THURSDAY, SEPTEMBER 9, 1909.

A MONOGRAPH ON THE TRANSIT CIRCLE.

Les Observations méridiennes: Théorie et Pratique. By F. Boquet. Tome Premier, Instruments et Méthodes d'Observation. Pp. xi+314. Tome Second, Corrections instrumentales et Équations Personelles. Pp. iv+342+xii. (Paris: Octave Doin et Fils, 1909.) Price, 2 vols., 10 francs.

THESE two volumes comprise one of two completed sections out of a total of twenty-nine devoted to astronomy and celestial physics in a new form of scientific encyclopædia in which astronomy is only one of forty divisions. The whole work, if and when completed, should run to at least a thousand handy little volumes at a uniform price of 5 francs per volume. An index to the complete series is also promised, but it is hardly contemplated that the demand for the whole set will be very great, the idea being that each subject is to be totally distinct, so that a minimum of irrelevant matter need be purchased by any interested specialist, and that such sections as are rapidly rendered out-of-date may be quickly replaced by revised editions without necessitating alteration of the whole work.

Our purpose now, however, is to deal only with the two volumes before us, premising that the "Bibliothèque d'Astronomie et de Physique céleste," to which they belong, is under the directorship of M. Jean Mascart. It may be fairly remarked, inasmuch as the titles of the other twenty-eight sections of this "Library" are given, that it is quite possible the number will have to be augmented, as there is at present no obvious place for more than one modern investigation without straining the meaning of some of the published titles. With some 600 pages entirely devoted to meridian observations, we are at first inclined to wonder why so much space was thought necessary. But the wonder does not last long, for the pages are quite small, and the amount of detail is very great, as is only fitting in an encyclopædia. Moreover, we soon perceive that the transit-circle, though the two parts are inevitably studied separately, is the *only* instrument considered. This strikes us as an error of omission, for there is no other place for discussion of the zenith telescope in any form. There is no mention of the various forms suggested in substitution for the ordinary one, such as the fixed telescope with meridian mirror or the transit with axis view, simply rotating in bearings east and west. A very possible explanation is that these various forms are not of much account in France, but their omission seems to be a mistake.

There does not seem to be much, if anything, of consequence omitted in reference to the transit circle itself, all kinds of instrumental errors being fully and carefully dealt with, several methods of determination or correction being given in many cases. For instance, a very clear account is given of Cowell's refraction tables as used at Greenwich, while division error and eccentricity, screw value and error, pivot error, wire intervals and inclination, flexure, and so on, are treated with great fulness. The printing chronograph in various forms is naturally conspicuous, this subject being one on which M. Boquet has written more than once before. Another subject with which he has similarly shown familiarity is given an importance we do not remember to have seen before, and that is personal equation, the adequate treatment of which is especially welcome. The various physiological or psychophysiological causes of error are very carefully differentiated, and at the same time no space is wasted on the numerous devices for determining absolute personal equation in transit observations, though a long list of references is given for the use of those who care to pursue the subject.

Perhaps those whose "eye-and-ear" observations are consciously or unconsciously taken by what may be called the chronometer comparison method, as distinct from Bradley's (M. Boquet calls it "méthode de l'œil et de l'oreille par estime du temps"), will question whether their observations are so inferior as M. Boquet assumes. The use of screens also for magnitude equation is liable to meet with similar objections to those urged against the pierced cube of the Greenwich transit-circle, but in this the author is only summarising what has been done and projected. There are, in fact, very few places where he has expressed a decided personal opinion, so that we are inclined to regret that the plan of the work allowed so little scope for personality. With the reservation as to omissions to which we have alluded, we can only hope that the rest of the thousand-odd volumes will maintain the high standard of thoroughness set by M. Boquet. W. W. B.

THE HISTORY OF MECHANICS.

Lectures de Mécanique. By E. Jouguet. Première Partie: La Naissance de la Mécanique. Deuxième Partie: L'Organisation de la Mécanique. Pp. x+210 and 284. (Paris: Gauthier-Villars, 1908–9.) Price 7.50 and 10 francs.

SINCE the eventful appearance of Mach's works on mechanics and heat, much greater interest has been shown in the historical development of applied mathematics, both for its own sake and from a growing conviction that the teacher of a subject ought to know something of its actual growth and expansion, as well as the current methods of expounding it. Recent works by M. Duhem show that even in France, the birthplace and home of clear-cut analytical systems, there is an appreciation of the value of historical research and of tracing the slow formation of the leading ideas and principles of mechanics.

For several reasons M. Jouguet's book will be found a useful supplement to its predecessors. In the first place he is an engineer, so that he is in full sympathy with such men as Stevinus and Huygens and Galileo, and gives considerable attention to those who, like Reich and Andrade, propose to deduce the laws of mechanics from actual experiment. At the same time he is by no means the case-hardened empiric who ignores the claims of logic, and despises speculation. In fact, it is noteworthy, and gratifying, that he practically admits Kirchhoff's thoroughly abstract, and so to say *a priori*, presentation of dynamics to be the best extant from a critical point of view; and he is conscious of the value of a self-consistent theory which can be applied as at least a first approximation to the actual facts of experience.

Another advantage of the work is that it does not pretend to be exhaustive. By choosing definite problems (such as impact, for example) and restricting himself to the consideration of really eminent writers, the author is able to give extracts of some length from works of great interest which are not generally accessible. In some ways this is more instructive than any amount of comment can be.

