dead Sea to the "rooting" of a Lebanon glacier, or the Central African lakes to ice-sheets from the Mountains of the Moon. Earth movements are among the possible causes of rock basins, and to which agency should the Scotch lochs be attributed? Increased erosion, due either to a confluence of glaciers or to a sudden diminution of slope in the valley floor, may account for the smaller, but difficulties present themselves in applying this explanation to some of the larger. For instance, we should expect that if the basin of Loch Maree had been excavated by ice, it would be a fairly uniform trough, descending from either end towards the middle, perhaps deepening and broadening a little near the mouth of any important affluent. Instead of this, it is nearly blocked in that part (where it is more than double its general breadth) by low islands (Fig. 1), rising from a submerged plateau, and besides this, the greatest depths, about 300 feet on the western and 350 feet on the eastern side, do not correspond with any marked topographical features. The fact also that south of the islands is a narrow water-basin, irregular in outline, and reaching a maximum depth of 230 feet, is difficult to explain on any hypothesis. Loch Ness, which is almost the longest of the Scotch lakes (for, with Loch Dochfour, it exceeds twenty-four miles), might seem, because of its depth—the maximum being 754 feet, fully 700 feet below sea-level—and of its uniform slopes, to support the hypothesis of ice-erosion; but some evidence might have been given that its division into two basins was due only to the deposits of the Foyers river, for the delta of the Moriston river on the northern side is more suggestive of a submerged valley.

FIG. 2.—Loch Knockie, looking North-east. From "Bathymetrical Survey of the Scottish Fresh-water Lochs."

Far from the least valuable part of the text is Sir John Murray's chief contribution—a clear and concise account of the various lakes known to exist on the surface of the globe. No abstract could do justice to this, so replete is it with interesting facts, the collection of which must have entailed great labour, for, as the bibliography shows us, they are dispersed among numerous publications. For many years to come this section will be invaluable to all students of limnology, in the widest sense of the term.

But we must conclude our notice of this encyclopædic work. We have to thank Sir John Murray, Mr. L. Pullar, and their able coadjutors for an admirable and sumptuous monograph, which, owing to the complete organisation, tells us more of the lochs of Scotland than Dr. H. R. Mill could ascertain about our English lakeland or Dr. T. J. Jehu about the llyns of Wales. We now know at least as much about them, and in some cases more, as Delebecque has been able to ascertain about the lakes of France, Forel and his coadjutors about those of Switzerland, the investigators of other European nations about the lakes of their own countries, or has yet been accomplished by energetic American surveyors on their own continent. We heartily congratulate Sir J. Murray and Mr. L. Pullar on this splendid and successful result of their labours. T. G. BONNEY.

THE WHITE MAN'S RULE.[1]

TO the great majority of people in this country the name Sierra Leone is nothing more than the vague geographical expression of a colony situated somewhere in Tropical Africa, once more familiarly known as the "white man's grave," and long regarded as the last resort of the hopelessly incompetent or the incurably vicious. That such a term of reproach is no longer applicable is shown in "A Transformed Colony," by Mr. Alldridge, whose personal knowledge dates so far back as 1871.

In a clear and attractive manner the author gives a description of the marvellous changes which have taken place as a result of the white man's rule. Situated amidst beautiful scenery, some little distance up the Rokell river, Freetown, the first settlement, now the capital and port of the colony, was originally the dumping ground for the liberated slaves drawn from all parts of West Africa; and from this collection of motley races has grown up a curious mongrel population, bound by no family or tribal ties, speaking no language of its own, and connected only by the common bond of a quaint English patois, and a paternal system of English government. To this has of recent years been added the Hinterland, peopled by numerous aboriginal tribes, each speaking its own language, preserving its own customs, and living under a more or less well-defined feudal system. As a result of the former conditions the Freetown creole has developed, a semi-civilised being with a superficial veneer of civilisation, an overwhelming mass of self-conceit, and a ludicrous capacity for imitating the less desirable qualities of the European. Never is he more happy

[1] "A Transformed Colony; Sierra Leone as it was and as it is, its Progress, Peoples, Native Customs, and Undeveloped Wealth." By T. J. Alldridge. Pp. xvi+368. (London: Seeley and Co., Ltd., 1910.) Price 16s. net.

than when, clothed in silk hat and frock coat, he struts proudly to church, the observed of all observers.

On the other hand, we find the aborigine, still the untutored savage, clothed in his loin cloth and little else, carrying out his ancestral pursuits of agriculture and war, but withal more likeable and trustworthy.

FIG. 1.—Numori. Steatite figures found in caves and supposed to be of very great antiquity. From "A Transformed Colony."

The author skirts very delicately the negro problem in West Africa (and we should have welcomed a bolder presentation of this question from one of his experience), but he does not fail to point out the evils of the purely clerical system of education which has been largely adopted in Freetown, with the result that a race of middlemen traders and clerks has arisen for whom it is becoming increasingly difficult to find employment. An interesting educational experiment is, however, being carried out in the Government school at Bo, in the Protectorate, which is of a different character, and will be followed with much interest by those who have the welfare of the negro at heart. It is intended only for the sons of chiefs, or the nominees of the townspeople, the object being to train the children to become good rulers when they grow up. There is no attempt at Europeanising them; on the contrary, it is strictly forbidden; native clothing is worn, native food eaten, native customs and institutions, so far as they are good, are encouraged, tribal patriotism is strengthened, and there is no interference with the religious beliefs of the pupils. Education proceeds on simple lines, and practical instruction in farming, carpentry, road-making, &c., is given. The results so far are encouraging, and such a scheme appears to offer the best prospects for the evolution of the negro on rational lines.

During the last few years the material development of the colony has been most striking. Railways and roads are spreading fan-like from the Port of Freetown through the "bush," carrying up the products of the Manchester looms and other luxuries of civilisation into villages where, a few years ago, the face of the white man had never been seen, and bringing back in return a rich harvest of palm oil, palm kernels, and rubber, from the hitherto untapped regions of the interior. The extent of this may be realised from the fact that the exports have increased threefold in ten years, from 290,991*l.* in 1898 to 831,259*l.* in 1907, and the revenue from 117,681*l.* to 359,104*l.* during the same period.

There is much else of interest to which only a brief allusion can be made. Mr. Alldridge draws a striking picture of the condition of the Protectorate twenty years ago—perpetual inter-tribal warfare, constant slave raiding, deserted villages with their fringe of skeletons whitening in the sun, and depopulated districts; contrasting vividly with the peaceful prosperity and commercial progress which are now to be found on all sides. But the book is full of such contrasts; on the one hand, the civilising influences of the bank, the ice factory, the railway, and the telegraph; on the other, the primitive barbarism of the bush, rudimentary arts, primeval marriage

FIG. 2.—A Secret Society. A Poro boy in dancing costume, Gaura country, Upper Mendiland. From "A Transformed Colony."

customs, the law of the Porro, the savage ritual of the Bundu, and, dominating all, the ineradicable thraldom of the fetish. It is an interesting story of the making of empire among the savage races of West Africa which will well repay perusal, and the value of the work is much enhanced by the numerous capital photographs of scenery and native customs with which it is illustrated. W. T. P.

GEOLOGICAL NATURE-STUDY.[1]

THE sixth volume of "The Book of Nature Study" is devoted to what is styled "the Physical Environment." This, again, is subdivided into "Meteorology, &c.," written by Dr. Marion I. Newbigin, and "Geology, &c.," by Prof. W. W. Watts. The titles of these subdivisions have been omitted, curiously enough, from the headings on pp. 1 and 92. Both authors, in pursuance of the plan of the work, guide the reader towards personal observation; and Dr. Newbigin especially addresses herself to the teacher, and considers throughout how certain facts are to be brought home simply to a class. Prof. Watts's pages are therefore more closely written and more enjoyable as literature, while those of his colleague are intentionally more didactic.

Throughout Dr. Newbigin's work there is a consistent attempt to impart just enough information to excite interest, and no more. The apostles of the centimetre scale will be shocked at the willingness of the author to accept "slovenly" results. The teacher is invited to direct attention later to the difficulties that arise from careless measurement. In the case selected, however, that of the rain-gauge (p. 25), the errors would cause no difficulty at all; the results would simply be wrong at the end of a given time, and there would be no means of finding out the truth. This is just the sort of easy-going procedure that would suit the average child; but does it conduce to education? Is it not wiser to explain and illustrate methods of observation, but to refrain from records that cannot be accurate within reasonable limits? All explanations of natural phenomena have a partial character; we are always making suppositions in regard to an unknown. Dr. Newbigin, however, shows a real preference for the partial explanation, and we fear that the teacher would often have to go much further than is here indicated, when confronted with the child's persistent "Why?"

The passages on "floods," "drought and deserts," or "rainfall and vegetation," show how well the author writes and teaches, within the limits expressly imposed upon herself. Astronomical considerations, sunrise and sunset, time, summer and winter, involve more difficulty, and we cannot see our own way, in such instruction, to dispense with the good old-fashioned terrestrial globe—one, of course, without an elaborate setting, and preferably turning on a wire axis supported at one end only. Dr. Newbigin (p. 53) leaves this to a later stage and to the teacher of geography. Meanwhile, the child is instructed in nature-study geocentrically, and will surely soon find something to unlearn.

Spring issuing from Limestone. From "The Book of Nature Study."

One point insisted on by the author, in common with many other writers, is that the atmosphere carries a "load of moisture." This phrase is, of course, singularly misleading when applied to invisible vapour, especially when the air is said to "throw down its burden" on cooling (p. 21, for instance, where this is stated in three different ways). How is the child to realise that the air, when it has done this, becomes heavier than it was before? The matter was so well treated long ago in Sir A. Geikie's "Physical Geography" that it is wonderful how it is slurred over in ordinary teaching. Surely, again, the cold surface of a hill (pp. 20 and 22) has very little to do with the formation of cloud around it. "Vapour" is used in two senses on pp. 19 and 21, where invisible vapour is postulated, and yet a cloud is said to consist of vapour. Are we not, in

[1] "The Book of Nature Study." Edited by Prof. J. Bretland Farmer, F.R.S. Vol. vi. Pp. viii+244. (London: Caxton Publishing Co., n.d.) Price 8*s*. 6*d*.

"Vorschule der Geologie. Eine gemeinverständliche Einführung und Anleitung zu Beobachtungen in der Heimat." By Prof. J. Walther. Vierte Auflage. Pp. x+294. (Jena: Gustav Fischer, 1910.) Price 2.50 marks.

"Die Vulkanischen Gewalten der Erde und ihre Erscheinungen." By Dr. H. Haas. Pp. viii+138. (Leipzig: Quelle u. Meyer, 1909.) Price 1.25 marks.

our desire to be untechnical, building in these matters without foundations, and was not Huxley's original scheme of "Physiography" a really sound guide to nature-study, even if it made its appeal to children somewhat older than those contemplated in the work under review?

Prof. Watts, at any rate, agrees with Huxley, and presupposes, in his geological section, a knowledge of the fundamental constituents of the earth. He refers freely to "silica," "carbonic acid," "minerals," "mica," and even "hydrated silicate of alumina." After all, is there more in this than is expected of the child when he is told to take one quart of milk to James Stewart of Auchencairn and one pint and a half to Mistress Campbell of Drumochter? The milk, the persons, and the farms are realities to him, and are therefore easy of comprehension. Is there any objection to making him equally well acquainted with the fundamental materials of the land? Prof. Watts gives the teacher the essential conceptions of geology, and leaves him to select what is suited to the comprehension of his class. His style is terse and vivid, and the illustrations selected by him, often from the photographs of Mr. Godfrey Bingley, are in every way worthy of the text. Since the principles of geology are so greatly concerned with the form of the earth's surface, the making of maps and models is included in the course, and the use of the plane-table, so attractive to beginners in geography, is explained and illustrated. Several of the technical terms in the chapter on the geological record, "brachiopoda," for instance, are not included in the index to the six volumes of the work; but the author moves on without hesitation—the teacher who undertakes the geological branch of nature-study must be ready to explain such technicalities to his class. Altogether, we cannot conceive a more effective introduction to geology than is here put forward.

To make two small criticisms, in the diagram on p. 210 the relations of the upper series of beds seem unnecessarily complicated by a surface-creep towards the valley on one side; and the chapter headed "Igneous Rocks" is mainly concerned with clastic rocks and earth movement. Since the conclusions stated are drawn from observation in our own islands, glaciers and volcanoes are more lightly treated than in many popular works. Prof. Watts has not gone out of his way to be popular, and has succeeded in being so in the highest of all senses.

Prof. Walther, in his "Vorschule der Geologie," has set much the same goal before himself. In five years his simple little book has run into four editions, and still forms a treatise that can be easily slipped into the pocket. The author is one of a band of German leaders in education who wish to see geology taught in all secondary (*höhere*) schools. He here leads on his reader to observe nature out of doors, and in a number of practical exercises shows the varied activities and changes on the surface of the earth. His diagrams are equally simple and convincing, whether of a tree forced to modify the form of its stem through the down-creep of a talus (p. 11), or of the formation of a granite tor (p. 29) by successive stages of decay. Even Dr. Newbigin would shake her head over Prof. Walther's rain-gauge (p. 42); but his charming directness of style gives one great confidence in his experiments. He permits us chemical formulæ, and even crystallographic systems; yet his work is quite unlike the text-books familiar in German schools. His little local sketches, such as the section of a swampy area in Fig. 30, are real lessons in geography; indeed, we have shown these pictures to a class in the field in explanation of the broad features of a landscape. We may differ with him on small points, such as his treatment of trough-faulting, which surely arises most frequently through the faulting of a fault by one of opposite hade; but he guides us onward from our first observations on a hillside until we can grasp the complexities of a geological map. He expects us to purchase one and use it, and supplies index maps for all the German surveys, with considerable lists of literature to assist our summer holidays. This confidence in the attractiveness of his subject is one of the charms of Prof. Walther's treatise; but we must remember that he appeals to pupils trained by longer working hours than our own, and to the sons and daughters of a people that regards education with respect.

Dr. Haas, in "Die vulkanischen Gewalten," adds one more to Herre's series of popular scientific monographs. The black-letter type, and occasional sentences in the long black-letter style, show that it is intended for general readers beyond the colleges. It is not concerned with personal observation, but contains, logically stated, the results of a wide range of research. The description of a volcano in time introduces us to earthquake problems and the constitution of the earth's interior. Though the writers referred to are naturally for the most part German, the author has read widely, and even quotes (p. 97) Albert Brun's view that the volcanic cloud consists of salts of ammonia. This leads on to an interesting discussion of how volcanoes might be produced without the presence of water in the original igneous mass, and of Stübel's theory of the formation of calderas by magmatic expansion and subsequent sinking of the central areas. There is much in this "popular" work that will be useful to the teacher of geology; and the illustrations of dust-clouds and lava-flows are refreshingly recent, after the oft-repeated woodcuts to which we have become inured.

GRENVILLE A. J. COLE.

THE MEDIUM OF CELESTIAL SPACE.

THE physicist knows well that the problems with which he has to deal are insignificant, or at best subsidiary, when compared with the great questions so intimately connected, What is matter? and What is æther? The astronomer, though he observes the operations of nature on a vaster scale, deals with problems of a less ultimate character. Thus, when he seeks to investigate the properties of that medium in which the solar system and the stars alike are moving, he is far removed from any metaphysical abstraction, and only seeks the answer to perfectly definite, concrete questions concerning the transparency and dispersive qualities of the medium. But if the questions are concrete, they are by no means simple, and though the last two years have seen a simultaneous attack on the problem on several converging lines, the main result has been to make us realise the immense difficulties which lie in the way of a definite conclusion.

Whether there is a general absorption of light in space, from whatever cause arising, is a point which suggests itself most obviously. Without attributing any absorptive power to the æther itself, it is easy to see reason for inferring that a loss of light does take place. The streams of meteors which enter our atmosphere have not always been within the sphere of influence of the solar system, but have probably come in incalculable numbers from outer space. There is a continual drain on the atmospheres of the sun and planets owing to the loss of the fastest-moving molecules. The empty spaces which have been found to exist in the midst of the densest star clouds, and the curious rifts which interrupt the continuity of certain bright nebulæ, suggest the presence of obstructing nebulous masses such as that which was only revealed by the outburst of Nova Persei. It is thus reasonable to suppose that a sensible amount of absorbing matter exists in space. But to form a quantitative estimate of its effect is a task of which our increased knowledge makes us only the more appreciate the difficulty.

The problem would be simpler if we could accept the conditions supposed by the earlier astronomers. For them the extent of the universe was indefinitely large, and the distribution of the stars roughly uniform. Moreover, they imagined that the intrinsic brightness of all stars was nearly constant, and that the observed differences of magnitude were almost entirely attributable to the effect of varying distance. But for an effective general absorption we ought, in these circumstances, to expect the whole sky to shine with the average brilliance of a stellar surface, and Halley, in supposing otherwise, was guilty of a simple error. The truth of this was perceived by Cheseaux (1744), and later by Olbers (1823), and both astronomers inferred an extinction of light in space without estimating its amount, or even supporting it by direct evidence, rather than admit that the universe was finite. The first estimate based on these premises was given by W. Struve in his "Études d'Astronomie Stellaire" (1847), a work of great historical interest. Using the data provided by Herschel's gauges, and the counts of Bessel and Argelander, Struve concluded that light coming from the mean distance of sixth-magnitude stars suffered a loss of 8 per cent. of its intensity. But we have ceased to regard as valid the premises on which this conclusion was based. We know now that the variability of the intrinsic light of the stars is so great that distance can no longer be considered as the chief factor in determining their apparent magnitudes. There are also grave difficulties in the way of assuming that the universe extends with finite density to an infinite distance. Seeliger has pointed out that unless the Newtonian law of gravitation be modified, an infinite strain will exist at every point; and even if the smallness of the total light of the sky be accounted for by some kind of absorption, a thermal difficulty remains; for any part of an infinite and eternal universe will be, as it were, within an isothermal enclosure, and the temperature at every point will be at least 6000° C. Such considerations, and the facts of observation, have led us to abandon the idea of an infinite universe, and Newcomb asserted, not only that the system of the stars was finite, but that there was no evidence that any extinction of light in space occurred. That will not hinder us from seeking for evidence. If we possessed a knowledge of the spatial relations and the luminosities of the stars, if, in a word, we held the key to the sidereal problem, we should be in a position to assess the absorption of light in space. But without assessing the loss of light according to distance, the sidereal problem cannot be solved. In fact, the two problems are interdependent, and it may be long before a satisfactory solution is reached.

There is, however, a subsidiary line of attack possible. The absorption may be selective in its character, or, in other words, its amount may be a function of the wave-length. This will be the case if it is due to scattering by particles the dimensions of which are of the order of a wave-length of light. It is not absolutely clear that a similar effect may not be produced by the æther itself. In either case a corresponding dispersion is to be expected, and the rate of propagation will depend on the colour of the light. If any celestial phenomenon be carefully observed which is strictly localised in space and in time, the relative rate of transmission for different parts of the spectrum can be detected. Newton approached the subject from this point of view, and suggested the eclipses of Jupiter's satellites as suitable phenomena for investigation. It is well understood now that the conditions of a gradual eclipse are quite unfavourable for the detection of subtle colour changes, and the distance in this case is altogether too small. The circumstances of stellar aberration have also been invoked to set a limit to the possible dispersion. But the sensitiveness of this test is also too small, for a difference of as much as one-half per cent. in the rate of transmission would at best produce a spectrum 0·1″ in length (and this is about the estimated width of the fine micrometer wire of the largest refractors). As nothing of this order is to be looked for, a finer test must be sought. Arago conceived the possibility of detecting a change of colour in variable stars according to the light phase. Contenting himself with the simple inspection of certain variables, he concluded that there was no such effect. As a matter of fact, more careful observers have noticed a change of tint accompanying the change of brightness; but even so the natural explanation is to be found in the physical character of the stars. This illustrates the need for a cautious interpretation of results, as well as for the most careful and refined methods of observation.

A great advance in practical methods has been made recently by M. Nordmann, of Paris. His plan has been to study the light curves of certain variable stars, using the light from different regions of their spectra, in accordance with the belief that a sensible dispersion in space must produce a want of simultaneity in the respective curves. With this object in view he designed an ingenious modification of the Zöllner type of photometer. By its means the light of the star examined can be compared with an artificial star produced by condensing on a small hole the light of an Osram lamp fed by a constant current. Before entering the eyepiece, the light from both images passes through one of three liquid light filters, and thus the comparison is made in red, green, or blue light as desired. Whatever opinion may be formed of the validity of M. Nordmann's conclusions, it is fair to say that his apparatus has been admirably designed, and that much is to be expected from the systematic application of his method to the study of coloured and variable stars. Finding the atmosphere of Paris unsuitable for delicate researches of this kind, he took his apparatus to Biskra, in Algeria, where he spent several months in 1907–8. Unfortunately, the climate of this station did not fulfil expectations, owing to the prevalence of sand storms, and this fact may account for a certain want of continuity in the observations in a research which demanded continuity as a necessary condition of complete success.

M. Nordmann studied chiefly the stars β Persei and λ Tauri. But before alluding to his results, we may refer to the nearly contemporaneous work of M. Tikhoff, of Pulkowa. M. Tikhoff has conceived more than one ingenious method of attacking the problem of dispersion in space. One of these is in principle the same as that of M. Nordmann, but differs from it in employing photography instead of direct visual estimates. By using bathed plates, the region of the star examined is photographed through certain screens, which are prepared in such a way as to allow only light belonging to restricted ranges in the spectrum to be effective. Thus, an orange screen may be expected to give results comparable with those obtained by visual methods, while a blue screen will give photometric estimates in the ordinary photographic region of the spectrum. By this method M.

Tikhoff studied the variables RT Persei and W Ursæ Majoris. Some years previously he had compared the velocity curves and the light curves of the stars δ Cephei and η Aquilæ, which are well-known spectroscopic binaries and variable stars. Inasmuch as an accepted theory of the physical nature of stars of this type is still wanting, this method must be considered radically unsound. But more recently M. Tikhoff has had the happier idea of comparing the velocity curves as determined from lines in separate regions of the spectrum. Theoretically, this would seem to be the method of all those which have been suggested which is the most free from objection. But it is doubtful whether, among the spectrographic observations already made, even of the highest class, suitable material exists for the successful application of the method. It is certainly possible to criticise on definite and practical grounds MM. Tikhoff and Belopolsky's discussion of the case of β Aurigæ.

The results already obtained may be tabulated thus :—

Star	Range μμ	Lag min.	Authority
β Persei	680–450	13	Nordmann
λ Tauri	,,	30	,,
RT Persei	560–430	4	Tikhoff
W Ursæ Majoris.	625–380	10	,,
β Aurigæ	450–400	10–20	,,

The third column, which alone requires explanation, contains the retardation, expressed in minutes, of some event observed in blue light over what is supposed to be the same event observed in light of greater wave-length. The event in the first four cases is the light minimum of the star, while in the fifth case it is the disappearance of the radial component of the velocity relative to the Sun. Unfortunately, we have no trustworthy determinations of the parallaxes of these stars. Pritchard's values for β Persei and β Aurigæ are near 0·06″, and M. Tikhoff himself has found the parallax of RT Persei to be insensible. Thus we can only note the qualitative agreement in the sign of the lag in all cases, which suggests that blue light is transmitted through space at a slower rate than light of longer wave-length. Yet the results are liable, even on this ground, to serious criticism, which has been expressed forcibly by Prof. Lebedew. It is not surprising that close inspection shows that the data in the case of β Aurigæ are not self-consistent. But in the other cases we cannot be certain that the observed event is really synchronous in its origin for different qualities of light. This essential condition may be nullified by the physical character of the star, as, for instance, by a selectively absorbing atmosphere of the occulting body. Prof. Lebedew is entirely right in suggesting these criticisms, but they do not prove that the medium filling space is without dispersive power; and even if this fundamental question is left open, it is to be hoped that researches will be continued on the same lines, for the ingenious methods of MM. Nordmann and Tikhoff bid fair to extend our knowledge of variable stars in a most helpful way.

Meanwhile the line of direct investigation of a possible selective absorption in space has been followed. If two stars the intensities of which are I_1 and I_2 require exposure times T_1 and T_2 in order to register images of equal density on a photographic plate, we may put (after Schwarzschild)

$$I_1T_1^p = I_2T_2^p.$$

A priori we might expect the same effect to be produced by the same incident energy, or $p=1$. As a matter of fact, a number of independent researches have suggested that p is much nearer the value 0·8. This deficiency in the value of p has been attributed to the properties of the photographic plate. But it occurred to Prof. Turner that the fact might have its origin in cosmic causes. He had deduced from the Greenwich astrographic results that "when the time of exposure is prolonged in the ratio of five magnitudes, the photographic gain is four magnitudes." This result, which has been reached by others in more or less the same form, is equivalent to the above statement that $p=0·8$. A number of facts connected with visual and photographic magnitudes could thus be reconciled by supposing that the small particles distributed in space actually produced a selective scattering in accordance with Lord Rayleigh's law.

It seemed as if a crucial test was at hand to try this hypothesis. It was only necessary for M. Tikhoff to apply his light-filters and to see whether the apparent law of photographic action was the same for the blue starlight which affects the ordinary plate, and for the visual rays to which the bathed plate is sensitive. The experiment was immediately made, and the first results seemed to bring a striking confirmation to the hypothesis. M. Tikhoff found that $p=0·67$ to 0·79 for the photographic rays, but that $p=0·91$ to 0·96 for the green-yellow rays. But Mr. Parkhurst, of the Yerkes Observatory, who has made a special study of the subject of photographic photometry, strikes a note of warning. Under conditions apparently similar, he has obtained $p=0·88$ for the ordinary plate, and $p=0·81$ for the bathed plate with colour-filter. These results go in the opposite direction and must be attributed to the different plates (Schleussner and Cramer) and filters employed. Mr. Parkhurst concludes that "if cosmical causes played any part in the matter they would be completely masked by photographic effects."

The inter-relation which has been noticed between the problem of absorption in space and the problem of sidereal structure has naturally engaged the attention of Prof. Kapteyn, who has been the most prominent and assiduous student of the latter question during recent years. He has noticed that the marked deficiency in the numbers of the fainter classes of stars is equally apparent in all directions of the sky. Unless this peculiarity is attributable to the effect of general absorption, we must suppose that the sun is situated at the centre of the universe, and though such a thing is perfectly possible, it is not specially probable. Kapteyn prefers to admit an absorption of light, and provisionally estimated the loss required by the hypothesis of nearly constant star-density as 0·016 of a magnitude for stars with a parallax of 0·1″. More recently he has brought forward an interesting argument of a qualitative kind. Miss Cannon's classification of star spectra distinguishes between two classes which differ only in showing greater or less relative absorption in the violet end of the spectrum. Arcturus is the type of the stars less affected, while α Cassiopeiæ is the type of those more affected in this way. If the property is not intrinsic in the stars themselves, stars belonging to the Arcturus class should be nearer to us than stars like α Cassiopeiæ. Hence the former class should, on the average, possess greater proper motions. Put to the test, 45 stars of the α Cassiopeiæ division gave an average centennial proper motion 11·4″, and 25 stars of the α Bootis division gave 47·1″. Thus the idea is confirmed that the distinction is due to absorption in space. A number of interesting points are involved in this line of argument, and it is to be hoped that it will be further tested by extending its area of application.

Quite lately Prof. Kapteyn has published a second and more extended research on the subject. In this he investigates the amount of selective absorption, and starts from the principle that "the phenomenon must manifest itself in this, that, *ceteris paribus*, the more distant stars will be redder than the nearer ones." As a measure of redness he employs the difference, photographic *minus* visual magnitude, derived from the Draper catalogue and the Harvard revision. It would be profitless to use direct determinations of parallax, for the material at hand is far too scanty and untrustworthy. Hence he derives the measures of distance from his own statistical discussions, which have enabled him to express the average parallax of a star as a function of its magnitude and proper motion. The necessary data have thus been found for 1433 stars, and separate equations have been formed for the different spectral classes and certain ranges of proper motion within each class. It is impossible here to follow the rather complicated discussion in detail, but the result obtained on certain simple assumptions as to the nature of the scattering of light implies a loss of

0·00867 of total light = 0·00945 of mag. for photographic rays
0·00427 ,, = 0·00465 ,, visual rays

in the case of a star the parallax of which is 0·1″, or the distance of which is 32·6 light-years. Kapteyn considers that these numbers represent lower limits, and finds no difference between galactic and extra-galactic regions of the sky so far as selective absorption is concerned.

Despite the contradictory nature of the evidence, it must be felt that the whole subject is full of interest. It is now receiving the most critical and exhaustive discussion, and the need for fresh material will stimulate original and appropriate observations. It is pleasant to learn from Prof. Kapteyn that the plan of work for the 60-inch reflector on Mount Wilson includes special provision for this line of study. Efforts directed with a serious purpose and pursued with sincerity do not go unrewarded, though the shape of the reward may not always be according to expectation.

H. C. P.

NOTES.

THE list of Birthday Honours was published on Friday last, but, as usual, men of science do not figure largely in it. Among the new Privy Councillors we notice the name of Sir William Mather, who has done much to promote technical education. The honour of Knighthood has been conferred upon Mr. H. Hall, His Majesty's Inspector of Mines for the Liverpool and North Wales district, and Dr. A. Hopkinson, Vice-Chancellor and principal of the Victoria University of Manchester. Colonel F. B. Longe, Surveyor-General of India, and Dr. R. T. Glazebrook, F.R.S., become Companions of the Bath (C.B.). Mr. J. H. Marshall, director-general of archæology in India, Mr. C. Michie Smith, director of the Kodaikanal and Madras Observatories, and Dr. M. Aurel Stein, superintendent of the Archæological Survey, Eastern Circle, are appointed Commanders of the Indian Empire (C.I.E.). The order of C.M.G. has been conferred upon Dr. A. D. P. Hodges, principal medical officer of the Uganda Protectorate, in recognition of his services in the suppression of sleeping sickness, and Prof. T. W. Edgeworth David, F.R.S., of the University of Sydney. Mr. C. O. Waterhouse, of the British Museum (Natural History), has been appointed a Companion of the Imperial Service Order.

SIR WILLIAM RAMSAY, K.C.B., F.R.S., has been elected an "Associé Étranger" of the Paris Academy of Sciences, in the place of the late Prof. Alexander Agassiz.

THE Albert medal of the Royal Society of Arts for the current year has been awarded by the council to Madame Curie, for the discovery of radium. The discovery, which was the outcome of Prof. Becquerel's researches into the radio-activity of uranium and its compounds, was made jointly by Madame Curie and her husband, Prof. Curie, professor of physics at the Sorbonne, in 1898. Prof. Curie died in April, 1906, and in May of the same year the faculty of sciences paid his widow the distinguished honour of appointing her his successor. She has since continued, on her own account, the researches she commenced in association with her husband. The Davy medal of the Royal Society was awarded to Prof. and Madame Curie in 1903, and the importance of the discovery has been fully recognised by the scientific world.

THE King has consented to become Patron of the Royal Society of Arts in succession to King Edward the Seventh, who became Patron on his accession, after having filled the office of president of the society for thirty-eight years.

THE President of the Board of Trade has appointed a committee to inquire what degree of colour-blindness or defective form-vision in persons holding responsible positions at sea causes them to be incompetent to discharge their duties; and to advise whether any, and, if so, what, alterations are desirable in the Board of Trade sight tests at present in force for persons serving or intending to serve in the merchant service or in fishing vessels, or in the way in which those tests are applied. The committee consists of the Right Hon. A. H. D. Acland (chairman), Lord Rayleigh, O.M., F.R.S., Sir Arthur Rücker, F.R.S., Mr. Raymond Beck, Captain T. Golding, Prof. F. Gotch, F.R.S., Mr. N. Hill, Mr. E. Nettleship, Mr. J. H. Parsons, Prof. J. H. Poynting, F.R.S., and Prof. E. H. Starling, F.R.S. Dr. W. Watson, F.R.S., and Mr. S. G. Tallents will be secretaries to the committee.

WITH reference to Mr. Winston Churchill's statement in the House of Commons on June 16, "that the time has now arrived when a definite effort should be made to break new ground and set up a higher standard" of safety in mines, we learn that a committee, appointed by the council of the Royal Society of Arts, and under the chairmanship of Sir Henry Cunynghame, K.C.B., is now considering the relative merits of a number of life-saving appliances which have been submitted in response to an offer, under the Fothergill Trust, of a gold medal or prize of 20*l*. for the best portable apparatus for enabling men to undertake rescue work in mines or other places where the air is noxious. The committee of the society is in communication with the South Midland Coal Owners Mine Rescue Experimental Committee, which is also conducting exhaustive inquiries with the view of discovering the most suitable apparatus for use in the South Midland coalfields.

THE King held his second Accession Court for the reception of addresses at St. James's Palace on June 22. Among the addresses presented were eight from universities and a number from learned societies. The King made special replies to the Universities of Oxford, Cambridge, Edinburgh, Dublin, and London. To the representatives of Oxford University his Majesty remarked:—"It is my desire to follow the example of my father and of Queen Victoria in sustaining and in fortifying those seats of learning on whose prosperity and influence the character and repute of our civilisation largely depend. Among them the University of Oxford, with its world-famous traditions of steadfastness and loyalty, will ever hold an honoured place." The reply to Cambridge University included the words:—"Your famous University may count upon my sincere goodwill, and, like King Edward, I shall watch its progress and expansion with lively interest. I am convinced that you will not fail in the responsibilities with which you are charged, and that the zeal for truth, love of learning, and a high ideal of character and conduct will ever be cherished and fostered in your midst." To the Edinburgh University representatives the King said:—"It gave me great pleasure to listen to the record which you have recited of the growth and increasing prosperity of the University of Edinburgh, since the time when, as Prince of Wales, my dear father matriculated as a student. The work of the universities is of far-reaching importance to the welfare of my people, and I feel confident that every extension of the sphere of their influence will be attended with beneficent results. I shall follow with deep interest and continual good wishes the work which is being done by your university in furthering the advance of sound learning and education." The reply to London University included the words:—"King Edward watched with keen interest the continuing prosperity and progress of the London University. He understood how much the strength and reputation of our country depended upon the moral and intellectual culture of her sons and daughters. He saw with pleasure the distinction and thoroughness with which the London University invested higher education in the capital. You may be assured that the fortunes of your university will ever be near my heart, and that I shall always take a lively interest in your welfare."

QUEEN ALEXANDRA received Captain R. F. Scott at Buckingham Palace on Saturday last, and expressed her deep interest in the forthcoming British Antarctic Expedition. Her Majesty presented Captain Scott with a Union Jack to be carried with the expedition, and to be planted at the most southerly point reached. A telegram from New Zealand announces that the Dominion intends to present the expedition with a quantity of coal and other stores on its arrival at Lyttelton. The *Terra Nova* left Madeira on Sunday for Simonstown, where she is due to arrive on August 1. Captain Scott is to sail from Southampton on July 16, and is due to reach Cape Town on August 2, and to leave there on August 13. The *Terra Nova* should arrive at Lyttelton on October 14, set sail on November 15 for the Antarctic, and reach the base on King Edward VII. Land on December 15.

THE *Times* correspondent in Berlin states that the preliminary expedition to Spitsbergen for the purpose of studying Arctic conditions in connection with the projected Zeppelin airship Polar expedition will leave Kiel on Saturday next in the North German Lloyd steamship *Mainz*, which has been specially fitted up for the purpose. It is said that Prince Henry of Prussia, as well as Count Zeppelin, will take part in the expedition, which is expected to last some eight weeks.

ACCORDING to a Geneva correspondent of the *Times*, an important Swiss scientific expedition left last week to make researches in the Cordilleras basin of the Andes. The expedition is in charge of Prof. O. Fuhrmann, of the University of Neuchâtel, and it will probably be absent two years.

MR. ROBERT NEWSTEAD, lecturer in economic entomology and parasitology at the Liverpool School of Tropical Medicine, and a member of the Entomological Research Committee of the Colonial Office, has gone to Malta to investigate the problem existing there of the menace to health by the sand-fly. The main cost of the expedition will be covered by a special grant from the advisory committee for the Tropical Diseases Research Fund (Colonial Office).

THE discovery of an immense reef of free-milling gold ore near Stewart, at the head of Portland Canal, British Columbia, is reported. It is stated that the reef has been traced for nearly twenty miles, and naturally there has been a great rush of miners and others to the locality.

IT is stated in the *Scientific American* that a fund has been started by Mrs. E. H. Harriman for the collection of complete data on mammals and other animals in the North American continent, and that Dr. C. Hart Merriam, chief of the Biological Survey of the U.S. Department of Agriculture, is about to resign his position to take charge of the work.

A REUTER message from Algiers states that two violent earthquake shocks were felt at that place, and throughout the west of the department, at 1.30 on the afternoon of Friday last. Later telegrams received in Paris on Tuesday state that earthquake shocks continue to take place in the district of Aumale, that Dowar el Enoch suffered particularly, and that twelve lives have been lost.

WE regret to learn of the death, at eighty-one years of age, of Mr. C. Greville Williams, F.R.S., author of many papers in organic chemistry, and for some years assistant to Lord Playfair in the department of chemistry of the University of Edinburgh.

THE *Athenaeum* announces the death, at the age of seventy-five years, of Dr. Julius Weingarten, professor of mathematics in the University of Freiburg im Breisgau.

MR. S. A. STEWART, whose death at the advanced age of eighty-four occurred through an accident at Belfast on June 15, was a distinguished Irish botanist and geologist, and until recently curator of the Museum of the Belfast Natural History and Philosophical Society. Mr. Stewart contributed valuable papers to the Royal Irish Academy and other scientific societies, and wrote in conjunction with the late Mr. T. H. Corry the standard work "A Flora of the North-east of Ireland," brought out in 1888. Although jointly planned, the early death of Mr. Corry a few years before publication left the chief execution of the project to Mr. Stewart. Nearly seven years later a valuable supplement was published by Mr. Stewart in collaboration with Mr. R. L. Praeger in the Proceedings of the Belfast Naturalists' Field Club. Mr. Stewart's contributions to geology were also most original and important. He was an Associate of the Linnean Society, a Fellow of the Botanical Society of Edinburgh, an hon. associate of the Belfast Natural History and Philosophical Society, and one of the founders of the Belfast Naturalists' Field Club.