M. Jouguet stops short of hydrodynamics, and only gives very brief accounts of the principles of least action and least constraint. Otherwise most of the main principles of dynamics and statics are illustrated. The chapters on internal forces are particularly interesting; so is a passage from Euler, which shows that he was vaguely conscious of the difficulties connected with the relativity of motion, and the impossibility of defining absolutely fixed axes of reference.

One reflection is almost certain to occur to the reader of these volumes, namely, that one great advance in the study of natural science has been the rejection of sham proposition about cause and effect, and adequate causes, and so on. It is distressing to find an able man like Wallis giving definitions of the most question-begging description, and stringing together such propositions as "other things being equal, a heavy body has a preference for the path by which it can sink the furthest." However, these early pioneers had a remarkable power of solving problems by elementary principles which they used without being able to express them in a proper, or even intelligible way; and the modern theories of light and electricity once more illustrate the curious paradox that theories based on the undefined and undefinable have the power, not only of simplifying our accounts of phenomena, but also of suggesting paths of discovery, and leading to larger control of the energy surrounding us.

If M. Jouguet's work reaches a second edition, he will doubtless correct "Bernouilli" to "Bernoulli." In a work of this kind it is rather irritating to find this time-honoured blunder repeated once more.

G. B. M.

ORGANIC MEMORY.

Die mnemischen Empfindungen in ihren Beziehungen zu den Originalempfindungen. By Prof. Richard Semon. Pp. xv+392. (Leipzig: W. Engelmann; London: Williams and Norgate, 1909.) Price 9 marks.

THE theory of the Mneme, propounded by Prof. Semon, has attracted the attention both of psychologists and of those naturalists who are interested in the profound problems of hereditary transmission. It is founded on the statement, which everyone is ready to admit, that a stimulus must affect the quality of living matter in such a way that the matter is not the same as it was before the stimulus acted. A permanent change, which, in a sense, may be called a memory, has been effected, or, to use the terminology invented by Semon, the action has been engraphic and the change itself is an engram. Repeated stimulation will make the engram more lasting. All stimuli then produce engrams, and the sum of the engrams of a living being is its mneme. Complex stimuli cause complex engrams, and if there is, under the action of some stimulus or other, a revivification of the complex engrams, then a condition termed ecphoria is produced, and the assemblage of engrams is ecphorized. If the new stimulus is in concord with the awakening of the complex engrams, this concord is termed by Semon homophonia, but if there is a discord, the homophonia may be restored in the case of psychical processes, by an introspective activity of the power of attention, or, in the case of a living organism, by regenerative processes acting ontogenetically, or by adaptation to the new conditions acting phylogenetically.

In this volume Prof. Semon discusses the theory with great clearness and commendable brevity, and he gives many illustrations. The theory may help to explain certain peculiar nervous conditions, as has been suggested by Dr. August Forel in his book on "Hypnotism." On the other hand, it may be of service to the naturalist in his ceaseless efforts to explain heredity, as was so forcibly put by Prof. Francis Darwin in his Dublin address to the British Association last year. Thus a stimulus may produce effects which radiate from the organised matter first affected to organised matter throughout the whole organism, either by nerve paths or by proplasmic intercellular filaments, and in this way faint engrams may be made on the matter of the reproductive elements, ova or spermatozoids. In some such way we may account for the transmission of acquired characters, a mode of thought, however, only to be ridiculed by those who hold that acquired characters are never transmitted. It may be said with much cogency that such a theory is only another method of arranging items of knowledge in one's mind; it is only an aid to memory and thought, without being a step towards an explanation. Although founded on well-known physiological facts, it rides off on the wings of the imagination, and it may be questioned if it really advances knowledge. Still, an ingenious theory is a stimulus and possibly a guide, and science is indebted to Prof. Semon for stating it in a succinct form in this interesting book.

JOHN G. MCKENDRICK.

THE PHYSICS OF THE ION.

Les Découvertes modernes en Physique. By Dr. O. Manville. Deuxième édition. Pp. iii+463. (Paris: A. Hermann et Fils, 1909.) Price 8 francs.

THE title of this work, "Les Découvertes modernes en Physique," since it is a single volume by a single author, is obviously incomplete. In effect the book is almost entirely, and might have been with great advantage entirely, confined to the relations between electricity and matter consequent upon the conception of the atomic charge and the isolation of the free negative charge as an electron. It is true that two chapters are devoted to the subject of radio-activity, concerning which we read in the preface:—

"Sur la *radioactivité de la matière* . . . nous avons dit que des généralités. Le domaine des faits dans cet ordre d'idées est si vaste et surtout si mobile, qu'il est encore très difficile de s'y orienter."

Ideas at the present time in radio-activity are more definite and well-grounded than in any other branch of physical chemistry, but it is clear the author's lack of knowledge in the recent and even the older work of the subject is responsible for his views. In subsequent editions this part of the work might be omitted. It follows, no doubt, the precedent set by Sir J. J. Thomson's well-known book on the conduction of electricity through gases; but what was natural enough when that book was written does not apply to a book published in 1909.

In the ground covered, the work does not differ materially from the one just quoted and many similar which have since appeared, but the treatment is interesting and lucid, and the critical examination and selection of the material chosen for presentation has been done impartially and well. The lack of any conspicuous originality is compensated for by clearness of exposition. In one respect, in that this is a French work dealing with a scientific movement which, if we exclude radio-activity, has proceeded mainly from this country and from Germany, the author is at an advantage, for the whole territory is surveyed in better perspective in consequence.