THE *Times* announces that a memorial to Lieut. Boyd Alexander, the explorer, who was murdered in the French Sudan in April, and his brother, Captain Claud Alexander, who also lost his life in Central Africa while engaged in scientific exploration, has just been completed at Wilsley House, Cranbrook. A sheet of water on the estate has been laid out as an exact reproduction in miniature of Lake Chad from plans by Lieut. Boyd Alexander. On the islands and banks of the lake are reproductions of thatched native huts, and there is preserved on the adjacent lawn one of the boats in which the Alexander-Gosling Expedition made its way down the river Yo to the Nile.

A COMPLIMENTARY banquet to some of the recipients of the Mary Kingsley medal of the Liverpool School of Tropical Medicine was given by the chairman of the school on Saturday last, when Surgeon-General Sir Alfred Keogh, C.B., who was one of the speakers, said he had endeavoured to help science in the appointment which he had lately vacated. His special mission was to endeavour to bring into the counsels of the War Office a realisation of the fact that medicine was an applied science, and that it was not concerned merely with the treatment of disease, but with its prevention. The problem of making the tropics habitable was easy, and they could make such countries as West and Central Africa as salubrious as Liverpool if they would only take the trouble to think about it and would organise for the purpose. Medical science had also a definite relation to war. He described the work of Sir David Bruce in practically stamping out Malta fever. Thanks to applied medicine, there had been added to the Indian Army for defensive purposes last year the equivalent of two battalions.

THE Cavendish lecture will be delivered to the West London Medico-Chirurgical Society to-morrow by Sir Thomas Oliver, who will take as his subject "Empyema and some Problems Connected Therewith."

THE summer meeting of the Junior Institution of Engineers will be held in Dublin and Belfast from July 16 to 23. The proceedings are to be opened by a reception at Trinity College, Dublin, by the provost and professors of engineering, and afterwards a number of engineering works, &c., will be visited.

THE autumn meeting of the Iron and Steel Institute will take place at Buxton on September 26 to 30.

THE necessity of applying what may be called the "intensive" method of treating some questions of Indian ethnology is enforced by a paper recently read by Sir R. Temple before the Royal Society of Arts on the people of Burma, and by the discussion which followed. The authorities are at issue on the order of the invasions from which the present population resulted. Sir R. Temple thinks that the order of entrance into the peninsula was Mon-Khmer, Tai or Shan, Bama or Burmese. Sir J. G. Scott believes that the Shan, if they migrated at all, formed the third body of newcomers; but he prefers to suppose that the Shan never migrated. Again, as regards religion, Sir R. Temple treats the vast majority of Burman Buddhists as Animists, Animism taking the form of Nat worship. Mr. E. Colston, on the contrary, holds that though Nat worship may be animistic in origin, it is an integral part of Buddhism, analogous to the Deva worship in Ceylon. These two authorities are again hopelessly at issue in their views as to the period when Hindu influence became powerful in the country.

THE iron styles used for writing in India are interesting, because it is through them that the types of the present scripts have been determined, the circular class of alphabets, like the Oriya or Burmese, depending upon the necessity, in order to avoid breaking the material, of moving the style in a curve, not in a straight line, along the fibre of the palm-leaf. Mr. I. H. Burkill in vol. vi., part i., of the Journal of the Asiatic Society of Bengal for the current year describes a large collection of these styles. He arranges them in no less than thirty-seven types, beginning with the most simple form, like a porcupine quill, and gradually developing into the most intricate and elaborate shapes.

IN the June number of *Man* Mr. T. M. Joyce describes some curious wooden engraved blocks used by the Bushongo of the Belgian Congo for ornamenting their bodies on festal occasions, and for staining palm cloth and embroidery fibres with a red pigment prepared by bruising the wood of a tree known as *tukula*. They are good examples of the work of this naturally artistic race. It is remarkable that, like our mourning rings, the heir of a dead man, acting as chief mourner, distributes a number of these articles to the immediate friends of the deceased as mementoes.

A GOOD example of the rain-making chiefs, to whom Prof. J. G. Frazer first directed attention, is to be found in a paper on such functionaries in the Gondokoro district, White Nile, contributed to the June issue of *Man* by Mr. W. E. Cole. The rain-maker shows considerable shrewdness in his proceedings. He always builds his village on a hill slope, which he knows attracts the clouds. He smears himself with wood ashes, and wears a number of charms. Then he produces a pot in which he keeps his rain-stones, generally pieces of crystal, aventurine, or amethyst, found on the neighbouring hills. These, in the true spirit of mimetic magic, he covers with water, and, taking in his hand a peeled cane split at the top, he beckons towards him the clouds if his people need rain. Sometimes he maliciously diverts the rain-clouds towards some unfriendly tribe. If by chance his incantations fail, he announces that some hostile chief in the neighbourhood has stolen the rain. This often leads to a raid on the offending village, and to many broken heads.

THE Bulletin of the Johns Hopkins Hospital for May (xxi., No. 230) is devoted to an important article by Drs. Crowe, Cushing, and Homans on the results of removal of the hypophysis cerebri, or pituitary body, a small glandular organ at the base of the brain. Methods were elaborated whereby the organ could be removed without injury to the adjacent brain. In dogs the most striking features following removal are development of a state of obesity, alterations in the sexual organs and skin, subnormal body temperature, sugar in the urine, psychic disturbance, and finally death—all of them symptoms which have occasionally been noticed in man in connection with tumours of the pituitary body. The paper makes a very notable addition to our knowledge of the functions of this organ.

THE difficulty of deciding whether butter is genuine or adulterated is illustrated in a paper by Mr. G. Brownlee issued by the Department of Agriculture and Technical Instruction for Ireland. The committee on butter regulations, in their final report, recommended that in the case of any butter giving a Reichert-Wollny number below 24 the presumption should be that the sample is adulterated with foreign fats. As certain Irish butters, known to be genuine, have been found to fall below this limit, an extended set of observations was made. It appears that the chief factor influencing the Reichert-Wollny number is the lactation period of the cows supplying the milk, and that in order to get butter of a more uniform composition the calving of the cows should be distributed more evenly over the year.

THE Department of Agriculture in the Leeward Islands carries out a number of experiments on sugar-cane, the results of which for the past season are now published. Of the varieties examined, some show themselves well suited for cultivation at all the various experimental centres, while others are more limited in their range and are at their best on certain special types of soil. The manurial experiments are mainly on the ordinary lines, but some new ground is broken. Molasses has been tried as a fertiliser with results that justify further investigation. It is not clear that either nitrogen, potash, or phosphoric acid is present in sufficient quantity to account for the increased crops, and the simplest explanation appears to be that the carbohydrate furnishes additional supplies of energy for the nitrogen-fixing bacteria in the soil, and thus leads to a gain in the soil nitrogen.

THE methods of picking, drying, and packing hops in Kent are described in some detail by Mr. Arthur Amos in the *Journal of the Board of Agriculture* (No. 2). Mr. Amos writes with a complete knowledge of the subject as a hop-grower, and is also a trained botanist; the article is therefore one of considerable interest. Hop production is a highly specialised branch of farming, requiring much more capital per acre than wheat or cattle production, and it includes not only hop growing, but also drying. The oasts, or drying ovens, are familiar objects to all who have travelled across Kent. The drying is managed by a skilled workman, who remains in charge during the whole time of hop-picking, and even sleeps on the spot so that he may be at hand in case of need. A good hop-dryer is a person of distinction in the village community, and rightly so, since he can by his efforts materially influence the value of the product.

THE extraordinary interest shown by the public in poultry production at the present time is discussed in the April number of the Journal of the National Poultry Organisation Society. To a certain extent a section of the daily Press is responsible for this outburst, but the popular interest always existed even before it was recognised by the Press. The society is proposing to take as full advantage as possible of the present favourable opportunities for the introduction of cooperative methods in egg production. It will be interesting to see how far cooperation may become a factor in English rural life.

THE *Field* of June 25 contains a summary of an important paper read by Mr. Pocock at the meeting of the Zoological Society on June 21 on the scent-glands of deer and antelopes, and their bearing on the classification of those groups. The author gave reasons for regarding the Indian four-horned antelope as related to the bushbucks rather than to the duikers, while the beira antelope of Somaliland is classed with the dik-diks instead of with the gazelles, and the saiga, the chiru, and the palla are removed from the latter group to independent positions. In the deer it is considered that the form of the antlers does not constitute a trustworthy guide to affinity.

IN the May number of the *National Geographic Magazine* Mr. H. M. Smith, the Deputy Commissioner, tells some of the wonderful results which have been accomplished by the Fisheries Commission in re-stocking the depleted waters of the United States with food-fishes, lobsters, oysters, &c. Nearly forty years ago the Government realised the urgent necessity for measures of this nature, and at the present day the official system of fish-culture is stated to surpass in importance and extent that of all other countries collectively. A few States did not join in the movement, with the result that there has been a shortage in the supply of the eggs of certain species. The obvious remedy for this is the assumption by the Federal Government of supreme power in regard to fisheries. For the first ten years of its existence the energies of the commission were concentrated on the culture of the eight commonest and most valuable food-fishes. Nowadays the list is six times as large, and includes shad, whitefish, Pacific salmon, white perch, yellow perch, cod, various kinds of flat fish, and lobsters. The hatcheries also rear numerous kinds of fresh-water species. The only permanent marine hatcheries are in Maine and Massachusetts, where, to use the author's own words, such species as cod, pollock, flat-fish, and lobsters are reared and distributed by the billion. Special attention is likewise directed to the diseases of fishes, particularly cancer, for which new laboratories are in course of erection. The article concludes with an account of new fisheries and new methods of fishing discovered by the commission.

IN an article in the June number of the *Zoologist* Mr. F. J. Stubbs endeavours to explain the mechanism by which aquatic birds are enabled to maintain themselves at different levels in the water. Moorhens, it is well known, will not unfrequently maintain themselves at a considerable depth below the surface by grasping plants with their toes, and it is suggested that the same means are sometimes employed by dabchicks. It is obvious, however, that such a method will not hold good for divers, in which grasping power is lacking. The mechanism, in the author's opinion, is afforded by the presence of a layer of air held between the "feather-film"—or mesh of barbules and cilia formed by the outer layer of the plumage—and the skin. "Each of the contour-feathers is provided with a separate apparatus of muscles, whereby it can be held out at right angles or pressed close to the body. In the first case the bird would appear round and fat, in the second very slim, and there would be a corresponding change in the extent of the air-envelope, and consequently of the buoyancy of the bird. By adjusting the thickness of this layer of air between the 'feather-film' and the epidermis the bird can alter its specific gravity." It is further considered that the water-repelling property of the plumage of a duck is due to the feather-film, and not to the natural oiliness of the feathers.

WE have received a series of contributions from the Palæontological Laboratory of Yale University, reprinted chiefly from the *American Journal of Science*. This department of the Peabody Museum, which became famous through the researches of the late Profs. O. C. Marsh and C. E. Beecher, well maintains its reputation under the direction of Prof. Charles Schuchert. The most important paper is one by Dr. G. R. Wieland describing in detail the remarkable Cretaceous turtle, *Archelon ischyros*, which has now been mounted for exhibition and measures considerably more than three metres in length. A discussion of this and allied Cretaceous fossils seems to show that the curious leathery turtles are the degenerate descendants of ordinary turtles. Baron F. von Huene and Dr. R. S. Lull publish a photograph and sketch of the original specimen of the small Triassic Dinosaur, *Nanosaurus agilis*, showing that it is much less satisfactory than might be supposed from Prof. Marsh's description. Prof. T. D. A. Cockerell and Dr. H. F. Wickham describe many insects and plant-remains from the Miocene of Florissant, Colorado; while Prof. Schuchert himself discusses a series of Silurian fossils from Arisaig, Nova Scotia, carefully collected by Mr. W. H. Twenhofel.

THE "Extracts from Narrative Reports of Officers of the Survey of India," for the season 1907–8, contain an interesting account of precise levelling carried out with the American binocular level. This instrument differs from levels of the ordinary form in several important particulars. It is provided with a second telescope, through which the bubble can be viewed and the scale reading at each end of the bubble observed at the same time as the staff reading is taken. The advantage of this is obvious, as the change in the position of the observer between the two readings, necessary in the older form of level, is almost certain to cause some shift in the position of the bubble. The staff is graduated on one face only, while the telescope diaphragm carries three horizontal wires instead of the usual single one. The two outside wires are equidistant from the centre one, and in making an observation all three wires are read. The necessity of having a second set of staff graduations on another face with a different zero and in different units is thus obviated, while the three readings form at least as effective a check against errors, and are more rapidly performed than the two required on the older system. The American instrument presents the additional advantage that the interval, as read on the staff, between the wires gives a measure of the distance of the staff from the observer. As an illustration of the precision of which levelling is now capable we may take the Bombay-Madras line. The length of this line is 806 miles, and the closing error was 0·607 foot, or about 1/100 inch per mile. A closely comparable figure could be derived from other lines. Taking another test of precision, viz. the difference in the results of two observers each making a single traverse of the same line, we arrive at a figure of about 1/20 inch per mile.

In our issue of December 23 last we briefly alluded to an interesting paper, by Mr. W. G. Reed, jun., on South American rainfall types, recently read before the Royal Meteorological Society. The author constructed a map of very large size, making use of all published data, and from an inspection of the curves it was seen that (generally speaking) there is a marked division of the rainfall into the following five types:—(1) double maximum, including the region north of the Amazon and west of Dutch Guiana; (2) maximum early in the year, including Guiana and the northern part of Brazil, except the coast region; (3) winter maximum, in the northern coast States of Brazil, also on the west side of the continent south of the equator and west of the Cordillera; (4) summer maximum, extending over central and southern Brazil, Bolivia and Paraguay, and as far south as Buenos Aires; (5) rain at all seasons, embracing the southernmost States of Brazil, Uruguay, south of Buenos Aires, and east of the Cordillera. Small graphs are drawn for stations exhibiting general types of the annual range of rainfall applicable to each of the large divisions. The author also compares his own map of seasonal rainfall with those previously published, preference being given to that by E. L. Voss contained in *Petermann's Mitteilungen*, 1907.

THE University of Wisconsin has issued an account of some instructive experiments on manuring which, while not new in principle, will be of value to agricultural lecturers. The sandy soils of northern Wisconsin are deficient in humus and in nitrogen, both of which could be applied as dung or purchased organic fertilisers. It is, however, much cheaper, and distinctly more effective, to grow a crop of clover on the soil during the previous year, and then to plough it in. The New Mexico Agricultural College has published a bulletin describing the methods of apple culture under irrigation. Apples will grow in a great variety of circumstances, and can be produced in regions lying outside the old apple belt if methods like irrigation are adopted.

THE *Electrician* for June 10 contains a supplement of 160 pages devoted to the applications of electricity to marine work. Already a large proportion of the auxiliary power required on a modern liner or battleship is supplied electrically, but the electrical engineer looks forward to the near future when electricity will play an important part in the propulsion of vessels. Three possible systems of electro-mechanical propulsion are described in this supplement. In each the prime mover is coupled direct to one or more dynamos, which in turn drive motors on the screw shafts. The great flexibility of the electrical method of transmission makes it possible to vary the speed of the vessel between wide limits without running the machinery at low efficiency. The question of the prime mover of the future is obviously an important one, and several of the writers of the articles expect the oil engine to displace the turbine, just as the turbine has displaced, or rather is displacing, the reciprocating steam engine.

A NEW petrol-electric motor omnibus, constructed by the Daimler Company, is illustrated in the *Engineer* for June 24. Two power units are fitted, one at each side of the frame under the seat line, each capable of developing 12 horse-power. The engines are of the new Daimler type, with crank shafts and frames extended for the dynamotors, by which term is meant an ordinary continuous-current dynamo which is also used as a motor. Each dynamotor is normally rated at 3 kilowatts, but has a give-and-take capacity of three to four times this rating. It is stated that on ordinary greasy roads it is found almost impossible to cause this new omnibus to skid or side-slip to any appreciable degree, and nothing in the nature of a dangerous side-slip has been experienced in 5000 miles' driving. This immunity is attributed to the following factors:—the extreme flexibility of the double-unit system; the better weight distribution obtainable by the construction adopted; the distribution of braking over the front and rear wheels, and the improved methods of braking employed; the improved co-axial pivot steering; and the comparative absence of unsprung weight. The total weight of the vehicle, complete and ready for running, is 3 tons 9 cwt., the regulations allowing 3 tons 10 cwt.

OUR ASTRONOMICAL COLUMN.

METEORITE AT BOMBAY.—Mr. W. F. Denning writes:—"Advices from India mention the fall of a brilliant fireball at Bombay on the afternoon of April 25 last, at 4.15 (standard time). One observer says the meteor flashed out three times in a descent nearly vertical, and the appearance suggested huge drops of fire from a Roman candle. A few minutes later there was a report as loud as one of the harbour guns, only more muffled, and the impression was that a big mine had exploded in the neighbourhood of Khandalla.

"At Lauovli a loud rumbling sound startled the inhabitants, the houses being shaken. Looking upward, people saw a long thin line of smoke rolling from the S.W. to N.E. across the sky. Further reports indicate that the fiery ball shot up from the direction of the sun.

"Other observers at Bombay say that the detonation resembled a blasting operation, heard for many miles around, and lasting nearly a minute. The meteor appeared as a white-hot ball, and it left a long, luminous trail. On striking the surface of the Bombay Harbour it threw up a high column of water with steam.

"At Khandalla a terrific noise was heard proceeding from the direction of Poona.

"It is doubtful whether the object really descended in Bombay Harbour, as one observer says, though it gave that impression, yet it evidently fell far beyond that spot. Directed from the S.E. sky, the radiant was probably in Leo, but the height of the meteor cannot be precisely ascertained from the data available. This is the third brilliant meteor seen in sunshine during the last nine months. Others were reported in England on October 6, 1909, and May 10, 1910.

"The region of Leo seems to be a prominent one for the supply of unusual meteors."

HALLEY'S COMET.—In Circular No. 3 of the Transvaal Observatory Mr. Innes publishes the observations of the tail of Halley's comet recorded by himself, Mr. H. E. Wood, and Mr. W. M. Worssell during May 17–21. Small sketches showing the form of the multiple tail at various times are also reproduced. In addition to the main tail there were two fainter glows separated by some degrees from the main stream near Pegasus, but re-approaching it in the neighbourhood of Aquila. Quite unexpectedly, as recorded by Mr. Payn and other observers, the remnants of the tails persisted in the eastern sky after the comet had passed the earth, and were seen each morning until the moon interfered, after May 21; but it was obvious that they were gradually fading away. On the morning of May 20 the tail was traced to R.A. 19h., dec. 5° S., 150° from the invisible nucleus. In a letter to Mr. Innes, Mr. H. C. Reeve, of Lorentzville, states that at 5 a.m. on May 19 the magnificent main tail extended to the Milky Way, and its attendant shafts were respectively 15° and 20° long, giving the whole the appearance of a huge transparent cone into which the earth was rushing. On the evening of May 19 the whole comet was south of the ecliptic, yet on the morning of May 20 the original, branched tail was still west of the sun and north of the ecliptic.

Mr. Finlay and Prof. Rudge, at Bloemfontein, report having seen a rupture of the tail, near Aquila, take place on the morning of May 18–19, but this was not recorded by any other observers.

Photographs of the comet were taken at the Transvaal Observatory, with the Franklin-Adams star camera, on every possible occasion, and are to be discussed in a subsequent Circular; one of them is reproduced on a plate which accompanies No. 4420 of the *Astronomische Nachrichten*. The chief characteristic of all the photographs is the complicated structure of the tail. Two groups of streamers are seen on either side of the axis, and, in addition, there are several side streamers showing kinks and irregularities; the photographs, in many points, resemble many of those taken of Morehouse's comet in 1908.

The *Astronomische Nachrichten* also contains notes from several Continental observatories generally confirming the results already published.

In the *Comptes rendus* for June 20 (No. 25, p. 1659) M. J. Comas Sola gives a *résumé* of the physical observations of the comet made, visually and photographically, with the 38-cm. refractor of the Fabra Observatory, during the periods of greatest brightness as a morning and as an evening object.

The comet began to be perceptible to the naked eye, at Fabra, on April 15, and the length of the tail whilst near perihelion was about 50 million kilometres (31·2 million miles). There were distinct changes in all parts of the comet after its inferior conjunction with the sun.

Before conjunction the tail was generally bifurcated and made up of numerous long filaments, without knots or sharp bends; M. Sola suggests that this simple straight appearance was the result of the intense repulsive action of the sun while the comet was so near to it. The head was relatively small, although surrounded by very feeble and extensive envelopes; measurements of the photographs generally give 110,000 km. (nearly 70,000 miles) as the diameter of the brightest part. Generally, the envelopes were eccentrically placed in regard to the axis of the tail, a feature which was very marked on May 11. The nucleus was very bright, and its diameter was about 3500 km. (nearly 2200 miles).

After conjunction, the tail was not bifurcated; on May 30 it was like a brush of numerous short hairs, and from May 31 it appeared as an aigrette, which became modified from day to day. The bright part of the head was larger, its diameter being about 160,000 km. (100,000 miles), but the fainter envelopes were reduced. The nucleus at this time was very small, probably not more than 1000 km. (625 miles) in diameter.

Measurements of the photographs of May 30 and 31 indicate that, within two million kilometres of the nucleus, the projected matter travelled at about 23 km. per sec. In a previous note M. Sola referred to projections from the head into the tail, and to the doubling of the nucleus on June 2; also to the appearance of several rapidly moving condensations on June 4. He now suggests that these appearances were a series of phosphorescent emanations which seemed to commence about May 31, and coincided with the change in the structure of the tail. Not wishing to state definitely the nature of these *ejecta*, he calls them *globes*, and gives some measures of their apparent distances on June 4. Taking a mean, he finds for the velocity with which a *globe* receded from the nucleus, 527 km. per second. All these globes appeared to vanish at a distance of about 25,000 km. from the nucleus.

OBSERVATIONS OF WINNECKE'S COMET (1909*d*).—In No. 4420 of the *Astronomische Nachrichten* Herr R. Prager gives a number of positions of Winnecke's comet observed with the 24-inch refractor of the Santiago de Chile Observatory between November 2 and December 13, 1909. At all times the comet was very faint, appearing as a circular patch of light 0·7′ in diameter, and having no tail or nucleus; after December 13 it was too faint to be seen.

COLOUR OF COMET 1910*a* DURING ITS PERIHELION PASSAGE.—Observed at the Transvaal Observatory on January 17, the great comet 1910*a* was near the zenith, and therefore practically free from the colour-absorption effects of our atmosphere. Mr. Innes records that, under these conditions, it was identical in colour with, and almost indistinguishable from, the pure snowy-white, alto-cumulus clouds which were passing at the same time (Circular No. 3, p. 21).

THE INTERNATIONAL BOTANIC CONGRESS AT BRUSSELS.

THERE was a large and representative gathering of botanists in Brussels on the occasion of the International Botanical Congress on May 14–22. The inaugural meeting took place in the large rotunda at the Botanic Gardens, but the serious work of the congress was carried out in the Salle des Fêtes in the grounds of the Exposition. The important subjects of deliberation were further consideration of the rules of systematic nomenclature and a series of propositions on phytogeographical nomenclature. The rules of systematic nomenclature which were drawn up as the result of the deliberations of the Vienna Congress in 1905 left open for future discussion special points in relation to non-vascular cryptogams and palæobotany. A number of sectional committees were appointed, and their recommendations formed the subject of debate at the recent congress. The chief matter for discussion was the starting points for nomenclature in the various groups. Was the date of publication of Linnæus's "Species Plantarum," 1753, which had been adopted as the beginning of nomenclature for seed-plants and ferns, to be the universal starting point throughout the plant kingdom, or would it be preferable to take the date of publication of later systematic works dealing with the various groups of cellular cryptogams?

After some informal discussion among the workers in the groups in question, a series of recommendations was agreed to by the congress. The date 1753 was accepted as the starting point for the Mycetozoa, Algæ (excepting certain groups to be noted below), Characeæ, Sphagnaceæ, Hepaticæ, and Lichens. The exceptions to the general rule for the Algæ were as follows:—Desmids, J. Ralfs, "British Desmidieæ," 1848; Oedogoniaceæ, K. E. Hirn, "Monographie u. Iconographie der Oedogoniaceæ," 1900; Nostocaceæ, M. Gomont, "Nostocacées homocystées," 1890, and E. Bornet and Flahault, "Nostocacées hétérocystées," 1886–8.

For the Fungi, Fries "Systema Mycologicum," 1821–32, was adopted as the point of departure, excepting for the Uredineæ, Ustilagineæ, and Gasteromycetes, which it was agreed should date from Persoon's "Synopsis," 1801. For Mosses, Hedwig's "Species Muscorum," 1801, was agreed upon. In order to reduce to a minimum changes of names which would result in cases where an early date was adopted as a starting point, special committees were appointed for each of the large groups to draw up lists of *nomina conservanda*, or names of genera which, from long-established use, should be retained, though inadmissible on grounds of strict priority. These lists will be put before the next congress of 1915; in the meantime, workers are recommended to make as few changes as possible from generally accepted nomenclature. The discussion of a starting point for the nomenclature of Bacteria, and of the Schizophyceæ, excepting the Nostocaceæ, was postponed until the next congress of 1915.

A useful decision was arrived at in connection with the names of pleomorphic fungi, the successive states of which have been described under different names. It was agreed that these should bear one generic and specific name, viz. the earliest given to the state, which it is agreed to call the perfect state, on condition that this name otherwise conforms to the rules. The "perfect state" is that which leads up to the ascus in the Ascomycetes, the basidium in the Basidiomycetes, the teleutospore in the Uredineæ, and the spore in the Ustilagineæ. The addition of figures, including microscopic details, was recommended when describing new genera or species of fungi.

In palæobotany some difficulty has arisen from the use of the same genus name for recent and fossil plants. In order to reduce to a minimum changes of name resulting from this cause, it was agreed to draw up a double list of generic names which are to be retained:—(1) a list of the generic names of living plants, duly published and in general use, which enter into competition with earlier names of fossil genera, such as Bucklandia; (2) a similar list of generic names of fossil plants which compete with earlier homonyms of living plants, which have been relegated to synonymy, in order to avoid the future use of such names for the living plant. In the former case the name of the living plant takes precedence, in the latter that of the fossil.

The palæobotanists showed some disinclination to fall into line with workers in descriptive botany generally in making use of a Latin diagnosis when describing new genera or species. It was, however, pointed out that a diagnosis, giving merely the important characters of the fossil in question, was required, and not a complete description; and, further, that such a diagnosis rendered the form in question far more widely intelligible than a description in a vulgar tongue. Those members who were present at Vienna in 1905 called to mind the difficulty experienced when attempting to limit the number and variety of vulgar tongues which should be admissible for the diagnosis of novelties. It was agreed that a Latin diagnosis should be given, with the recommendation to the author to add a full description in a vulgar tongue.

The last matter for discussion was the proposition to add to the list of *nomina conservanda* for seed-plants. The original list, which was agreed to by the Vienna Congress, was admittedly incomplete, but as it had been accepted and used for five years many botanists were disinclined to amend it. A list of additions was proposed which, if accepted, would have upset again changes made since 1905 in conformity with the rules. On the other hand, the new list contained names of large and important genera, such as Persea, which could only be retained if included in a list of *nomina conservanda*—on strict grounds of priority they are inadmissible. It was decided to remove from the list those names of genera the inclusion of which would be subversive of changes already made, and with this important alteration the additions to the original list were agreed upon.

Dr. John Briquet, upon whom as Rapporteur-Général has fallen the brunt of the work of the section of systematic nomenclature, was persuaded to continue in office for the next five years until the congress of 1915.

The Vienna Congress had also appointed a commission of eminent plant-geographers to draw up recommendations for phytogeographical nomenclature. The reporters of the commission, Profs. Flahault and Schroeter, drew up a report embodying their own views and those of other workers upon various aspects of the question, and also a series of recommendations based on the consideration of the views and suggestions put forward. These recommendations were accepted by a large majority of the commission, and formed the subject of debate at the congress. It was recognised that the congress should not attempt to pass laws or rules, but merely recommendations supported by reasoned annotations. It became evident, however, that a general agreement on the recommendations as a whole was not likely to be reached, and the reporters therefore decided to put before the congress only those recommendations upon which there appeared to be substantial agreement. The substance of these was as follows:—

(1) That every author should explain exactly what he understands by the terms he uses.

(2) That the popular names of units of vegetation in the various languages should be retained.

(3) That the principle of priority in phytogeographical terminology is inadmissible.

(4) That a polygot synonymic dictionary of phytogeographical terminology with bibliographical references should be compiled by a special commission.

(5) That the colour scheme suggested by Prof. Engler for maps of tropical vegetation be recommended for adoption.

(6) That ecological phytogeography may be defined as the study of the relationships of plants and plant-communities with their environment.

These recommendations were carried *nem. con.* As regards the somewhat contentious question as to the meaning and definition of the two terms *plant-association* and *plant-formation* which have come into use to designate the most important units of vegetation, Prof. Flahault stated that there appeared to be general agreement in considering the *association* as a unit of definite floristic composition and the *formation* as something different from the association.

Though it has not resulted in the establishment of a uniform system, the work of the commission has been of the greatest use in forcing workers to think about the concepts and terms they employ and in promoting international exchange of views; the promised synonymic dictionary will be invaluable.

An invitation to the congress to meet in London in 1915 was accepted.

At the conclusion of the congress many of the members went on to Berlin to visit the new Royal Botanic Garden and Museum, at the invitation of the director, Prof. Adolf Engler. The spacious new gardens, with the commodious plant-houses, museum, and herbarium, which have been arranged by Dr. Engler at Dahlem, fifteen minutes by rail from Berlin, have replaced the older, smaller, and less convenient institution in the Grunwaldstrasse, Berlin. A special interest attaches to the gardens and museum at Dahlem. Starting *de novo* with the advantage as object-lessons of the great botanical institutions throughout the world, Dr. Engler has organised a garden and museum on thoroughly scientific lines, and embodying the ideas of a great systematist and plant-geographer. It was a great privilege to be conducted through the grounds and buildings by Dr. Engler, with the help of Prof. Urban, the assistant-director, and other members of the staff, and in the glorious summer weather which prevailed at the end of May the gardens showed to the best advantage. The arrangement is strictly scientific and educational, a small space only being devoted to mere ornamental gardening. A large portion is arranged on the lines of plant-geography. Here we find a representation of typical German forest-land and other Central European formations, and, so far as space and climatic conditions permit, illustrations of the vegetation of widely different areas both in the Old and New Worlds. A most striking feature is the Alpine section, or Alpinum. Miniature mountain ranges have been thrown up, as far as possible to scale, and formed of the natural stone, and planted with the characteristic species and plant associations of the mountain area in question; an attempt has also been made to indicate altitudinal distribution. The student is thus able to make himself acquainted by an object-lesson, to some extent, at any rate, with the flora of the Swiss Alps, the mountains of the Caucasus, or the Himalayas. Miniature streams and waterfalls add to the effect.

Another section is devoted to biology and morphology, while another forms a systematic teaching collection, with facilities to enable the student to work at the plants on the spot. Medicinal and economic plants have also their section. A great part of the area is devoted to the arboretum, a fine collection, though still young, as work on the gardens was only begun about fourteen years ago. The plant-houses include a fine tropical house illustrating a tropical landscape, with a wonderful lawn of *Selaginella Kraussiana*, and forming the main feature in a four-sided series of smaller houses devoted especially to aroids, tropical dicotyledons, tropical orchids, other tropical monocotyledons, tropical ferns, various succulents, Cactaceæ—these last two forming a particularly fine collection—tropical economic plants, tropical water and marsh plants, Cape plants, subtropical Australian plants, and others; also a large temperature house and numerous culture houses. The museum contains a spacious herbarium and a number of fine exhibition galleries, including sections devoted to biology, systematic botany, palæobotany, plant-geography, and economic botany, also a section illustrating the products of the various German colonies. In addition there is a large lecture theatre, a laboratory, and a number of work-rooms. The whole forms a magnificent example of botanical organisation and enterprise.

On the following day opportunity was given for visiting the State School of Horticulture and the Biological Institute for Agriculture and Forestry, both adjoining the Botanic Garden.

An interesting and enjoyable meeting closed with a pleasant excursion on the Wannsee to Potsdam, arranged by the Union of Systematists and Plant-geographers. This included a visit to Sans-Souci and the Royal Park and Gardens under the guidance of Director Fintelmann.

A. B. R.

AN ENGLISH PHILOSOPHICAL CONGRESS.

ON Friday and Saturday last, June 24 and 25, joint meetings of the Aristotelian Society, the British Psychological Society, and the Mind Association were held at 22 Albemarle Street, London, at which subjects of wide philosophical and psychological importance were discussed before large and interested audiences. The discussions were based upon papers previously printed and circulated among the members of the several societies. On Friday afternoon the problem of "Instinct and Intelligence" was considered on the basis of papers by Messrs. C. S. Myers, C. Lloyd Morgan, H. Wildon Carr, G. F. Stout, and Wm. McDougall; Saturday morning was devoted to the discussion of the question, "Are Secondary Qualities Independent of Perception?" on the basis of papers by Messrs. T. Percy Nunn and F. C. S. Schiller; and the congress was brought to a close on Saturday afternoon with papers on the nature and development of attention, by Mr. G. Dawes Hicks; the "faculty" doctrine: outline of some experiments on school children in relation to this doctrine, by Mr. W. H. Winch; and some observations on the æsthetic appreciation of colour combinations, by Mr. E. Bullough.

I.—*Instinct and Intelligence.*

Dr. C. S. Myers maintained the view that instinct and intelligence are inseparable in all forms of mental activity, animal and human alike; that they are respectively the objective and subjective aspects of the same thing, viz. mental process in general and in its various particular manifestations; and that instinctive behaviour, while characterised by mechanism in its objective aspect, is from the point of view of the experiencing subject characterised by finalism. He criticised the two assumptions commonly made with regard to instinct as a form of mental process distinct from intelligence, viz. that in instinctive behaviour as such there is no awareness in the individual's consciousness of the end to be achieved, and that such behaviour is fixed and from the beginning perfect. He pointed out that an instinct is to be distinguished from a mere reflex or chain of reflexes by (1) a feeling of activity, and (2) a vague awareness of the result of the instinctive action *before* the action is actually performed, both characteristics being present in the very first manifestation of the instinct. These rudiments of conation and meaning are essential constituents of any activity deserving the characterisation "instinctive." Observations of instinctive activities in insects and other animals do not justify the view that such activities are "perfect the very first time," or that they exhibit undeviating uniformity; "even ants are capable of learning from their elders," and this power is generally regarded as a sign of intelligence. The common view that man has few instincts compared with the lower animals is partly accountable for by the fact that "he is never aware that he is acting instinctively." His inner or subjective acquaintance with those activities pronounces them to be of the nature of intelligence.

Lastly, from the more general points of view of evolution and philosophy, the finalistic interpretation of the evolution of mind, and indeed of the entire universe, is the necessary complement and essential correlative of the mechanical interpretation, if our thought is to be saved from that pure abstraction—purposeless mechanism.

In conclusion, neither are instincts identifiable with reflexes, nor do they form a third class in addition to those of reflexes and intelligence. Summing up in Dr. Myers's own words:—"According to my view and my use of the words, instinct regarded from within becomes intelligence; intelligence regarded from without becomes instinct."

Prof. Lloyd Morgan agreed with Dr. Myers so far as to admit that the two factors, instinct and intelligence, "are present in the most intimate relationship throughout very nearly the whole range of animal behaviour as exhibited by those organisms in which the central nervous system has reached a sufficiently high level of development and differentiation to justify the use of the words 'instinctive' and 'intelligent.'" In his view, "the instinctive factors depend entirely on how the nervous system has been built up through heredity under that mode of racial preparation which we call evolution; intelligent behaviour depends *also* on how the nervous system has been modified and moulded in the course of that individual preparation which we call the acquisition of experience." (Dr. Myers suggested in the course of the discussion that this was genetic rather than psychological analysis.)

Prof. Lloyd Morgan illustrated his views by means of a somewhat detailed account of the experience of a young moorhen chick, and gave as a brief definition of instinctive behaviour, behaviour which is "practically serviceable on the occasion of its first performance," thus including within its scope reflex action so far as this is accompanied by consciousness. He also referred to the behaviour of the Yucca moth, and to the stinging of prey by the solitary wasps, as instances of instincts performed once only in the lifetime of the individual, where learning by imitation, &c., was impossible. He considered that the element of intelligence supervened in originally instinctive behaviour by the introduction of "meaning" through "factors of revival," though he emphasised the fact that "this is every whit as much the outcome of the innate potentiality of the moorhen as the originally instinctive performance." If instinct be identified with innate potentiality, all intelligent behaviour involves an instinctive element.

Mr. H. Wildon Carr considered the problem from the philosophical standpoint, and gave a detailed exposition of Bergson's views, which he supported by arguments for the most part metaphysical. He refused to identify natural dispositions or tendencies with instinct, and for this reason found himself unable to agree with Dr. Myers's view. He emphasised the contrast between the very complicated instinctive activities of ants, bees, &c., many of which cannot by any possibility have been learnt by individual experience, and the more pronounced cases of intelligence in man, and, reminding his audience that "instinct and intelligence are not observable facts, but interpretations," proceeded to show how the two terms represent two distinct lines of evolution of animal life, along each of which there is to be found no tendency towards evolution in the direction of the other. Along one, instinct evolves at the expense of intelligence; along the other, intelligence evolves at the expense of instinct. "The fundamental difference is one of kind, and lies in the mode of apprehension of reality, and the kind of knowledge that serves the activity of each. It is this essential difference that accounts for the degree of consciousness or unconsciousness, plasticity or fixity that characterises each, and not *vice versa*. . . . It is not a scientific but a metaphysical distinction, which rests on a criticism of the nature and limitations of intellectual and instinctive knowledge." Intelligence is a knowledge of the relations of things, instinct is a direct insight into their inner nature. Bergson has employed the word "sympathy," in its technical sense, to represent this kind of knowledge. In Mr. Carr's view, mechanism and finalism are mutual contradictions, resulting from the limitations of merely intellectual knowledge.

Prof. G. F. Stout agreed with Dr. Myers, as against Prof. Lloyd Morgan, that every instinctive action as such is determined by intelligence, for the reason that the very first performance of an instinctive action involves intelligence. Adopting provisionally Prof. Morgan's own criterion of intelligence as "learning by experience," he showed that the learning must take place on the first occasion and not on the second (where the second is the presentation of a situation similar to that of the first, but to which the animal reacts in a different way owing to its previous experience). "On the second occasion the lesson is utilised; but in order to be utilised it must already have been learned." Unless there is mental reference beyond the immediate present there can be no intelligence, but such reference cannot be furnished by mere revival of past experience itself lacking reference. Conation, or the felt tendency towards an end, which, equally with the cognitive aspect, is present in the first performance of an instinctive act, forms the basis of attention and initiative which contributes to the "future reference" above-mentioned, and also definitely marks off instinctive action from merely reflex action.