Both in the first part, which is of a general elementary character, and in the second, which deals for the most part with the mathematical theory of ions in physical phenomena, the author introduces his subject with an excellent account of the older work on the passage of electricity through ionised liquids before passing on to the newer ideas which followed the study of the discharge of electricity, first in high vacua and later, after the discovery of X-rays and other ionising agencies, in gases at various pressures. We are thankful for this juxtaposition of subjects which are usually regarded as independent owing to the fact that the one has been largely developed by chemists and the other by physicists; but at the same time it brings out the difficulties that arise when we seek to apply the newer views to the case of liquid electrolytes. The two subjects have surprisingly little connection with one another at the present time, and anyone who has to teach both must be painfully aware of the difficulties of harmonising them. In this book the newer work on gaseous ions and their properties, the various means of producing ionisation by kathode-rays, X-rays, flames, &c., the re-combination and diffusion of ions are discussed very thoroughly from the physical point of view along regular lines. In the second part an account of the electronic theories of metallic conduction and of magneto-optical phenomena is given, while the more metaphysical developments connected with the electronic constitution of matter, and the entanglement of ether by moving masses are properly left to the end of the two parts respectively. The book has no index, and is marred by an extraordinary number of misprints, the rectification of which occupies many pages of errata at the end.

OUR BOOK SHELF.

Problemi grafici di Trazione Ferroviaria. By P. Oppizzi. Pp. viii+204. (Milan: Ulrico Hoepli, 1909.) Price 3.50 lire.

IN the preface the author tells us that although graphic methods are often used by the general mechanical engineer, they have up to now been neglected by the railway engineer. This book is intended to show how such methods may be applied to the solution of nearly all problems in connection with the working of trains on railways. In this object the author has well succeeded, and it may safely be predicted that any reader who has once used graphics in the very easy and simple manner represented in this book will never again have recourse to analytical methods. Indeed, there are cases where analysis becomes so complicated that its use by a busy engineer, even if he has the required mathematical ability, is out of the question; as an example may be cited the acceleration diagram of a train drawn by a steam locomotive. Tractive effort and resistance vary in a very complicated manner with the speed, and this, again, being the time integral of acceleration, which in turn depends on the difference between tractive effort and resistance, it is easy to see that a purely analytical treatment leads to almost hopelessly involved formulæ. Yet the author is able to solve this and many other problems by his graphics in a comparatively easy way, and with a degree of accuracy quite sufficient for practical purposes.

The book contains eight chapters, in which the following subjects are treated:—train resistance as a function of speed, weight, and type of coach and locomotive; tractive effort of locomotives of various types at various speeds, gradients, and curvature of line; speed-time-distance diagrams during acceleration; possibility of making up for lost time; running down long gradients and action of brakes; total time required for a given run; consumption of fuel or electrical energy and conditions of greatest economy; efficiency of service. In all cases the author gives numerous examples to show the application of his methods to cases which are taken from practical work, and thus even a reader whose mathematical knowledge is only elementary is able to profit by this book.

This work should prove most useful to railway engineers, and an English translation would be welcome to many. There is only one fault to find with the book, and that is the very untidy appearance of the diagrams. They have all been drawn on squared paper, the divisions being in millimetres. A page covered closely with such lines is very tiring to the eyes, and if, in addition to the multiplicity of lines, there is some writing added to the curves and the whole is reduced in rather a coarse way by photography, the effect is by no means pleasing. It would have been better if the author had omitted the millimetre divisions and retained only the lines placed a centimetre apart. GISBERT KAPP.

General Treatise of Meteorology. Part i., Statical Meteorology. By Prof. A. Klossovsky. (In Russian.) Pp. xii+642. (Odessa, 1908.)

THE complete work will comprise four parts. The two first—statical meteorology and dynamical meteorology—will not necessitate a knowledge of higher mathematics; they will form the course of meteorology properly so-called, while parts iii. and iv. will be devoted to the exposition of special questions and to the principles and use of instruments. A glance at the first volume of Klossovsky's "Meteorology" shows at once that it is the outcome of a long and useful career. In fact, the first meteorological labours of the author date from the year 1882, and from that time Klossovsky has not ceased to devote all his efforts to teaching at the Odessa University, and to the organisation and direction of the network of meteorological stations in the south of Russia.

Klossovsky's manual, far from being simply a work of compilation—the most complete of any now extant—is distinguished by its originality and by the wealth of the author's critical views. In many parts of the work we meet with pages where certain connections between meteorological data and those of other sciences are admirably described; *e.g.* at p. 179 and following pages the calorific economy of the human body is discussed. Further, original observations are met with for the first time; thus, at p. 273, the results of the actinometric observations made by Savelieff at Kiev. Again, the whole chapters devoted to solar radiation and to the study of earth temperature are interesting to read.

In no other treatise are the questions relating to underground temperature expounded in so complete a manner. The discussion of the results of the author's observations on the temperature at different depths in soil covered with grass and otherwise is especially noteworthy. On p. 334 there is a table giving for each month of the year the temperature at depths of 0·60 m. and 1·20 m. in forest and field adjoining. The forest diminishes the annual amplitude; the differences (field—forest) are $+3{\cdot}0^{\circ}$ C. and $+2{\cdot}7^{\circ}$ for the means of July, $-0{\cdot}4^{\circ}$ at a depth of 60 cm. and $-0{\cdot}2^{\circ}$ at 1·20 m. in January.