Prof. Stout rejected Mr. Carr's view that instinct is a peculiar way of knowing, distinct from intelligence, his reason being that he could "find nothing in the instinctive behaviour of animals which cannot be accounted for by the combination of certain purely biological adaptations with psychical processes marked by intelligence fundamentally akin in nature to all other intelligence." He sided with Prof. Morgan against Dr. Myers in thinking that use of the term instinct should not be extended to cover all cases of inherited nervous organisation conditioning the development of intelligence, but that the word should be used "to mark off a distinct kind of connate endowment," viz. congenitally definite modes of behaviour; but he supplemented Prof. Morgan's criterion of definiteness (definite enough to be "practically serviceable on the occasion of its first performance") by saying that the congenital definiteness referred to was "a definiteness such as would require to be explained as the result of learning by experience or conscious contrivance, if it were not directly provided for by inherited constitution of the nervous system, as determined by the course of biological development." What non-instinctive congenital endowment provides for is "a special capacity for acquiring skill and knowledge," itself dependent on interest and retentiveness. It is marked endowment in this direction which distinguishes genius from ordinary ability.

In Stout's view, instinct "is mainly confined to animal life, and in the life of animals it has a two-fold function. On the one hand, it is a substitute for learning by experience. On the other, it has an educative value as a condition of learning by experience; it has this value inasmuch as it provides an animal with the experiences which are useful to it, and thus enables it to learn just what it requires to learn. In the case of human beings, this function of instinct is, in the main, superseded by instruction. All that either instinct or instruction can do is to supply appropriate experiences. How this material will be utilised depends on other factors."

Mr. William McDougall found himself for the most part in close agreement with Dr. Myers and Prof. Stout. He regarded instinctive processes and intelligent processes as of essentially similar nature, as involving the same fundamental modes of mental activity, but considered that "we can properly and usefully distinguish between mental processes that are conditioned wholly or mainly by innate dispositions on the one hand, and on the other hand such as are conditioned by dispositions that have been largely built up through the experience of the individual," and that "the words instinctive and intelligent may properly be used to mark this distinction." He objected to Stout's use of the designation intelligent for every process which is *capable* of producing modification of innately determined modes of behaviour, even when such modification is not, as a fact, brought about. Intelligence is only operative when a modification is effected. Thus the Yucca moth, laying its eggs in the Yucca flower on a single occasion in its life, may be said to perform an act which is purely instinctive, having no admixture of intelligence. Prof. Bergson's view of instinct, presented by Mr. Carr, is not supported by the facts. The work of Dr. and Mrs. Peckham on solitary wasps has shown that instinctive activities are far from being perfect and invariable in nature, and that they may be combined with a (seemingly) high degree of intelligence. In Ammophila the capacity for acquiring and acting upon detailed knowledge of locality is found developed to an extraordinary degree. This development of intellect is all the more remarkable when we consider at what a disadvantage the higher insects are placed compared with the higher mammals in being deprived of all the advantages for training of the intelligence given by a period of youth (play, &c.).

Bergson's use of the term sympathy does not seem very appropriate or helpful in many actual cases of instinctive activity, *e.g.* that of the paralysing wasp.

Lloyd Morgan's view that the strictly mechanical interpretation of natural processes is the only one permissible to science forces him to the identification of instinctive action with compound reflex action, and causes him to ignore the extremely important conative character exhibited by the process.

The criterion of being "practically serviceable on the occasion of its first performance" is not sufficient to mark off instinctive activity from reflex action on the one hand, and from intelligent behaviour on the other.

The small part assigned by most psychologists to instincts in the development and functioning of the human mind is surprising and difficult to understand. Especially is this the case with regard to Prof. Stout's system of psychology, and its explanation would seem to be that Stout limits the application of the term instinct to forms of mental process expressed through innately coordinated motor mechanisms. "Now all our mental processes manifest themselves through the agency of preformed motor coordinations, innate or acquired. For Stout, then, as for me (McDougall), instinctive process can be marked off from other modes of behaviour only by reference to the origin of some part of its conditioning factors in the innate constitution of the organism. For Stout the innate factors by which it is marked off are the motor mechanisms only by which the mental process manifests itself in bodily movement; for me they are also and chiefly the innate disposition by which the whole instinctive mental process is conditioned." The specific conative tendency exhibited by each instinctive process is a far more important and characteristic feature of the process than the operation of innate motor coordinations. The only reason why Stout selects the latter rather than the former as the differentia of instinctive process is "because the more essential feature, the specific conative tendency, continues to reveal itself at all levels of mental development and throughout the life of the human mind, while the innate motor factor comes clearly into view only in instinctive processes that are relatively pure."

Another characteristic of purely instinctive activity which Stout has failed to note is the existence of an unmodified innate perceptual disposition which conditions the perception evoking the instinctive reaction. Such innate perceptual dispositions continue to be active in the adult human mind, though undoubtedly modified and differentiated through experience.

McDougall summarised his view of instinct as follows:— "A typical example of a purely instinctive action implies the existence in the creature's innate constitution of, first, a specialised perceptual disposition; secondly, a specific conative tendency that is excited when this perceptual disposition is played upon by the appropriate sense-impression; and, thirdly, some coordinated system of motor channels through which the conative tendency works towards its satisfaction. The three things belong together; each implies the other two; each can subserve the life of the organism or of the species only in conjunction with the other two; all three together constitute a functional unit which is transmitted as such from generation to generation; and to such a functional unit of the innate constitution only, and to no part of it alone, and to no other fact or feature of the organic world, can, I submit, the name instinct be properly applied."

II.—*Are Secondary Qualities Independent of Perception?*

Dr. T. Percy Nunn maintained in his paper "(1) that both primary and secondary qualities of material bodies 'are really in them, whether anyone's senses perceive them or no'; (2) that they exist as they are perceived; and (3) that sensations, as mental entities exercising a representative function, need not, therefore, be postulated." He attacked the view that there are elements in experience (*e.g.* tooth-ache) whose being consists "only in being experienced," and these are therefore psychical in nature, showing how the (false) belief in their psychical nature arose. In place of this view he advocated a form of the theory of realism which he considered to be more consonant with the facts of science and immediate experience, and which involved the theses above-mentioned. He devoted much space to the consideration of the problems of error and illusion as they appeared from this point of view.

Dr. F. C. S. Schiller criticised Dr. Nunn's theory of realism from the point of view of pragmatism, and endeavoured to show that all his arguments were based upon pragmatical postulates. He also considered critically the senses in which the words ***independent, extramental, reality***, had been used in the paper, and to what extent the theory advocated could be regarded as a metaphysical one.

III.—*Psychological Papers.*

Prof. G. Dawes Hicks criticised the views of attention which made it either, on the one hand, "a unique faculty" or "mode of mental energy" having presentations for its objects, or, on the other hand, a property of the presentations themselves regarded as independent and interacting with one another. He advocated the treatment of the problem of attention from the genetic point of view, and urged that the attempt should be made to form some conception of the conditions under which attention became possible in the primitive mind. After a consideration of the various factors influencing the attention process, such as feeling-tone, intensity of stimulus, &c., he traced the gradual growth of voluntary attention and indicated the relation of attention to willing and to the consciousness of self.

Mr. W. H. Winch discussed the value of the "faculty doctrine" in the light of experimental results obtained in the investigation of different forms of memory, accuracy, &c. The results of investigations into the transfer of practice effects, in which the method of "equal groups" was employed, were given, and were shown to prove slight transfer in the domain of memory, but none in that of accuracy, the improvement in the allied function being so small, even in the former case, compared with the improvement in the medium of training itself, as to make the balance of evidence against the "faculty doctrine."

Mr. E. Bullough described a series of observations made on a large number of individuals as to their preferences for colours, when seen in pairs, and the reasons given by the subjects themselves for such preferences. The two methods of (A) appreciation and (B) production were employed, and the material used was coloured silks. The subjects were found to belong to the following "perceptive types":—(*a*) objective type; (*b*) "physiological" type; (*c*) "character" type; (*d*) associative type. Definite relations were shown to exist between these perceptive types and the various criteria of preference or rejection of pairs of colours, such as "balance," "unification and dissociation," "consonance and dissonance," &c.

The societies dined together at the Criterion Restaurant on Friday evening, Prof. W. R. Sorley being in the chair. In the course of the after-dinner speeches the important suggestion was made by Prof. S. Alexander, and accepted with acclamation by the company, that the Aristotelian Society should strive to become the representative society of English philosophers, much as the Chemical Society, the Physical Society, &c., represent English science in those subjects.

WILLIAM BROWN.

THE MOTION OF THE MOON.

THE *American Journal of Science* for June contains an interesting article in which Prof. E. W. Brown discusses possible causes for the want of agreement between the moon's observed motion and theory. In his second section Prof. Brown gives a summary of these outstanding discordances:—(1) a secular acceleration 2″ greater than that due to the change of the eccentricity of the earth's orbit round the sun; (2) a term of 300 years' period and coefficient 15″; (3) a term of 60 years' period and coefficient 2″.

The secular acceleration is usually ascribed to tidal friction. Prof. Brown considers certain hypotheses as to the origin of the three-hundred-year term. He takes no further notice of the sixty-year term. It is quite possible, however, that the secret will be ultimately revealed by the term of shorter period, for if we assume that the forces required for the two terms vary as the coefficients and inversely as the square of the periods, it appears that the force required for the smaller term is the larger; moreover, the period of the sixty-year term is already known with a smaller percentage of error, and the next few years' observations will accentuate this consideration in its favour.

The fourth section of the paper lays down the fundamental rule which controls this detective problem. Any hypothetical cause must be dismissed from consideration that would produce a motion in either perigee or node above thirty seconds of arc in a century. Here Prof. Brown is at least as cautious as there is any need to be; he might have said fifteen seconds instead of thirty.

The sixth section dismisses from consideration the figure of Jupiter, the cumulative effect of the asteroids, and light pressure. Imperfections in the calculated theory seem to Prof. Brown inconceivable, and those who have followed his work will agree with him.

The seventh section raises the hypothesis of an equatorial ellipticity in the sun's figure. There is no direct evidence of such an ellipticity, and, moreover, it becomes necessary to assume that the period of rotation of the sun must be of a length that can be specified to its hundred-thousandth part. It is true that this period lies between the extreme values that have been determined from observation of the photosphere, and these values differ by six parts in a thousand; but it is clearly a large assumption to take 1·00000 (five zeroes) as the true value of a quantity of which all we are entitled to say is that it probably lies between $1 \pm 0{\cdot}003$.

The eighth section deals with magnetic hypotheses. The discordance between theory and observation in the moon's motion is not due to the secular motion of the magnetic axis of the earth, but it is possible to frame hypotheses as to the moon's magnetism that cannot be dismissed as impossible.

The conclusions of the ninth section, dealing with the moon's libration, are very similar in character to those of the preceding section. Some hypotheses can be ruled out, for they involve librations that would have been already detected by observation, but other hypotheses remain tenable for the present, in particular a long-period libration of fifty seconds.

THE TRAINING OF ENGINEERS IN FRANCE.[1]

IN a lecture published in the *Revue générale des Sciences* for April, M. André Pelletan compares the training of engineers in France with the similar training given in the United States, England, and Germany. He devotes himself more particularly to the courses of study provided for those intended to occupy the highest engineering posts.

In so far as the lecture deals with the courses elsewhere than in France, there is, naturally, little that is new in his paper, but his statement in regard to the training given in the École polytechnique will cause surprise to those not well acquainted with the work of that important institution.

It appears that students enter about the age of seventeen, as soon as they have passed the French equivalent for an English matriculation examination (the *baccalauréat*).

[1] "La Formation des Ingénieurs en France et à l'Etranger." By André Pelletan.

They then commence the preparatory course, which occupies, on the average, not less than three sessions, for, although 22 per cent. of the students complete preparatory courses in two sessions, 45 per cent. take three sessions, 27 per cent. four sessions, and 4 per cent. five sessions. This preparatory course comprises mathematics, chemistry, mechanics, and physics, as well as modern languages; it extends over about seven months in each year, and the course is repeated year by year. M. Pelletan thinks that to make a student follow the same course for an average of three years must frequently tend to make him rather stupid. According to him, the course in mathematics is much too theoretical in its character; the students spend too much time on analytical geometry; they deal too much with abstractions and too little with problems involving realities and actual numbers; as a result, their attempts to apply the mathematics they have learned lead to results, not only false, but actually absurd.

When the student has completed his preparatory course he spends two years on the more advanced courses, making a total of five years' study. A very large part of his time is devoted to higher mathematics, as is shown by the fact that about 36 per cent. of the marks awarded for purposes of classification are given to this subject, while mechanics and machinery receive about 26 per cent., physics about 21 per cent., chemistry about 20 per cent., astronomy (!) about 9 per cent., architecture about 2 per cent., history and literature about 4 per cent., German about 4 per cent., drawing about 5 per cent., and military subjects about 5 per cent. According to M. Pelletan, a large part of the mathematical course is simply a repetition of the work done before.

The amount of time spent on practical work is absurdly small; none is mentioned in the case of mechanics and machinery; only six lessons are given in physics and eleven in chemistry; on the other hand, the physical welfare of the students is treated more seriously, for they receive eighty lessons in horsemanship, sixty-four in gymnastics, forty in fencing, and sixteen in boxing.

Students are allowed little liberty; they are under military discipline, have little leisure, and are required to spend a considerable time in drill, &c.

According to M. Pelletan, the result of this is that the most mediocre students, provided they are gifted with a good memory, come out first in the list and receive the best positions; in all that concerns "red tape" they are perfect, but they lack initiative, for they have never been allowed to think or do for themselves.

It is not for a foreigner to criticise French methods, many of which, as the writer well knows, are admirable, but if the premier engineering school of France is conducted on the principles set forth in this paper, there is certainly ample room for that reform which the author demands. The present writer has ventured to suggest to the director of the École polytechnique that a reply should be made to this indictment of his institution.

J. WERTHEIMER.

REFRIGERATION.[1]

A SHORT account of the first International Congress on Refrigeration appeared in NATURE of October 2, 1908, and served to indicate the important position which refrigeration has taken in the fields of technics and commerce.

The bulky volumes before us, in which communications appear in their original French, English, German, or Italian, fully confirm that view. The subjects discussed range from magneto-optic investigations on liquid hydrogen, through the preparation of cooling agents to the law of the transport of chilled food; from the use of liquid air in mining to its use for increasing the efflorescence of bulbs.

These 200 communications vary very much in character. Some are *résumés* of well-known work at low temperatures, others compilations by authors who appear to have been ignorant of the work of others in the field, and to have thought it necessary to fill their papers with elementary transcriptions from text-books.

[1] Premier Congrès international du Froid, Paris, Octobre 5-12, 1908. Tome i., Comptes rendus, pp. iv+700. Tomes ii. and iii., Rapports et Communications Vol. ii., pp. iv+1009+ii; vol iii., pp. iv+963+ii; illustrated. (Paris Secretariat-Général de l'Association du Froid; London: 3 Oxford Court, Cannon Street, n.d.) Price, 3 vols., 25s.

The vast majority, however, are new and valuable additions to the subject. Many are the results of prolonged and careful experimental research on questions such as the industrial separation of oxygen and nitrogen from the air, the specific heat of certain salt solutions, the conductivity of insulators under experimental and under practical conditions, and both relatively and absolutely. Naturally much attention was paid to the preservation of food of all kinds, both on land and at sea. In this connection the particularly complete investigations from America on the physiological effect of cold storage for varying times and at varying temperatures on poultry are specially noticeable. This paper is accompanied by really beautiful photographs of sections, and quite disposes of the notion that cold storage has any bad effect on nutritive values if maintained at the proper temperature and followed by careful thawing in dry air. Many other communications discuss the same question less exhaustively with regard to other food materials. In this connection it is noticeable that, on the whole, the standard of the English papers was below that reached by those from the other great countries. Happily, this defect was to a large extent made up by the colonial communications; but this does not fully atone for the want of any official notice of the congress by the Boards of Trade and Agriculture. The difference is particularly marked with reference to America, and is only an indication of the want of interest these departments take in the fields which they are supposed to represent. Another question which appears in several communications in various forms is that of suitable units for the refrigerating industry. It is extremely desirable that some agreement should be arrived at which would be internationally acceptable. As a result of these deliberations an international bureau has been formed, which has come to some agreement, and which will submit recommendations to the next congress at Vienna in October, 1910.

FRANCIS HYNDMAN.

UNIVERSITIES AND TECHNICAL TRAINING.[1]

PERHAPS the most noteworthy educational event of modern times was the origin and development of the Universities of Berlin and Bonn. After the Battle of Jena and the humiliating Treaty of Tilsit, after the closing of the University of Halle by Napoleon, at a time when Prussia had sunk under the heel of Bonaparte to the rank of scarcely a third-rate Power, the King, influenced chiefly by the brothers Wilhelm and Alexander von Humboldt, determined to look to higher education as a means of retrieving his country's fortunes. Such was, and still is, the faith across the Rhine in the practical value of education to the State. Napoleon got his Treaty of Tilsit, but there were men by the side of the Prussian King with great ideas, men who with stern and far-seeing determination forged weapons which, during the hundred years which have passed since then, in the field, in the laboratory, and in the *Seminar*, have made Prussia, have made Germany, what they are to-day.

The mediæval university as it developed in England held residence, in the sense of actual living together in seclusion, as an essential condition of study. The modern university, following the almost universal practice, required residence indeed, but residence only in the sense of working and thinking together, in science in the laboratory, in literature and philosophy in the *Seminar*. The faculties of the mediæval university were retained—theology, law, medicine, and philosophy—music and other technical subjects were left outside to the care of special schools. The mediæval university, as we have seen, had behind it the accumulated prestige of centuries; the modern university had no such individual advantage; it built upon the common educational history of mankind, and adapted itself with the greatest freedom to the requirements of the time. There is much wisdom in the saying that a university is born old. The mediæval university was a centre of dogmatic teaching; research, if not explicitly discouraged, was practically discouraged by the fact that general culture, the training of the judgment, was aimed at, not specialised learning; a recent Cambridge writer puts the object as "not how to keep our trade, but how to keep our souls

[1] From a lecture delivered before the Royal Dublin Society on March 9 by Prof. A. Senier.

alive." The modern university broke away from this entirely, its ideal being research, with absolute freedom. Paulsen, in his well-known work on "German Education," says:—"Scientific research cannot possibly be regulated by decrees of the ruling powers, but can only thrive in full liberty: to find aims and objects, means and ways of speculation and research, must be left to individual initiative." The teaching of sufficient preparatory knowledge, chiefly in languages and mathematics, was left to the secondary schools, these having long attained to a very high degree of efficiency in Germany. Thus the modern university became a research university, the object of study, according to Paulsen, being "the ability to think scientifically, that is to say, the ability to comprehend and test scientific researches, and to conduct them; and in the second place, to solve practical problems on the basis of scientific knowledge." This ideal, which includes both the pursuit of pure science and its technical applications, was realised to the greatest degree in the philosophical faculty. The results were sometimes great and sometimes small, but were always honest attempts to do something toward the advancement of knowledge.

To be successful in research it is necessary to confine the attention to special departments of the subject of study, to specialise, and to become acquainted, at first hand, with the work of previous investigators, their difficulties and failures, as well as their final results, obtained in the original records published in the scientific journals of their respective countries—not from inhuman text-books or mechanical indexes. Every large research laboratory consists of a little army of specialists who consult one another in the subjects in which each has special knowledge, just as in ordinary life one consults the physician, the lawyer, or the engineer. Next, success depends largely on imaginative capacity. This should be strengthened by every available means. Many find strength in poetry, fairy-tales, the Arabian Nights, in music—for by the scientific method, conjectures, hypotheses, have to be invented, to be subjected to rigorous experimental or other testing, and to be abandoned, modified, or established as they are found to conform, or not to conform, to nature. Again, everything should be done to awaken and to cultivate natural curiosity respecting the unknown: the leader, the teacher, should never miss an opportunity to direct attention to possible new developments. Prof. Appell, of the Sorbonne, recently defining a man of science, said he did not mean "the man who knows," but the man who "combines with his knowledge scientific activity, that is to say, a curiosity always alert, indefatigable patience, and, above all, initiative and again initiative."

In the foregoing paragraphs I have endeavoured to indicate the conditions essential to the success of research, to the success of a research university—conditions from without, contributed by the community, by the State, a suitable environment; and conditions from within, properly trained leaders and students to follow them, afterwards to carry on the leadership. Thus, as to the first condition, Wilhelm von Humboldt in a State paper, in 1810, says:—"The State should not treat the universities as if they were higher classical schools or schools of special sciences. On the whole, the State should not look to them at all for anything that directly concerns its own interests, but should rather cherish a conviction that, in fulfilling their real destination, they will not only serve its own purposes, but serve them on an infinitely higher plane, commanding a much wider field of operation, and affording room to set in motion much more efficient springs and forces than are at the disposal of the State itself." As to the second condition, in the selection of leaders, of professors, Paulsen tells us that "proficiency in some branch of scientific research was regarded from the first as the principal requirement, aptitude for teaching coming into consideration only in the second place, although it would be more correct to say it was taken for granted that a prominent scholar who had distinguished himself in scientific research was always likely to make the best and—in the last and highest resort—the most efficient teacher." Professors and students gathered in the Prussian capital, the work of the laboratories and the *Seminare* began—men like Fichte, Schleiermacher, and Wolf; Mitscherlich and Rose; later, Hegel, Böckh, the brothers Grimm, Scherer, Bopp, Niebuhr, Ranke, Savigny, and Eichhorn; Mommsen, Virchow, Helmholtz, and Hofmann, and so many others, did therein their life's work. The work of these men, their glorious example, is felt to-day, either directly or through their students, throughout the world of learning. There is scarcely a university or college now in existence in which, not one, but many workers look back directly or indirectly to Friedrich Wilhelm's university in Berlin with gratitude and with affection.

To trace the effects of the research university, which after Berlin and Bonn became universal throughout German countries, though of absorbing interest, cannot be undertaken here, even in outline; but the result in two directions must not be passed over altogether—first, the effect of habits of research on our general views of education; and, secondly, the extraordinary rise of chemistry in the nineteenth century, directly ascribable to it. As to the first point, it has gradually come to be recognised that work in research has an educational value to the worker, quite apart from its value in other respects, as awakening and strengthening what is noblest and of greatest utility in man, which places it at least on an equality with the older studies peculiar to the mediæval university. The thoughtful student can hardly enter a research laboratory without feeling that he is entering a place sacred to the wondrous mysteries of nature—a place where, when he has attained the requisite knowledge and dexterity, he will be permitted to put questions to nature, and, it may be, see something of those mysteries revealed. An explorer famous for his achievements will take him by the hand, and will in the friendliest manner direct him, will tell him what to do and where to go. He will lead him at first along some short and well-worn paths; he will then allow him to venture on longer ones, but still worn with footsteps, which he will recognise as those of former students, who subsequently became great explorers; then little by little he will be encouraged to go out alone into paths less known, until in time he will wish to push on, to extend his wanderings into unknown regions, a little at first, but afterwards more and more, to seek his own way, into regions of wondrous and, to his imagination, of unlimited possibilities; and the reception by the old explorer and the others, on his return, is a pleasure so exquisite that it exceeds any possible description. In most of this wandering he is associated with his fellow-explorers, who have like aims and like aspirations—men whom to know and to work with is the highest form of education.

The second point to which I wish to allude, as a direct result of the establishment of research universities, is the great development of the science of chemistry during the last century. Just before and about the beginning of the century there were three centres of notable activity in chemistry; one was in England, another in France, and the third in Sweden. The work of these served to lay the foundations of the science: in England, by Priestley, Black, Cavendish, Dalton, and Davy; in France, by Lavoisier, Berthelot, and Gay-Lussac; in Sweden, by Bergmann, Scheele, and Berzelius. With some important exceptions, the work of these chemists was isolated; they did not train students or found schools of after-workers; they owed little, almost nothing, to universities—the research university had not arisen. But the exceptional students were indeed important—men of genius who in any circumstances would have forced their way: Faraday, the student of Davy; Wöhler, the student of Berzelius; and Dumas, and, above all, Liebig, the students of Gay-Lussac. Dumas in Paris and Faraday in London worked practically by themselves, and their great discoveries are well known: they were generals of the highest genius, but without an army; but it was reserved for Liebig, and his great collaborator Wöhler, who both returned to Germany, there, with the splendid environment of the new research universities, to be instrumental in founding organic chemistry, and raising the science generally to the high position it attained. A further example of the indebtedness of the world to the brothers von Humboldt is the interesting fact that Alexander von Humboldt was the discoverer of both the French Dumas and the German Liebig: his influence it was that induced Dumas to leave the apothecary's shop in Geneva to go to Paris to Gay-Lussac; and it was by his interest, too, that the German student Liebig was brought to the notice of the great Frenchman. At Giessen Liebig founded the first chemical laboratory—indeed, the first science laboratory—open regularly to students; there, and afterwards at Munich, he conducted his great researches, and trained the research students who continued his work, and who themselves or their successors still continue it in all countries. Without the research university all this would have been impossible.

A few words must be devoted to Napoleon's experiment in founding a university centralised in Paris, and doing no teaching or research of any kind. One of the effects of the Revolution was the abolition in 1793 by the Convention of the ancient universities of France. The effect on education was disastrous. To remedy this, Napoleon, in 1806 and 1808, determined to establish an examination university for the whole of France; and this university, once established, continued until our own time, and has only recently been abandoned in favour of the German type. The University of London, founded in 1825, was of the Napoleonic type, for well-known reasons; and the Royal University of Ireland followed on the same lines. All this has now happily been changed, in Paris, in London, and in Dublin; and they must be few who would urge to-day that education by examination can lead to anything but failure to literature, to science, or to the State.

Realising with Carlyle that "the end of man is an action, not a thought," the research university has always recognised that the end of learning is not itself, but the benefit that it confers on its own votaries and on mankind. Thus Liebig was alert to the applications of his scientific discoveries and to the possession on the part of his students of the special talent necessary, the aptitude, for making such applications efficiently. Liebig's first inquiry, on fulminates, led to the modern manufacture of those substances and generally to the explosives industry. Similarly other researches either originated or improved almost every industry of the last century into which chemistry enters. His concern throughout his life for the requirements of medicine, of agriculture, of our food supply, and the enormous advances to which his discoveries led, need not be recapitulated. Hofmann himself, who perhaps more than any of Liebig's students realised his master's ideal, and became, after Liebig, the greatest scientific teacher of his day, came to England in 1845 to take charge of the newly founded Royal College of Chemistry. For twenty years he worked in London with well-known results to science and manufactures and to the training of research chemists and teachers. It was the time of the Great Exhibition, and it seemed as if chemistry was transferred to England. But the environment was not congenial. We had no research universities. Humboldt's universities were too great an attraction. Palaces for research were built for him, first at Bonn and finally at Berlin; and, naturally, the great research teacher re-crossed the Rhine. The industries which otherwise might have been ours followed him, and, directly or indirectly, the great rise of chemical industries in Germany, of which we hear so much at the present day, is to be ascribed largely to the work of this wonderful man and the surroundings of the research university. Hofmann continued the practice of Liebig in entrusting to those of his students who gave evidence of having the requisite capacity the application of his scientific discoveries. At least one of the large colour works in Germany was thus indirectly connected with the university laboratories in Berlin. This was a labour of love on the part of his students; but it led eventually to the enrichment alike of master and pupil, to a degree that professors in these lands can only envy. Thus the research university, splendid as were its achievements in pure science, never lost touch with technology; and there can be no question that this was to the advantage of science itself, quickening it by contact with the concrete conditions of real life, and justifying it by a worthy object.

But it gradually became apparent that there was an important field of research between the discoveries of pure science and their actual use in manufacturing processes. This was recognised as a field of work somewhat different in its point of view from that of pure science, but, like the latter, requiring the highest degree of knowledge and skill. It has been conveniently termed technical research. For example, there are many more coloured compounds known than dyes; but some of these might be converted into dyes if the requisite conditions could be discovered by which changes could be effected in their molecular structure in accordance with well-known laws. Again, the synthetic formation of indigo, of the structure which chemists imagine to represent its molecule, though long known as a laboratory experiment, was until recently economically impossible as a manufacturing operation. To overcome this difficulty, with a faith akin to that of the Humboldts in the success of their universities, one of the large industrial undertakings in Germany set to work with its little army of technical research chemists, and after years of patient labour, and the expenditure of three-quarters of a million sterling, the reward has been success. The demand for this technical research work has grown in Germany as it has in no other country. The large industrial undertakings have their own laboratories devoted to it, and, in addition, the practice has become general of retaining, at substantial salaries, the interest of the university professors, for the advantage of particular manufacturers. German professors of chemistry are now princes indeed compared with their position in the time of Liebig. But all this has not been sufficient to meet the demand for technical research work and for trained workers; and there has arisen a new class of high school, the technical research university, of which that at Charlottenburg may be taken as a type. These new institutions, by the standard required for entrance, and by the quality of the work they do, are entitled to take, and do take, rank equal to the university, and they confer a doctorate in engineering.

We have now considered four types of institutions for the advancement and diffusion of learning and of its applications to society—institutions of acknowledged university rank: of the mediæval or residential college university, exemplified by Oxford; the research university, as seen at Berlin; the examination university, first known in Napoleon's University of Paris; and the technical research university, as seen at Charlottenburg. In England, where numerous new universities have been established in recent years, the type adopted has been a combination of the German research university and the German technical research university, the one or the other type predominating according to local needs, and the whole adapted to its surroundings, particularly to the conditions of secondary education. Whatever view may be held respecting the German practice of separating these two types, as adapted to German conditions, it will, I think, be generally agreed that, for the conditions which prevail in these islands, the combination of the two in the new universities is a wise arrangement. Our two new universities in Ireland are also of this combined type, and are to be adapted to Irish educational conditions and the needs of the country.

Two advantages the German university has which are not found in this country: the one is the *Seminar*, the other the coordination between the secondary school and the university, which relieves the university of all work except research and preparation for research. In science the influence of Liebig, through his students, was so great that science laboratories, after the model of Giessen, have become the recognised attribute of science professorships throughout the world; but the corresponding laboratories for literature and philosophy are with us entirely wanting. No doubt the work is done here in a less organised and different way, but the institution of organised and properly equipped *Seminare* would be an important advantage to the literary, philosophical, and other departments of our universities. The second advantage referred to possessed by the German university is the character of the leaving examination of the secondary school. It corresponds to our matriculation examination, with the added knowledge acquired by about two years' university study in arts, and its acceptance by the university as evidence of sufficient knowledge for matriculation relieves the university of that most unfortunate practice, so common here, of giving the student an examination as his first experience on entering. The student in "Faust" who said, "Zwar weiss ich viel, doch möcht ich Alles wissen," would have been surprised had his first experience been an examination. The higher matriculation standard in Germany, and the fact that the German student is older—the average age is twenty to twenty-five years—on entering the university, must be borne in mind when comparisons are made as to the proper time for specialisation and research to commence.

If we desire to rival the work of the German universities, we should seriously attempt the better organisation and coordination of our entire educational system. One might imagine a trunk railway with stopping-places and branches. The trunk line might represent pure science, literature, and philosophy, and be always extending itself further; the stopping-places to where the scholars or students branch off to apply their training to livelihood occupations. Where exactly these stopping-places should be placed should be fixed after careful deliberation. Most would branch off for the arts and crafts from the primary school; most of the remainder would branch off after the secondary school; a small proportion would enter the university, branching off for the professions at places decided upon. Encouragement to enter the university should only be given after careful consideration. Far too many men nowadays are painfully struggling against nature in the university, to the detriment of the occupations for which nature really equipped them. Even in the German Empire only 13 out of every 1000 of the male population enter the university.

The *Times*, in a recent leading article, says:—"Germany has built up a chemical industry, worth tens of millions of pounds annually, through the agency of research chemists, methodically trained in her numerous technical schools." This is quite true; but there is one further requirement that must be mentioned: German manufacturers know the value, in dividends, of the services of trained research chemists; Irish and English manfacturers do not; and no matter how many and how well trained our university students become, the effect on the country's industries will be small unless they find suitable fields of operation. This is a serious and fundamental question which might well be taken up by industrial improvement movements and by anyone who has the ear of the public.

RECENT DEVELOPMENTS IN TELEGRAPHY AND TELEPHONY.[1]

FOR many years the simple form of Morse apparatus or its equivalents served the requirements of most countries, but as the telegraph service grew and the traffic rendered it imperative to erect long lines directly connecting distant cities, the problem of obtaining a greater revenue from the large capital expenditure involved became pressing, and progress was made broadly on three distinct lines of development. In the first, means were designed for the transmission of several messages simultaneously over the same conductor; in the second, by the use of suitable mechanical and electrical devices, the actual speed of transmission was raised in overhead wires to ten or twelve times that possible by manual operating, and, finally, type printing and writing systems were invented with varying degrees of success.

A method which in theory admits of sending as many as twelve simultaneous messages in one direction, or double that number if duplexed, depends on the superposition of musical vibrations on a telegraphic circuit at one end of a line. To effect this result, a number of electrically driven tuning-forks, arranged to vibrate at different frequencies, are connected through telegraphic keys to a line wire, so that on depressing any one key a series of electrical vibrations, of the frequency of its companion tuning-fork, are sent through the line. At the far end the receivers are of a type that will respond to musical vibrations only, and each receiver is constructed or adjusted to respond to the vibrations of one of the distant tuning-forks alone, and to no others. If any one key is depressed a simple musical oscillation traverses the line, and the receiver in tune responds. If two or more keys, however, are depressed simultaneously, a series of compound curves is transmitted, and those receivers that are in tune with the various components of the curves respond, and all the others remain unaffected. This system originated in America, but it has been developed and improved by Mercardier in France, where it is said to have given good results recently. In the modern apparatus the receivers consist of so-called mono-telephones, each of which is so made and adjusted as to respond to only one frequency.

The second method of increasing the output of telegraphic wires is the automatic or machine-transmitting instrument, which is typified by the Wheatstone apparatus adopted and perfected by the Post Office in Great Britain. In all instruments of this character a long paper ribbon is perforated by a suitable machine in an arbitrary manner, and the transmitting and receiving apparatus is so designed as to transcribe these perforations, at the distant end, into Morse signals, into similar perforations, into type-printed messages, or even into written characters.

This Wheatstone system has been very fully developed in the United Kingdom. It is capable of dealing with traffic at a maximum rate of 450 words per minute, and it is invaluable for the transmission of news. Thus, in the central office in London, items of news may have to be transmitted to fifty or more towns simultaneously. Circuits are made up for news transmission, each providing for a number of towns, some of the circuits being of a permanent character and some formed temporarily to meet special requirements. As many as eight Wheatstone slips can be punched simultaneously in one operation, and each length of slip is run through the necessary transmitters at the highest speed considered judicious. When long Press messages are received they are divided into sections, and each section handed to a separate telegraphist for perforating, so that the transmitting apparatus can be kept to its maximum capacity. Without this useful and adaptable apparatus, it would be almost impossible to deal satisfactorily with the vast amount of news traffic which is sent daily to every town in the country.

For ordinary public message traffic on lines of moderate length, where each individual message is short, the Wheatstone has certain disadvantages, namely, the initial delay in perforating the slip, its distribution, and, finally, the re-distribution of the received slip amongst the writing telegraphists, for it is obvious that at the high speed at which Wheatstone is worked, several operators are required at each end of the line to keep pace with the apparatus. In practice in this country, for circuits of moderate length it is generally considered preferable to provide direct Morse apparatus worked simplex, duplex, or quadruplex, as circumstances may dictate.

With overhead lines the limit of speed in automatic working is that imposed by the receiving apparatus, which, owing to its self-induction, obstructs the reception of Morse signals at a higher speed than that named. This difficulty has been overcome by substituting a chemical for an electromagnet receiver. In this form the current at the received end passes through a long paper ribbon saturated with a solution which is decomposed by a positive current. The Morse signals appear in blue lines on the received slip.

It is said that with this method a maximum speed of 1000 to 1200 words is possible under favourable conditions, but the difficulty in working at such high speeds, where characters are received in Morse code and have to be transcribed manually, is the division and distribution of the slips amongst the large number of writers necessary to keep abreast of the work, the precautions needed to avoid loss of messages, the injurious effect of brief contacts caused by workmen, which result in the loss of several words, and last, but not least, the difficulty and delay in obtaining repetitions where errors, false signals, or missing words render this necessary.

All the foregoing methods increase the carrying capacity of the wires; in other words, they reduce the capital expenditure per message, but none of these increase the output per operator, nor do they diminish the working cost in the instrument-room; in fact, with high-speed automatic transmission this cost may be higher than with other methods described. The messages have to be prepared by the perforation of the punched slip, telegraphists have to control the sending and receiving apparatus, and the Morse slips, as they are reeled off the receiving apparatus, have to be divided and distributed amongst a number of operators for transcription. The initial pre-

[1] From the "James Forrest" Lecture, delivered before the Institution of Civil Engineers on June 22 by Sir John Gavey, C.B.

paration of the transmitting slip will always, of course, be necessary in all automatic systems, but inventors have turned their attention to increasing the speed and reducing the cost of transcription at the received end, in the case of manual as well as automatic sending, by the substitution of typing apparatus worked mechanically or electrically for the manual transcription. A very considerable number of instruments has been designed to achieve this end, but one of the earliest, which has met with permanent success, and by means of which a very large proportion of the work in Europe and nearly the whole of the Trans-continental work is dealt with, is the well-known Hughes's type-printing instrument.

The Hughes method of transmission has many advantages. It provides a clearly typed message for delivery instead of a written one, it removes a possible source of error in transcription, and it increases the speed of working as compared with Morse by about 25 per cent. It can be duplexed, and it is used by the Post Office on all its Continental wires. It has, however, the disadvantage that a considerable interval of time elapses between the transmission of two consecutive signals owing to the revolving arm having to traverse all the intervening letters. Baudot has obviated this waste of time by adopting the multiple system of telegraphy. He entirely abandons the Hughes method of transmission, and he forms an arbitrary signal code which, by means of five consecutive currents, some plus, some minus, in combination, he represents each letter of the alphabet, figures, or other signals. By his method he can provide four or six channels simultaneously on one wire, each being worked manually.