One of the characteristics of Klossovsky's work is the care with which the most recent advances have been taken into consideration; *e.g.* at p. 512 observations made in January, 1907, are noted, and at p. 606 the results of unmanned balloon ascents at Uccle up to April 11, 1907, are included. The titles of the chapters in this first volume are:—Composition of the atmosphere; physical properties; water in the atmosphere; the oceans; solar radiation; terrestrial radiation; earth temperature; increase of heat with depth; ocean temperatures; temperature of the lower strata of the atmosphere; atmospheric pressure; formation of hydrometeors; temperature and pressure in the upper atmosphere; abnormal departures. H. A.

An Introduction to the Study of Integral Equations. (Cambridge Tracts in Mathematics and Mathematical Physics.) By M. Bôcher. Pp. vi+72. (Cambridge: University Press, 1909.) Price 2*s.* 6*d.* net.

ONE main problem discussed in this tract is the following: let $f(x)$ and $K(x, \xi)$ be known functions, it is required to determine the function $u(x)$ so as to satisfy the equation

$$u(x)=f(x)+\int_a^b K(x, \xi)u(\xi)d\xi.$$

Prof. Bôcher shows, mainly after Fredholm, that under certain conditions of a very general kind, a solution exists, and may actually be put into the explicit form

$$u=f(x)+D^{-1}\int_a^b D(x, \xi)f(\xi)d\xi,$$

where D is a determinate function of a, b, and $D(x, \xi)$ a determinate function of a, b, x, ξ. That it should be possible to prove this in a simple, and at the same time rigorous manner is a good illustration of the increasing power of modern function-theory. Prof. Bôcher's exposition is very good; he begins by a heuristic discussion, which in a way resembles the ordinary method of successive approximations. Having thus been led to a certain expression as a presumptive solution, he proceeds to verify the fact that it is one.

Other workers in the same field who receive due attention are Abel, Liouville, Hilbert, Schmidt, and Volterra; and there are various subsidiary or supplementary articles of great interest.

As No. 10 of the "Cambridge Tracts in Mathematics and Mathematical Physics," Prof. Bôcher's work thoroughly helps to fulfil the object of the series; it is brief, self-contained, and stimulating, while giving sufficient reference to original sources.

The Scaly-winged. A Book on Butterflies and Moths for Beginners. By R. B. Henderson. Pp. xii+115. (London: Christophers, n.d.) Price 1*s.* net.

THE study of entomology is always extending its range, as shown by the numerous books which continue to be published especially relating to the order Lepidoptera, or butterflies and moths, which always seems to be the most popular of all, probably because many insects included in it are attractive in appearance, and easy to collect. The study is pursued systematically in several of our great public schools, and Mr. Henderson informs us in his preface that "the entomological, like most of the other sections of the Natural History Society of Rugby School, is entered by examination," and that as he did not find a suitable book for beginners to use in preparation for such an examination, he has compiled one for the purpose.

The various chapters deal with insects in general, and the Scaly-Winged in particular; metamorphosis; Psyche (imago); the Sister States (difference between butterflies and moths); bionomics: the place of Lepidoptera in the scheme of nature; the museum; appendix: note on the vision of insects; and list of some useful books for consultation, Furneaux's "Butterflies and Moths" being specially recommended. There are twenty-two useful text-illustrations of structure and apparatus, and the instructions for collecting and preservation in the chapter on the museum are particularly good.

Fossil Plants. Sixty Photographs illustrating the Flora of the Coal-measures. By E. A. Newell Arber. Pp. 75. Gowans's Nature Books, No. 21. (London: Gowans and Gray, Ltd, 1909.) Price 6*d.* net.

IT is not often that anything has been done to popularise the study of the plants of the past, a subject of which the "educated layman" is, as a rule, profoundly ignorant. This neat little volume, with its beautiful photographic illustrations of some of the most important coal-plants (club-mosses, ferns and fern-like seed-plants, horsetails, sphenophylls, and early gymnosperms) is well calculated to rouse an interest in the flora of so many million years ago. The great majority of the photographs are from casts and impressions, showing the external aspect of the fossils, and these are all admirable; we have never seen a better collection. Some of the few microphotographs of sections, illustrating the internal structure, are equally good, though in one or two cases clearer examples might have been selected. The short explanatory notes (scarcely a dozen pages in all) are, as the name of the author guarantees, thoroughly sound and up to date; they are just enough to whet the reader's appetite for more, which is all that can be expected or desired of a sixpenny nature picture-book.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Systematic Position of Mœritherium.

PERHAPS of all the groups of mammals at present existing, no two are more dissimilar in general form than the Proboscidea and the Sirenia, but, nevertheless, the suggestion made long ago by de Blainville, that these animals are nearly related, has of late years been shown to be almost certainly correct, the discovery of early members of both groups in the Lower Tertiary beds of Egypt having to a great extent bridged the gap between the two orders. The animal that perhaps most nearly approaches the ancestral type of the two groups is Mœritherium, which, however, has hitherto been regarded as already far advanced along the proboscidean line, and if not directly ancestral to the undoubted primitive elephant Palæomastodon, at least closely related to its ancestor, and representing a stage of evolution through which it must have passed.

In an article "On the Feeding Habits of Mœritherium and Palæomastodon," published in NATURE of July 29, Prof. H. F. Osborn seems to dissent from this view to some extent, to emphasise the Sirenian characters of Mœritherium, and to regard it rather as a belated Sirenian which had not undergone the specialisation for a purely aquatic life already attained by some Sirenians contemporary with, or even earlier than, it. Prof. Osborn to a large extent bases his conclusions on peculiarities shown in some more or less conjectural restorations of the heads of Mœritherium and Palæomastodon, his chief reasons for the separation of Mœritherium from the Proboscidea being (1) the small size and high anterior position of the eyes and the high position of the ears, both said to be characteristic of the Sirenia; (2) the difference in the arrangement of the anterior teeth and mouth-parts from that found in Palæomastodon.