The Baudot system admits of the transmission of a much larger number of messages over each wire than the Hughes. It is also more flexible, inasmuch as the various channels it provides can be divided amongst an equal number of towns; thus Paris can use two channels to Lyons and two to Marseilles over a Paris-Lyons circuit extended from Marseilles, and so on. It is largely used in France, and has been introduced into this country.

It will have been observed from the foregoing that there are three distinct methods of telegraphic transmission with which we are mainly concerned to-night, although others might be mentioned. In the first, an arbitrary code of signals is repeated in similar arbitrary signals by which the alphabet is artificially represented, and the message is read by a skilled operator; in the second, what may be termed the dial type of apparatus is used, where two type-wheels, either moved mechanically or electrically, revolve isochronously, and they may either show fleeting letters or print them in permanent characters; and in the third, an arbitrary set of electrical signals is devised which actuates specially designed apparatus which may reproduce the message in legible characters, printed, or even written. The third method has been utilised by various inventors and applied to automatic transmission, so as to dispense with manual transcription at the receiving station.

In all cases a paper ribbon or slip is perforated by punches generally actuated by a specially designed type-writer keyboard, in which the depression of any key causes a series of perforators representing the arbitrary combination of the corresponding letter to appear on the slip. This is passed through an automatic transmitter; the electrical currents corresponding with the perforators are transmitted over the circuit, and the distant apparatus actuated.

Murray has devised a system which has undergone lengthy trials both at home and abroad. His slip has one row of perforations which gears into the moving mechanism of the transmitter, and below this a second series of perforations which represent his artificial signalling code, which is of the Baudot type. At the receiving apparatus an exact counterpart of the transmitted slip with its perforations is reproduced, and this perforated slip is passed through and actuates an automatic type-writer, which prints the message.

Creed has worked in the same direction, but he uses the ordinary Wheatstone alphabet already described, and, of course, the Wheatstone transmitter. At the receiving end a perforated Wheatstone slip is reproduced by a punching machine, which, controlled by the reverse currents from the transmitter, and, using compressed air as a motive-power, perforates the received slip at considerable speed. This slip is then passed through an automatic type-writer adapted to work with the Wheatstone alphabet, which types the message on a long slip, to be gummed on the telegraph form. In both these cases the received slip can be inserted in a second automatic transmitter and the message sent on to another town—an advantage in the transmission of news, which frequently has to be re-distributed from large provincial centres to other towns having no direct communication with London. Both these systems are in use in the British Post Office.

Siemens and Halske in Berlin have devised an automatic system in which, by means of suitable apparatus, the message is printed by the receiving apparatus direct by photographic methods.

Writing telegraphs, based on the fact that two ordinates at right angles to one another can be made to describe any curve, have been designed. The telewriter, in which the pen is connected to two arms which follow the movements of the writer, and which in doing so pass over varying resistances and transmit to line currents of varying strength, is well known. At the receiving end two pivoted electromagnets, placed in a very powerful magnetic field, are deflected over arcs dependent on the strength of the current circulating at any moment. Two arms at right angles to one another are connected to the transcribing pen, one arm being pivoted to each magnet, and the writer's movements are reproduced.

There is only time to refer briefly to the beautiful writing apparatus designed by Pollak and Virag. In this a slip is perforated by suitable means with nine rows of holes of varying sizes; suitable flexible brushes make contact through these holes between batteries and the line wires, and thus cause currents of different electromotive forces and duration to circulate over the line, and to act on two telephone receivers at right angles to one another. Rays of light are reflected from one to the other and on to a photographic slip, and the written messages, which can be transmitted at 600 to 1000 words a minute, appear developed and fixed on the sensitised paper which emerges from the dark closet of the apparatus.

Submarine telegraphy is not susceptible of the many developments that have been possible with land-lines. The high electrostatic capacity, varying from 0·3 to 0·4 microfarad per mile, and the very long lengths that are necessary to connect the great continents of the world, rendering the use of any but the most delicate apparatus impossible on long cables. The receiving instruments originally invented by the late Lord Kelvin, then Sir William Thomson, are still the only apparatus available for the reception of messages on long Transcontinental cables, and so far it has not been found possible to increase materially the speed of working except, of course, by increasing the dimensions and cost proportionately.

In ordinary telegraphy, when transmitting through an overhead line, the frequency of the current alternations is only 180 per second for 450 words per minute, and the current has actuated the apparatus at the further end before the battery connection has ceased. Another condition, however, is introduced when a conductor is used for telephonic speech in which a maximum frequency of 1800 to 2000 vibrations per second has to be dealt with. In these cases the transmission from the telephone assumes complex wave-forms, and the effect of even a moderate capacity becomes far more marked than in the case of telegraphic transmission. If a simple wave impulse were emitted in a circuit containing neither capacity nor inductance it would maintain its form, and it would only lose in amplitude owing to the waste of energy in heating the conductor. With much capacity in the circuit, however, the wave tends to elongate, and if the capacity be sufficiently great and the line sufficiently long, the following wave overtakes the lagging tail of the previous one; they blend more or less together, and having lost their distinctive character they fail to impress on the receiving telephone the distinct character of the sound from which they emanate.

The loss of the overtones means diminution of the timbre of the voice; in other words, through speech may still be possible, but the voice ultimately becomes less recognisable until, when a certain limit is passed, if the resistance of the conductor be not too great, it may degenerate into a low-toned imitation of speech, or with the smaller conductors which are used for city work the attenuation rapidly lowers the volume of sound until it becomes unrecognisable. Self-induction is the analogue of inertia in mechanics; therefore, if it were possible to endow the circuit in which a wave was in movement with sufficient self-induction to prevent the tailing and consequent distortion of its form, the limit of speech would be materially increased, as the attenuation due to resistance alone would have to be provided for. Now it is possible to achieve this result to a certain extent by adding artificially to the self-induction of telephone cables, technically termed loading. The ideal method would be to increase the self-induction uniformly throughout, and attempts have been made to effect this by lapping a copper conductor with thin iron wire or tape of a high magnetic permeability. Another method consists in distributing magnetic coils at uniform distances of a mile or two apart throughout the length of the line. Under these conditions the distance over which speech is possible has been increased from two and a half to three and a half times.

The British Post Office has recently laid a cable with distributed inductance between England and France which will increase the range of speech about four times as compared with a similar type of unloaded cable.

The rapid and enormous development of the telephone service that has taken place throughout the world within the last few years is a remarkable achievement of the electrical engineer. The principle of the microphone, which converts sound vibrations into electrical vibrations, and of the telephone, which re-converts the electrical into sound vibrations, are so well known that I need not dwell further on the subject than to point out that Graham Bell's telephone, as it left his hands in 1876, is essentially the same instrument, slightly improved in mechanical construction, as he gave it to the world, but all the other adjuncts of a complete telephone service have been profoundly modified, and we are not yet in sight of finality.

In the period during which the ordinary telephone equipment has undergone modifications, inventors have turned their attention to the design and perfection of an automatic telephone in which each subscriber, by a simple method of manipulation, may without the intervention of an operator at the exchange obtain direct access to any other subscriber connected with the service. One of the earliest systems of this type was known as the Strowger. Each subscriber's line terminates on a line switch which forms part of a group of 100 switches. This switch is connected by ten circuits, the equivalent of the plugs and cords in a manual board, with a series of selectors each accommodating 100 junction lines. According to the size of the exchange, there may be two or three sets of selectors connected similarly by means of junction circuits, and, finally, there is a connector, a somewhat similar instrument, which makes the connection between the two subscribers.

Each telephone has a dial with finger holes and numbers. On removing the telephone from the hook the procedure is as follows. If, say, No. 4852 is wanted, the caller inserts his finger in hole 4 and revolves the dial up to the limiting stop. This actuates the line switch, which causes a connecting plug to enter the springs of the first disengaged junction leading to the selector group of 4000. The same action follows in sequence with 8, 5, and 2, the final movement of the connector making the connection if the required subscriber is disengaged. If he be through to another a busy back signal (a vibratory current) is given. When the connection is made and the conversation is complete, the hanging up of the telephones restores the connections to the normal. This method has had considerable development amongst the independent telephone companies in America.

On the subject of the future development of telegraphs and telephones, few of those acquainted with the subject would venture to dogmatise, but certain statistics I have prepared will convey to you possibilities far more pregnant than any amount of speculation. The following figures, for the years 1902 and 1907 respectively, have been gathered from authentic returns, and they embrace information from every country of importance throughout the world:—

Telegraph and Telephone Statistics—Wire Mileage.

Telegraphs	1902	1907	Increase
Land wires	3,659,659	5,038,981	1,379,322
Submarine cables	212,894	259,000	46,106=21·6%
Telephones			
Wire	7,467,417	19,839,537	12,372,120
Subscribers' stations	3,534,036	8,406,336	4,873,330

Large figures frequently fail to impress the mind, but when it is stated that this mileage of wire will soon, if it has not by this time, equal one-third the distance from the earth to the sun, the remarkable activity of the modern telegraph and telephone service will perhaps be more forcibly realised.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

BIRMINGHAM.—The engineering department is losing the services of Mr. F. H. Hummel, lecturer in civil engineering, who has accepted the chair of engineering at Belfast, and of Dr. J. D. Coales, lecturer in electrical engineering, who has been appointed principal of the Wolverhampton Technical School.

CAMBRIDGE.—The observatory syndicate, in a report to the Senate on the Huggins dome and the astrophysical building, state that the buildings now erected may be regarded as consisting of two parts, though for the sake of economy in construction they are structurally blended. The first part consists of a dome 23½ feet in diameter, together with a small room for accessory apparatus and a room for any observer who may be making use of the Huggins instruments installed in the dome. These are to be called the Huggins dome and the Huggins observer's room. The second part—the astrophysical building—comprises a computing room, which also serves as a library, and a small room appropriated to the use of the head of the department. The Huggins instruments are now ready for adjustment and use.

The Goldsmiths' Company have given 700*l.* for the equipment of the metallurgical department of the chemical laboratory.

The prize of 50*l.* out of the Gordon Wigan fund for a research in chemistry has been awarded to Mr. J. Thomas, Trinity, for experimental investigations on "The Isolation of the Aromatic Sulphinic Acids" and "The Resolution of Externally Compensated Quinoline Derivatives containing Two Asymmetric Carbon Atoms."

Mr. W. F. Penée, of the Indian Forestry Service, will deliver a course of lectures on Indian forestry during the Michaelmas term of 1910.

OXFORD.—The next award for the Radcliffe prize will be made in March, 1911. The prize, which is of the value of 50*l.*, is awarded by the master and fellows of University College every second year for research in any branch of medical science comprised under the following heads:—human anatomy, physiology, pharmacology, pathology, medicine, surgery, obstetrics, gynæcology, forensic medicine, hygiene. The prize is open to all graduates of the University who shall have proceeded or shall be proceeding to a medical degree in the University. Candidates must not have exceeded twelve years from the date of passing the last examination for the degree of B.A., and must not, at the date of application, be fellows on the foundation of Dr. John Radcliffe. The memoirs must be sent to the University Registry on or before December 1.

The Rolleston memorial prize, the value of which is 60*l.*, will be awarded in Easter or Trinity term, 1912. The prize is open to such members of the Universities of Oxford and Cambridge as will not have exceeded ten years from the date of their matriculation on March 31, 1912, and is to be awarded for original research in any subject comprised under the following heads:—animal and vegetable morphology, physiology and pathology, and anthropology, to be selected by the candidates themselves. Candidates wishing to compete should forward their memoirs to the registrar of the University before March 31, 1912. The memoirs should be inscribed "Rolleston Memorial Essay," and should each bear the name and address of the author. They may be printed or in manuscript, memoirs already published being admitted to the competition.

The electors have appointed Mr. Raphael Meldola, F.R.S., professor of chemistry in Finsbury Technical College, City and Guilds of London Institute, to deliver the Herbert Spencer lecture in the course of next Michaelmas term. No more appropriate selection could have been made than that of Prof. Meldola, whose wide range of scientific knowledge and interest, extending far beyond the bounds of his special subject, and whose well-known sympathy with everything which can tend to further the progress and popularise the results of physical and biological research, justify the expectation that his lecture will be of exceptional interest and value. The subject and date of the lecture will be announced later.

Mr. Selwyn Image, who has recently been elected to the Slade professorship of fine art, is well known to naturalists as a keen student and collector of the British Lepidoptera. He is a Fellow of the Entomological Society of London, and is at present serving on the council of that society.

The delegates of the common university fund propose shortly to appoint a reader in social anthropology.

At the tercentenary festival of Wadham College, held on June 23, allusion was made both by Lord Curzon and by Sir Archibald Geikie to the connection of the college with the early history of the Royal Society. The latter speaker gave it as his opinion that but for Dr. John Wilkins, the warden of Wadham, under whose auspices the Oxford meetings of "the association of certain worthy persons inquisitive in Natural Philosophy" (Walter) began about 1648 or 1649, the Royal Society might never have come into existence.

SHEFFIELD.—Dr. J. Robinson has been appointed junior lecturer and demonstrator in physics, and Mr. J. Miller assistant in the architectural department.

MR. H. S. JACKSON, research assistant in plant pathology at the Oregon Agricultural Experiment Station, has been appointed professor of botany and plant pathology in the Oregon Agricultural College.

THE Speech Day of the Merchant Venturers' Technical College, Bristol, will be Friday, July 22, when Colonel F. C. Ord, C.B., the master of the Society of Merchant Venturers, will distribute the prizes.

DR. H. S. JENNINGS, hitherto professor of experimental zoology at the Johns Hopkins University, has been appointed professor of zoology and director of the biological laboratory of the same University, in succession to the late Prof. W. K. Brooks.

THE Cleveland College of Physicians, now the medical department of Ohio Wesleyan University, is to be consolidated with the medical department of Western Reserve University at the close of the present college year. Mr. H. M. Hanna has given the sum of 50,000*l.* as an additional endowment fund for the medical department.

IT is announced in *Science* that two more industrial fellowships for the investigation of the diseases of plants (making four in all) have been established in the New York State College of Agriculture. They are to be known respectively as the Herman Frasch fellowship and the John Davey fellowship. The first-named provides for the investigation of the use of dry sulphur as a fungicide both to the plants and in the soil, and the second provides for the investigation of heart-rot of trees.

A NEW University for Natal is, says the *Westminster Gazette*, to be opened formally in August next. It is anticipated that a large number of students will be enrolled at once. Under the South Africa Act of Union the University will come under the jurisdiction of the Union Government, while education, other than higher education, will be vested in the Provincial Council for a period of at least five years. The Act establishing the University provides that instruction shall be given in classics, literature, law, science and art, and other studies. Designs for a handsome building have been approved by the Natal Government. Already Mr. W. N. Roseveare has been appointed professor of mathematics and Mr. Bews professor of botany and geology.

THE Rural Education Conference, which has been constituted by the Presidents of the Board of Agriculture and Fisheries and the Board of Education, for the discussion of all questions connected with education in rural districts, and for the periodical exchange of views between representative agriculturists and the two departments, will be composed as follows:—Lord Moreton, Lord Barnard, the Right Hon. Lord Belper, the Right Hon. Lord Reay, G.C.S.I., G.C.I.E., the Right Hon. A. H. Dyke Acland, the Right Hon. H. Hobhouse, Sir Francis A. Channing, Bart., M.P., Sir A. K. Rollit, Major P. G. Craigie, C.B., Mr. Graham Balfour, Mr. C. Bathurst, M.P., Mr. G. A. Bellwood, Mr. J. F. Blackshaw, Mr. W. F. Brockholes, Mr. G. G. Butler, Mr. A. W. Chapman, Mr. F. J. Chittenden, Mr. S. H. Cowper-Coles, Mr. D. Davies, M.P., Major J. W. Dent, Mr. H. J. Elwes, F.R.S., Prof. W. R. Fisher, Mr. P. Hedworth Foulkes, Mr. W. J. Grant, Mr. A. D. Hall, F.R.S., Mr. W. A. Haviland, Prof. C. Bryner Jones, Mr. T. Latham, Mr. J. L. Luddington, Mr. H. Martin, Mr. E. Mathews, Rev. R. Meyer, Mr. W. Parlour, Mr. C. N. P. Phipps, Mr. J. H. Sabin, Mr. A. F. Somerville, Prof. W. Somerville, Mr. A. E. Bromehead-Soulby, Mr. C. Turnor, Mr. F. Verney, M.P., Prof. T. Winter, and Prof. T. B. Wood. The Right Hon. H. Hobhouse will act as chairman of the conference, and Mr. E. G. Howarth, of the Board of Education, and Mr. H. L. French, of the Board of Agriculture and Fisheries, will act as joint secretaries.

ON May 28, at the Regent Street Polytechnic, London, Mr. Blair (education officer to the London County Council) gave an address on "The Newer Education" to the members of the Federated Associations of London Non-primary Teachers. Mr. Blair said that the adverse criticisms sometimes passed on the results of modern elementary education arise from ignorance of the progress that has really been made in this direction during the last fifty years. There is now hardly an illiterate person in the country, and, moreover, the facts that crime has decreased, that sanitary conditions have improved, that the death-rate has fallen, and that the funds of savings banks and provident societies show a steady increase, must all be attributed indirectly to the work done in elementary schools. We were in this respect far ahead of Germany. An important part of the recent work of the London County Council has been the institution of its scheme of scholarships for children fit to pass from the elementary to the secondary schools. The full development of this scheme is yet to come, for there is a distinct need that the child, leaving the secondary school at the age of sixteen and not wishing to take up elementary-school teaching, shall have some course of definite technical training. So far as wage-earning capacity is concerned, boys and girls leaving secondary schools at this age are in no better position than children leaving the elementary schools at the age of fourteen. After reading certain examiners' reports referring to the unsatisfactory work in some secondary schools, Mr. Blair stated that there is still a tendency for this work to be too academic in character, and he urged that secondary-school teachers must strive to correlate their teaching with the facts of life, and remember that upon them falls a large part of the responsibility for training the child for its future duties as a citizen of the Empire. Some statesmen consider that before long we may be called upon to meet a serious national emergency, and the way in which we shall do this will depend on the work of the teachers both in the elementary and in the secondary schools.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 23.—Mr. A. B. Kempe, vice-president and treasurer, in the chair.—A. **Mallock**: Damping of sound by frothy liquids. The object of the note is (1) to explain the well-known fact that a vessel which, when empty or filled with a homogeneous liquid, gives a musical note when struck, ceases to do so when the liquid contains bubbles of gas; (2) to direct attention to the fundamental difference between the damping of waves propagated through a gas containing spheres of liquid (*e.g.* rain or fog), and that which occurs in a liquid containing bubbles of gas. The damping of sound waves by fog has received considerable attention, and it has been shown that although presence of liquid particles does cause a certain amount of dissipation, loss of energy is small, and this agrees with observation. On the other hand, with a liquid containing bubbles, damping of vibration is excessive, practically the whole of the wave energy being dissipated in a few wave-lengths or periods. When spheres of liquids are disseminated in a gas, compressions and dilatations take place in the latter much as if only the gas were present, and the increased dissipation is due to slight modification in the motion of the gas, brought about by the liquid spheres. In the converse case, when bubbles of gas are disseminated through a liquid, variation of volume consequent on the passage of a wave takes place almost entirely in the gas, and distortion of the liquid about the bubbles of whose volume is the variable introduces a rate of dissipation of a different and larger order. It is pointed out that in a mixture of liquid and gas (in the form of bubbles) the velocity of wave propagation is less than that in either constituent alone, and has a minimum when the proportion of gas to liquid has a certain value. If the mixture consists of air and water, minimum velocity of propagation is reached when the volumes of air and water are nearly equal, and is then about one-fourteenth the velocity of sound in air. When the volume ratio of gas to liquid exceeds a certain limit, depending on the order in which the bubbles are arranged, the latter cannot remain spherical, and the mixture then becomes a froth, or collection of air cells separated by thin liquid walls. It is shown by experiment that such froth is a very effective agent in damping vibrations.—Prof. P. V. **Bevan**: The dispersion of light by potassium vapour. The work described in this paper was an attempt to measure quantitatively the amount of dispersion in the vapour of potassium. Dispersion takes place in the vapour chiefly on account of the red absorption lines, but is also to a smaller extent due to other lines of the principal series. Measurements were made showing dispersion affected by the first six pairs of lines of the principal series, and an effect could just be detected at the next pair of lines. The dispersion was found to fit a Sellmeier formula, and values for four of the constants for this formula were obtained. On theoretical grounds we can conclude, from the relative values of the constants of the dispersion formula, that the number of atoms taking part in the absorption of the light after the first pair of lines must be only a small fraction of the total number present in the vapour, and that this fraction decreases with the number of lines in the series. It is suggested that the explanation of series lines must therefore be looked for in systems which are not the atom pure and simple, but probably atoms to which a corpuscle or more than one corpuscle become attached. Several types of quasi compounds may thus be formed in a way suggested by Sir J. J. Thomson, and the periods commonly associated with the atoms may be the periods of these systems. Our conception of the atom may be thus considerably simplified, as the number of degrees of freedom for each individual atom may be diminished very largely if this view be the true one.—J. W. **Gifford**: Additional refractive indices of quartz, vitreous silica, calcite, and fluorite.—J. Ivon **Graham**: The absorption spectra of sulphur vapour at different temperatures and pressures, and their relation to the molecular complexity of this element. The absorption spectra were photographed at temperatures varying from 530° C. up to 900° C., at atmospheric pressure, and at constant temperatures, under pressures between atmospheric and 10 mm. of mercury. The photographs at constant pressure with the above variation of temperature show the presence of two distinct absorption spectra; these are attributed to the intra-molecular vibrations of the S_8 and S_2 complexes respectively, the former producing a series of absorption bands between $n\,(=\lambda^{-1})$ 2000 and n 2600, with mean position of maximum absorption about n 2500, whilst the relatively lighter S_2 molecular system, by taking up vibrations of greater frequencies, produces a series of bands lying between n 2900 and n 3820, with mean position of maximum absorption about n 3750. Since *only two* distinct spectra are evident, it is concluded that the equation $S_8 = 4S_2$ represents the sole reaction that occurs in the dissociation of sulphur vapour on heating from its boiling point up to 900° C. The interpretation of the photographs of the absorption spectra of the vapour at different (constant) temperatures, but with reduction of pressure, indicates that above 580° C. the dissociation of the molecule S_8 is simple, that is, there is direct dissociation into S_2 complexes, but at or below 520° C. the dissociation takes place with the formation of molecules intermediate in complexity between the above two aggregates. The position of maximum absorption of each band is towards the more refrangible edge, whilst the individual bands of each series appear to become stronger, also in the more refrangible direction. The two series of bands are shown mapped in oscillation frequencies, the similarity between the series being much more evident when illustrated in this manner. Reproductions of photographs also accompany the paper.—Dr. T. H. **Havelock**: The wave-making resistance of ships: a study of certain series of model experiments. In a previous paper (Proceedings, A, vol. lxxxii., p. 276, 1909) the author discussed the variation of the wave-making resistance of a ship with its speed, and a formula was obtained by specifying the action of a ship in terms of a simple equivalent pressure distribution travelling over the surface. The present investigation is a more systematic study of some of the coefficients of the formula, the experimental data being taken from published records of tank experiments with models. The discussion is limited to types for which the resistance-velocity curve shows clearly the humps and hollows which are usually ascribed to interference of wave systems originating at the bow and stern; the tabulated results form a numerical study of the latter theory, and exhibit the variation of the coefficients of the simple equivalent pressure system with the displacement of the model, the proportion of parallel middle body, and various coefficients of fineness. Without attempting to express the coefficients by empirical formulæ, sufficient information is available to allow of an approximate estimate of their values in similar models; this is illustrated by the *Turbinia*, and the result is discussed in relation to the published record of trials of that vessel. The characteristic interference effect mentioned above appears to occur specially in rather full-ended models, with fairly high cylindrical coefficients; in this case it is permissible to regard the equivalent pressure system as having two parts associated with the bow and the stern respectively. An examination of models with finer ends suggests that this simple interference theory is inadequate in certain cases; the study of a modified type of pressure distribution is indicated.—Dr. Georges **Dreyer** and W. **Ray**: The blood volume of mammals as determined by experiments upon rabbits, guinea-pigs, and mice, and its relationship to the body weight and to the surface area expressed in a formula. The blood volume of animals has for many years been the subject of numerous investigations. This is but natural considering its great importance for the study of disease. As, however, the results obtained are very discordant, the authors have determined the blood volumes of rabbits, guinea-pigs, and mice by Welcker's method, by washing out the circulatory system and by following the percentage fall of hæmoglobin after bleeding. The experiments of the authors have given the following results:—(1) The blood volume of living mammals can be determined very accurately by bleeding the animal (about 20 per cent. of its original blood volume) and determining the percentage fall of hæmoglobin at the moment when equilibrium is reached. This method gives results remarkably concordant with those obtained by washing out the circulatory system. In employing this method it is absolutely essential that the animals should not have been bled before. (2) In normal healthy mammals (rabbit, guinea-pig, and mouse) the blood volume is satisfactorily expressed by the following formula, $B = W^{\frac{2}{3}}/k$, where B is the blood volume in cubic centimetres, W the weight of the individual in grams, and k a constant to be ascertained for each particular species of animal. This formula indicates that the smaller animals of any given species, which have a relatively greater body surface than heavier ones, have also a relatively greater blood volume. That is to say, the blood volume can be expressed as a function of the surface area. It is therefore misleading to express the blood volume as percentage of the body weight, as has hitherto been invariably done. (3) The constant k, by means of which the blood volume in cubic centimetres can be calculated from the formula $B = W^{\frac{2}{3}}/k$ when the weight of the animal in grams is known, is approximately, for rabbit, 1·58; guinea-pig, 3·30; mouse, 6·70.—E. C. **Hort**: Autotoxæmia and infection. The object of this communication is to show that fever, loss of weight, and changes in the antitryptic values of the blood serum, three phenomena common to bacterial and protozoan infection in man, can be reproduced in animals by the subcutaneous injection of small quantities of distilled water. Elaborate controls were set up throughout, and absence of sepsis repeatedly proved by autopsy and by microscopical sections. *Fever.*—Sixty guinea-pigs received single injections of boiled distilled water in quantities varying from 1 to 10 c.cm. Fever resulted in fifty. Thirty guinea-pigs received multiple injections, always followed by fever except when the injections were too closely crowded, or too large, when subnormal temperatures resulted. Twelve rabbits received single injections varying from 10 to 60 c.cm. Fever followed in all. Ten rabbits received multiple injections. All showed fever. Fever after each injection was always rapid in onset, abrupt and fugitive in both guinea-pig and rabbit. By appropriate spacing of injections continuous fever can be produced, ceasing with the injections. Hypersensitisation was frequently observed. Establishment of a constant between weight of injection, animal injected, and degree of fever induced has been so far impossible. *Weight.*—The effect of small single injections was inconclusive. Multiple injections always produced marked loss, recovery ensuing on discontinuance of injections if few in number. *Antitryptic values.*—Multiple injections produced marked rise in values, strikingly parallel in gross effect to the rise produced in the same species of animal by single injections of diphtheria toxin, or of emulsions of living bacteria. From these experiments it would appear that however great the share taken by bacteria and protozoa in initiating the disease-complex of infection, the net result is, perhaps to a large extent, a state of true auto-intoxication. The results obtained suggest that such auto-intoxication is in part directly due to absorption of derivatives of the infected cells themselves, and only indirectly to the absorption of bacterial products.

Physical Society, June 10.—Prof. H. L. Callendar, F.R.S., president, in the chair.—Dr. W. E. **Sumpner** and W. C. S. **Phillips**: A galvanometer for alternate-current circuits. The galvanometer described is the result of an attempt to construct a measuring instrument by means of which inductances and capacities can be compared by bridge methods as accurately as it is possible to compare resistances. The instrument is like a moving coil galvanometer in almost every respect, except that its field is due to a specially constructed electromagnet excited by an alternating voltage.—A. E. **Garrett**: Positive electrification due to heating aluminium phosphate. Many of the results obtained, in particular (*a*) with varying pressures and constant temperatures, (*b*) at atmospheric pressure in which after removal of all free ions by a field sufficient to produce a saturation current, a current of equal values for ions of both signs was found at an electrode placed behind that on which the saturation voltage acted, and (*c*) the loss of charge of a Faraday cylinder when screened from the action of free ions, indicate that one of the products due to heating aluminium phosphate is in the form of neutral pairs or doublets which afterwards split up into negative and positive ions.

Royal Anthropological Institute, June 14.—Prof Gowland, past-president, in the chair.—P. A. **Talbot**: The Ekoi of southern Nigeria. The Ekoi dwell by the border of the German Kamerun. Their land, between its maze of rivers, is one stretch of dense "bush," whch reaches even to the summit of the hills, of which the greater part of the country consists. The whole existence of the race mirrors the twilight and mystery of the bush, peopled to the native's fancy by strange, half-human shapes, such as were-leopards and the genii of trees and rocks. Magic is the keynote on which the lives of the Ekoi turn. Idiong, the practice of divination, is much resorted to, and is clearly connected with ancestor worship, the dominant factor in the religion of the race. The great festival of the year is that of Eja, held at the time of the new yams. Investigations have proved that these rites are almost identical with many of the darker traits of the old Adonis-Attis-Osiris worship. Many beliefs and customs of the Ekoi have come down from remotest antiquity. They have a marvellous folklore, which at times shows poetic feeling, at others a keen sense of humour. There are legends to explain all customs and beliefs. The land is full of societies, secret and otherwise, the chief of which is the Egbo Club, which ruled the country before the coming of the white man. Though a polygamous people, the chief wife, not the husband, is the head of the house, and women's rights as to property and the custody of children are most strictly safeguarded by native law.

Zoological Society, June 14.—Dr. S. F. Harmer, F.R.S., vice-president, in the chair.—R. I. **Pocock**: The cutaneous scent-glands of ruminants. The author pointed out that the structure of the feet, whether furnished with special glands or not, supplied valuable data for classifying the genera of antelopes and deer, and showed that with some modifications, such as the removal of Tetraceros from the Cephalophinæ to the Tragelophinæ, of Dorcotragus from the Antilopinæ to the Neotraginæ, and of Pantholops, Saiga, and Æpyceros from the Antilopinæ, the subfamilies usually admitted were valid groups. In the case of the deer, it was interesting to note that Rucervus, Panolia, Elaphurus, and Sika were closely allied to Cervus, Dama being a totally distinct type. Axis and Hyelaphus belonged to another group, while Rangifer, Alces, and Capreolus, as Sir Victor Brooke claimed, belonged to the section typified by Dorcelaphus, Mazama, and other American deer.—R. **Lydekker**: A wapiti and a muntjac. The author described two wapiti antlers from Tibet as *Cervus canadensis wardi*, and a muntjac from An-wei, China, as *Cervulus bridgemani*. The latter was characterised by its dark blackish-olive colour, the black ears of the female and the yellow ones of the male, coupled with the relatively wide divergence of the antler-pedicles.—R. **Lydekker**: Three African buffaloes.—Dr. A. **Cabrera**: Two new antelopes. The author described a new species of Damaliscus from British East Africa and a new chamois from north Spain.—Dr. E. A. **Wilson**: Changes of plumage in the red grouse (*Lagopus scoticus*) in health and disease.

PARIS.

Academy of Sciences, June 20.—M. Émile Picard in the chair.—H. **Deslandres**, L. **d'Azambuja**, and V. **Burson**: An extraordinary solar filament. A detailed account, with reproductions from photographs, of a filament which appeared on April 11. It had the peculiarity of having large radial velocities, mostly ascending, which at certain points exceeded 100 kilometres per second. The solar disturbance of April 11 was not apparently accompanied with terrestrial magnetic disturbances.—J. **Boussinesq**: The principles of mechanics and their applicability to phenomena which appear to contradict them.—E. **Bouty**: A new measurement of the dielectric cohesion of argon. The determination of the dielectric cohesion of argon is attended with difficulties which do not arise in the case of the other rare gases. For a fixed pressure, for no apparent cause, there are progressive variations in the minimum difference of potential capable of causing the discharge. By making two consecutive measurements rapidly at widely different pressures this difficulty is partly got over. The cohesion of argon was finally found to be practically double that of helium, the gas immediately preceding it in the periodic table.—A. **Chauveau** and M. **Contejean**: The elimination of nitrogenous waste in the act of renal secretion, the subject having been deprived of food. The relation between this elimination and that of water, the vehicle of the urinary excreta. The reciprocal independence of the two phenomena. The amounts of water and urinary nitrogen excreted in the young subject are independent, and hence variations in the quantity of urine secreted, in the course of a series of experimental periods, introduce no difficulties in the significance of the nitrogenous excreta carried away by the urine.—M. **Gouy**: The mutual action of two kathodes in the magnetic field. In high vacua, when the negative charges are connected by the lines of magnetic force, they produce an action of unknown nature, which is shown by a marked lowering of the explosive potential and by the production of the inter-kathodic light.—M. **Nicolau**: The variation in the motion of the moon.—Edmond **Bauer** and Marcel **Moulin**: The luminosity of the sun and the solar constant. A description of a new method of determining the constant in Stefan's law.—J. Comas **Solà**: A *résumé* of physical observations made on Halley's comet.—E. **Vessiot**: The integration of complete systems.—M. **Hadamard**: Some properties of Green's function.—Paul **Renard**: A method of causing an aëronef to pursue a rectilinear path with a minimum expenditure of total work.—B. **Szilard**: An action at a distance on the coherer produced by metallic contacts. Instead of putting one extremity of the coherer to earth, as usual, it is connected with one pole of an alternating current, the other pole being earthed. In this way the sensibility of the coherer is greatly increased, and some applications of the modified coherer are described.—F. **Croze**: The prolongation of the band spectra of carbon gases in the extreme red and infra-red. For carbon monoxide photographs in the infra-red show several bands resembling the bands already known in their structure, and occupying very closely the place predicted according to the known law of distribution. The results with cyanogen were similar.—Ch. **Fabry** and H. **Buisson**: Some electrical and spectroscopic properties of the arc between metals.—G. **Sagnac**: An interferometer with superposed inverse light rays giving in polarised white light a narrow central fringe and narrow coloured fringes with white interspaces.—Louis **Dunoyer**: A method of measuring a magnetic field in magnitude, direction, and sense.—L. **Houllevigue**: The formation of kathodic deposits. The walls upon which the metallic deposit forms are those possessing a positive charge, allowing the electrical neutralisation of the kathode granules.—A. **Perot**: Some peculiarities of the mercury arc in a vacuum. A study of the distribution of the fall of potential in the arc, together with the demonstration of the existence of an extra pressure at the anode.—E. **Baud** and L. **Gay**: The temperature of crystallisation of binary mixtures. On the basis of certain assumptions, the lowering of the freezing point is shown to be proportional to the logarithm of the molecular concentration and to the absolute temperature of crystallisation. For very dilute solutions this is equivalent to Raoult's formula. Experimental proofs of the logarithmic formula are given.—Daniel **Berthelot** and Henry **Gaudechon**: The photochemical synthesis of carbohydrates at the expense of the elements of carbon dioxide and water vapour in the absence of chlorophyll. The photochemical synthesis of quaternary compounds. Various gaseous mixtures were exposed to the action of the rays from a mercury vapour lamp. Carbon dioxide was obtained at the ordinary temperature from a mixture of oxygen and carbon monoxide. Carbon dioxide and hydrogen gave a little CO and formaldehyde; no trace of acid was formed in this reaction. Formamide was produced in the same way from ammonia and carbon monoxide.—G. **Austerweil** and G. **Cochin**: Some relations between molecular constitution and smell.—E. **Léger**: Crystallised aloinose and its identity with *d*-arabinose.—H. **Arsandaux**: A new contribution to the study of the laterites.—Raoul **Combes**: The best illumination for the development of plants.—V. **Pachon** and Em. **Perrot**: The cardio-vascular action of green coffee compared with that of corresponding doses of caffeine. The action noted is due to some other agent than caffeine.—A. **Magnan**: The influence of the alimentary *régime* on the intestine in birds.—G. **Seliber**: The coloration of the pigment in two fungi.—A. **Étard** and A. **Vila**: The analysis of protoplasmic materials. A discussion of the various group reagents which may be used for the separation of the substances present in the liquids resulting from the hydrolysis of protoplasmic materials.—M. **Noel**: The infiltrations on the *massif* of Zaghouan (Tunis).

DIARY OF SOCIETIES.

THURSDAY, JUNE 30.

ROYAL SOCIETY, at 4.30.—A New Method for the Quantitative Estimation of Hydrocyanic Acid in Vegetable and Animal Tissues: Dr. A. D. Waller, F.R.S.—On the Structure, Development, and Morphological Interpretation of the Pineal Organs and Adjacent Parts of the Brain in the Tuatara (*Sphenodon punctatus*): Prof. A. Dendy, F.R.S.—On the Scattering of Homogeneous β-Rays, and the Number of Electrons contained in the Atom: J. A. Crowther.—On the Spontaneous Crystallisation and the Melting and Freezing Point Curves of Mixtures of Two Substances which form Mixed Crystals and possess a Minimum or Eutectic Freezing Point. Mixtures of Azobenzene and Benzylaniline: Miss F. Isaac.—On the Determination of the Chief Correlations between Collaterals in the Case of a Simple Mendelian Population Mating at Random: E. C. Snow.—The Propagation of Sound in a Fog: C. J. T. Sewell.—A Determination of the Ratio of Mass to Weight for a Radioactive Substance: L. Southerns.—The Relative Atomic Weights of Nitrogen and Sulphur: F. P. Burt and F. L. Usher.—The Relation of Light Perception to Colour Perception: Dr. F. W. Edridge-Green.—The Anatomy and Morphology of the Leaves and Inflorescences of *Welwitschia mirabilis*: Miss M. G. Sykes.—And other papers.

FRIDAY, JULY 1.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology of West Yorkshire, with Special Reference to the District to be Visited during the Long Excursion: Prof. P. F. Kendall.

FRIDAY, JULY 8.

PHYSICAL SOCIETY, at 5.—A Thermo-electric Balance for the Absolute Measurement of Radiation: Prof. H. L. Callendar, F.R.S.—The Convection of Heat from a Body cooled by a Stream of Fluid: Dr. Alexander Russell.—On Hysteresis Loops and Lissajous' Figures, and on the Energy wasted in a Hysteresis Loop: Prof. S. P. Thompson, F.R.S.—The Energy Relations of certain Detectors used in Wireless Telegraphy Dr. W. H. Eccles.

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