As to the characters of the eyes and ears, they seem to be purely adaptive, and are simply the result of the admittedly semi-aquatic habits of Mœritherium, and would not be expected to exist in purely terrestrial members of the group. The apparent height of the ears is, moreover, mainly the consequence of the small development of the occipital region of the skull compared with that found in the heavier-headed Palæomastodon. As to the arrangement of the jaws and the anterior teeth, it seems to represent exactly such a stage as a mammal with the normal Eutherian dentition would be expected to pass through before attaining the condition found in Palæomastodon. Certainly the anterior dentition of Mœritherium is quite unlike that of any known Sirenian; thus in Eosiren, a contemporary of Mœritherium, it is the first pair of upper incisors, not the second, that is enlarged, while the other incisors and the canine are already in a fair way to the complete disappearance characteristic of the later Sirenia. In the lower jaw the differences are greater still, Eosiren possessing the strongly deflected symphysis probably already partly covered with a horny plate, and in which the incisors are undergoing reduction; in Mœritherium, on the other hand, there is no deflection of the symphysis, and the first pair of incisors is small, while the second form large procumbent tusks, very similar to those found in many primitive Proboscidea. Mœritherium is further distinguished from the contemporary and even earlier Sirenians by the possession of a well-developed pelvis, which was supported by a strong sacrum composed of three fused vertebræ. The hind limb is, unfortunately, not completely known, but the femur was large and straight, being similar in many respects to that of Palæomastodon. In several other ways, also, Mœritherium differs from the Sirenia and approaches the Proboscidea; thus the position of the auditory meatus with reference to the zygomatic process of the squamosal and to the neighbouring bones is as in Palæomastodon, and quite unlike what is seen in the Sirenia. Again, the cervical vertebræ, though short, show no traces of the extreme shortening already present in Eosiren.

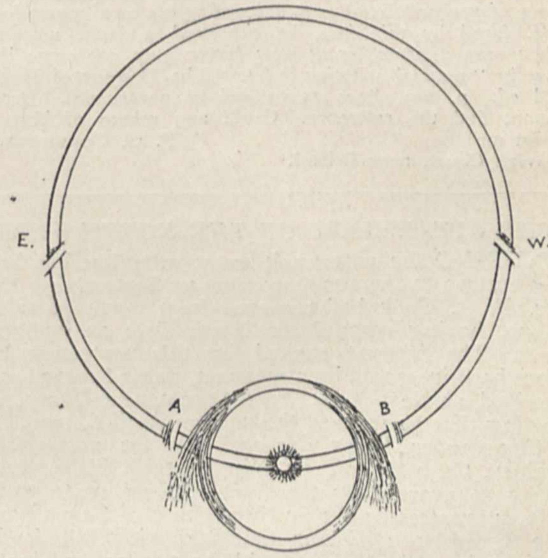
Another argument in favour of the relationship of Mœritherium to Palæomastodon is the existence of forms like *Moeritherium trigonodon* and *Palaeomastodon minor*, which, though unfortunately at present very imperfectly known, appear, both in their size and in some respects in their tooth structure, to be annectant forms.

On the whole, it seems that the weight of evidence is in favour of regarding Mœritherium as a proboscidean, though perhaps not on the direct line of ancestry of Palæomastodon, and retaining some characters of the original Proboscideo-Sirenian stock.

CHAS. W. ANDREWS.

Remarkable Halo of August 21.

THE accompanying diagram is a sketch of the Danzig phenomenon as observed at Blackpool on Saturday, August 21, between 11.45 a.m. and 0.30 p.m. There had been heavy rain and stormy winds on the previous night and in the early morning up to 10 a.m. At 11.45 a.m. thunder cloud and cumulus extended all around the horizon, but in the vicinity of the zenith, where the 22° halo and the western portion of the mock sun ring now appeared, there was no trace of cirrus or other cloud form, although a very pale milky tint might be discerned.



At noon the sky was overcast, but by 0.25 p.m. it was again clear at the zenith, and the complete phenomenon stood out very prominently, the 22° halo very vivid and brilliant with what would appear to be its arc of upper contact, the mock sun ring being very clear and of a silvery hue, and the mock suns; the two furthest from the real sun being apparently at the intersection of the mock sun ring with the 90° halo. This halo, however, was nowhere else visible.

There was nothing like an image of the sun at the N. point of the 22° halo; but this was a position of very great brilliancy, with the usual reddish colouring on the edge nearest the sun and the gradual shading off outwards to a bluish-white. The S. point was also a position of maximum brightness, though less intense than the N. point, while the E. and W. portions of the halo were fainter and untinted, but quite discernible.

The two nearer mock suns at A and B likewise could hardly be called images of the sun, but resembled the N. point of the 22° halo, as though they were the intersections in the mock sun ring of another halo, nowhere else visible, of about 33° radius. They were thus somewhat elongated, projecting slightly on either side of the ring. The two further mock suns were of a similar character, but with no colour.

Some special peculiarities seem to have been :—(1) The absence of cloud in the region of observation where the phenomenon was at its brightest. (2) The complete continuity of the mock sun ring, the portion within the 22° halo being quite distinct. (3) The fact that the arc of upper contact had its *concave* side towards the sun, and extended for more than 90° on either side of the point of contact, gradually growing more diffuse and faint. This seems to be quite a special characteristic. (4) The peculiar shape of the mock suns and the positions of the two nearer the sun. These were not on the 22° halo, but outside the arc of upper contact, as shown in the sketch, the arc bisecting the distances measured along the ring between the mock suns and the halo.

At 0.30 p.m. the sky again became overcast, nor could any trace of the phenomenon be seen afterwards. In the afternoon and evening the wind was very cold, and there was a fair amount of cloud, but on the whole it was fine and sunny. The night, however, was wet and stormy.

W. McKEON.

Stonyhurst College Observatory, August 30.

Man and Environment.

I AM under the impression that it is recorded somewhere that Darwin expressed the following opinion:—He considered the fact that when man appears he appears, not as a "blind" subject of his environments, but with power to determine largely, not only his own environments, but those of generations of men succeeding his own generation; and, faced by this fact, he expressed a doubt whether, when man appears, some new factor may not come into play in "natural selection" (*cf.* "The Descent of Man," 2nd ed., p. 613, lines 15 to end of paragraph). But I cannot find the reference. Could any reader of NATURE assist me? F. C. CONSTABLE.

Wick Court, near Bristol.

THE ATTAINMENT OF THE NORTH POLE.

DURING the past week great attention has been given to the announcement on September 1 that Dr. F. A. Cook had returned from north polar regions, having reached the North Pole on April 21, 1908. The interest excited by this statement has since been increased by a message, dated September 6, received at New York from Commander Peary, reporting that he reached the pole on April 6, 1909.

Commander Peary departed for the north from Sydney, Cape Breton, on July 17, 1908, his intention being to proceed by the Smith Sound route to his winter quarters on the northern shore of Grant Land. He hoped to start for the pole with fully-loaded sledges from the "Big head" he encountered in the Polar Ocean in 1906, to the north of Grant Land, in about latitude 84° N. The last information concerning him indicated that in the middle of August last year his ship, the *Roosevelt*, was continuing her voyage northwards from Etah, the expedition's base of supplies on Smith Sound. He took sounding apparatus with him, with the intention of obtaining a line of soundings from Grant Land to the pole. When he left last year he stated that, should he reach the pole, news of his success might be expected between August 15 and September 15, and the message received on September 6 has justified his expectations.

It is difficult yet to arrive at a satisfactory opinion as to the value of the observations from which the explorers conclude that they reached the North Pole, but as both Dr. Cook and Commander Peary are responsible travellers, it must be assumed that they realise the difficulty of determining the position of the pole, and took the necessary precautions to establish the validity of their claims. We have no right to doubt their statements, but the publication of the observations at an early date is greatly to be desired, so that the matter can be placed beyond question. In the case of Commander Peary, his previous work in Arctic regions is so well known that geographers have accepted his announcement without hesitation, and a congratulatory message has been sent to him by the Royal Geographical Society. On the occasion of his previous expedition in 1906, he approached to within two hundred miles of the pole, and there was every reason to anticipate that this year he would reach the pole itself. His plans were known, and his long experience of Arctic conditions justified confidence in their successful accomplishment. There has, however, been much discussion upon Dr. Cook's journey and achievement, and as he claims to have reached the North Pole nearly a year before Commander Peary, it is of interest to give a few particulars relating to him and his expedition.

Dr. Cook is an American medical man, with varied experience of exploring work in both the Arctic and Antarctic regions. He served as surgeon on Commander Peary's second expedition to West Greenland in 1891, and was a member of the Belgian Antarctic expedition under Commander De Gerlache, which spent the Antarctic winter of 1898 drifting about on board the *Belgica* in the ice-covered seas to the south-west of Graham Land. Both in 1903 and 1906 Dr. Cook conducted expeditions to Alaska, with the object of achieving the ascent of Mount McKinley, 20,390 feet high, the loftiest mountain on the North American Continent, and after repeated failures reported that he had succeeded in reaching the summit. Two years ago it was announced that he was desirous of organising an expedition to the South Pole, and it came as a surprise to most people to learn in the autumn of 1907 that he was encamped at Etah, on the north-west coast of Greenland, and proposed to make a "dash" for the North Pole.

Briefly, Dr. Cook's story is that he left his base at Etah on February 19 of last year, accompanied only by a force of Eskimos, and dogs for pulling the sledges. The route varied slightly from that adopted by Commander Peary. Dr. Cook struck westwards across Smith Sound to Ellesmere Land, and continued westwards across that island to Nansen Sound, which separates Ellesmere Land from Axel Heiberg Land, one of the new lands discovered by the Sverdrup expedition on board the *Fram* in 1898–1902. From Cape Hubbard, the northernmost point of Axel Heiberg Land, Dr. Cook pushed out over the polar ice on March 18. Three days later the last of the supporting parties returned, and Dr. Cook continued his march to the pole with only a couple of Eskimos. Between the 84th and 85th parallels of north latitude, he sighted land to the west, but "the urgent need of rapid advance on our main mission did not permit a detour to explore the coast." This, continues Dr. Cook, in the narrative which he has supplied to the *New York Herald*, was the last sign of solid earth seen on the northward march, though, "from the 87th to the 88th parallel much surprise was caused by an indication of land ice. For two days we travelled over ice which resembled a glacial surface. . . . There was, however, no perceptible elevation, and no positive sign of land or sea." Farther north, Dr. Cook says, "signs of land were still seen every day, but they were deceptive illusions, or a mere verdict of fancy. . . . The mirages turned things topsy-turvy, inverted mountains, and queer objects even rose and fell in shrouds of mystery; but all of this was due to the atmospheric magic of the midnight sun."

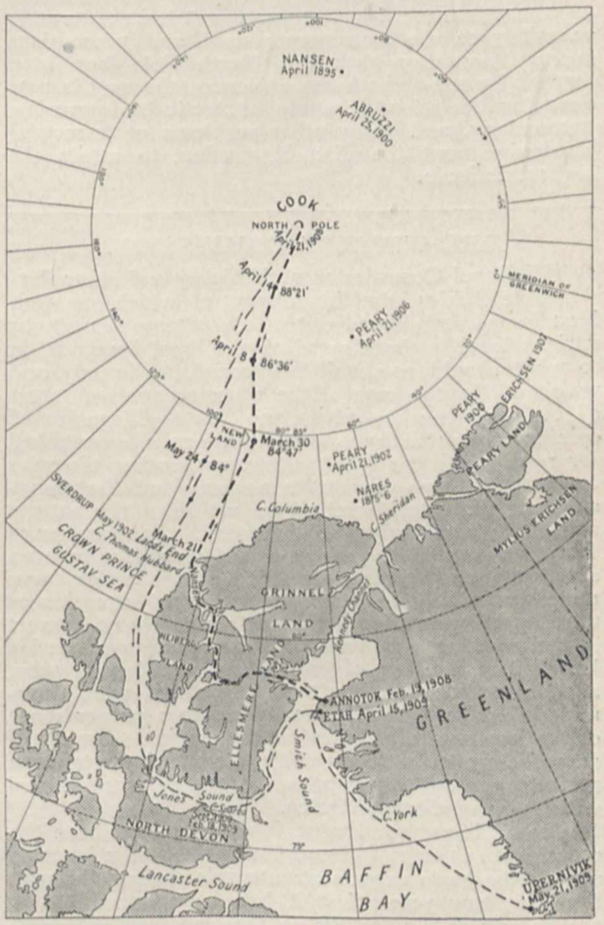
Finally, to quote the words used by Dr. Cook on September 7, in a lecture to the Royal Geographical Society of Denmark:—"On April 21 my observation gave 89° 59′ 40″—that is, 20″ from the pole. We advanced the 20″ and I made another observation, and several others that day and the next. I think there is no doubt that these observations will prove that we have been on and around 90°—the North Pole." The return march was then begun. Instead of being carried by an easterly drift to the Greenland coast, the little party found themselves some distance west of Axel Heiberg Land. Continuing south to Jones Sound, they wintered in primitive fashion at Cape Sparbo, on the coast of North Devon, and subsequently made their way across to the Greenland coast, whence Dr. Cook obtained a passage to Copenhagen on board a Danish Government steamer.

Not so much the fact that Dr. Cook was unaccompanied by any white companion, as certain surprising features in the above story make it advisable to await the examination of Dr. Cook's instruments and journal of observations before his claim to have reached the pole is definitely admitted. Cape Hubbard, from which Dr. Cook pushed out into the Polar Ocean, is situated in about latitude 81° 15′ N., *i.e.* 525 geographical or rather more than 600 statute miles from the pole. To have covered this in thirty-five days Dr. Cook must have advanced northwards at an average rate of seventeen statute miles a day, making no allowance for deviations from a due north and south line. An even greater rate of travel was maintained for a longer period of time by Lieutenant Mecham on a sledge journey among the islands of Arctic Canada during the long series of the Franklin search expeditions. Nothing like such a rate of progression northwards has, however, been achieved by any previous traveller over the ice of the open polar sea. Nor is it correct to say, as Dr. Cook is reported to have said, that he was able to rely on more favourable conditions because he travelled earlier in the year than previous explorers. Dr. Nansen and Lieutenant Johansen left the *Fram* in about 84° north on March 14, 1895, and reached their farthest north in latitude 86° 5′ north on April 8, their average daily northing being thus about six miles. Captain Cagni, of the Duke of the Abruzzi's expedition, left the winter quarters of the *Stella Polare* in Teplitz Bay, Franz Josef Land, latitude 81° 47′ north, on March 11, 1900, and reached his farthest north in latitude 86° 33′ on April 25, his average daily northing having been about seven miles. In 1906 Commander Peary pushed out over the polar ice from the northern coast of Grant Land, just south of the 83rd parallel, on March 6, and reached his farthest north in latitude 87° 6′ on April 21, his average daily northing having been about six miles.

From these records it will be seen that by travelling northwards over the Polar Ocean at the rate of seventeen miles a day, Dr. Cook has far surpassed the most strenuous efforts of his predecessors. All the explorers mentioned were capable of, and did on occasion perform, journeys of twenty and more miles a day. But in advancing northward they all found themselves greatly delayed by open lanes of water and pressure ridges in the ice. Dr. Cook says very little about any difficulties of this nature, although he does on one occasion mention that "much of our hard work was lost in circuitous twists around troublesome pressure lines and high irregular fields of very old ice. The drift, too, was driving eastward with sufficient force to give some anxiety." If the conditions he encountered throughout his march were similar to those experienced by previous travellers over the Polar Ocean, it is astounding that he should have been able to travel so much faster than they.

Of course, conditions vary in different seasons and along different routes, and Dr. Cook may have been exceptionally favoured. There is no need to doubt his good faith, but for confirmation of his calculations it will be necessary to await the examination of his records. The precision with which he reports his position on April 21 would seem to show that he scarcely appreciates the difficulty of securing exact observations under the conditions as regards refraction, &c., which prevail near the pole.

However this may be, and whatever the precise point attained by Dr. Cook, there seems little doubt that he made an extended journey over the polar ice; but scientific research was not Dr. Cook's object, and his journey can possess little scientific value. He carried no sounding apparatus, and has brought back only the vaguest information about the new lands to the north-west of Greenland. The land which he did



North Polar Map. Dr. Cook's route is shown by broken lines. Commander Peary's route is not indicated, because the details are not yet available.

sight, indeed, was probably the land which Peary sighted in 1906, or some extension thereof. Further north, there is a suggestion that the party travelled over glacial ice, but Dr. Cook has nothing definite to report which indicates the existence near the pole of anything but the ice-covered Polar Ocean. Some points have still to be cleared up. In more than one report Dr. Cook is credited with stating that the land he sighted after leaving Axel Heiberg Land abounds with game; yet he did not come within several miles of the land, and, according to the *Times*, met with no game beyond Heiberg Island. If Dr. Cook reached the pole, he has given a remarkable illustration of pluck and endurance, but his journey seems likely to have a minimum of scientific value, and there is still room where he has been for a well-equipped scientific research expedition to do excellent work in studying the geographical problems of the region. A mere "dash" to the pole may awaken a certain amount of sentimental interest, and direct public attention to the traveller, but it is of no value from the scientific point of view unless exploration—physical or geographical—is carried on. Commander Peary appears to have been equipped with apparatus for taking soundings and making other observations of polar conditions, and he has telegraphed to the director of the American Museum of Natural History, New York, "I am bringing a large amount of material for the museum." The scientific importance of polar expeditions must be judged by the new knowledge obtained rather than by the determination of a mathematical point more or less accurately according to the instruments used and precautions taken. Assuming that the North Pole has been reached by one or both the explorers, the way is now clear for the scientific study of Arctic hydrography, meteorology, and many other problems of terrestrial physics without the disturbing effort to attain the highest latitude.

THE WHISKEY COMMISSION.

THE Royal Commission on Whiskey and other Potable Spirits, the final report of which has just been issued, originated out of the attempts made by various local authorities to obtain legal decisions as to what should or should not constitute brandy and whiskey. In the case of the other recognised forms of ordinary potable spirits, no acute differences of opinion appear to have arisen. When a man asked for rum or gin the legal mind representing the man in the street was content to assume that that long-suffering individual received an article of the nature, substance, and quality he demanded. As a matter of fact, the man in the street raised no difficulty even about the two forms of potable spirits which have more particularly engaged the prolonged attention of the Royal Commission. He had absolutely no interest in the touching solicitude which was displayed on his behalf by a number of professional gentlemen, who, apparently from purely altruistic motives, were determined that he should be awakened to a proper sense of the importance of knowing the origin and mode of manufacture of articles which he had hitherto been perfectly content to purchase because he was satisfied with their quality and price.

What is brandy and what is whiskey have been the occasional subjects of discussion in the public journals and in the trade organs at intervals during the past three or four years, but it has been impossible to arouse any public feeling on these momentous questions. The fact is, the agitation, such as it was, was wholly artificial. It simply originated in, and turned upon, a struggle between competing trade interests. Brandy, by use and wont, has been universally regarded as a spirit obtained by the distillation of fermented grape-juice; whiskey as a spirit obtained by the distillation of a fermented "wash" derived from some form of cereal, usually, but not invariably or wholly, malted barley. But owing to the unfortunate grape disease (Phylloxera) which, a generation ago, devastated the French vineyards, especially in the Charentes, where the particular grapes mainly employed in the manufacture of Cognac are grown, the manufacture of factitious brandy was greatly stimulated. This consisted of some form of distilled spirit—obtained usually from grain, or from beetroot molasses, or, occasionally, from potatoes, artificially flavoured with "brandy essence" and coloured with caramel. This article entered into competition, not only with the genuine product, but with a factitious brandy "drawn and made from malted corn," which has been produced for more than a couple of centuries in this country under the name of "British brandy," a term first legally sanctioned by the Spirits Acts of 1860. In due time the vineyards were re-planted, the Charente vines being grafted on American stocks, and the manufacture of Cognac by the time-honoured methods was re-established. Naturally the manufacturers contended that their product was the only legitimate brandy, and that the factitious articles were not entitled to the name of Cognac, or when sold in this country to the term brandy, unless this was qualified, as in the case of "British brandy," by some prefix which should serve to differentiate it from the product of the grape.

This, then, as regards brandy, is the *fons et origo* of the trouble. It was useless for the contending parties to appeal to our law, since, as the Commission states, there is no statutory definition of the term "brandy"; nor is there any binding judicial decision on the subject. The 148th Section of the Spirits Act of 1860, it is true, contained an implied definition of "British brandy," which would have covered the case of all factitious brandies sold in this country, whether made here or not, but this was repealed in 1880, so that there is no longer a legal definition even of "British brandy."

As regards whiskey, the cause of contention was not so much the nature of the material from which the spirit was derived, although this did to some extent enter into consideration, as the manner in which the distillation was effected. Originally all whiskey was made by means of comparatively small stills—of the type known as pot-stills—in which the fermented wort was distilled by the direct application of fire. But about the year 1831, Eneas Coffey invented and patented a form of still adapted for continuous working, in which the alcohol is driven out of the wort by means of steam, and the mixture of steam and spirit is then separated by an ingeniously contrived condensing or rectifying arrangement which enables a much "cleaner" spirit to be produced—that is, a spirit much more free from what are held to constitute the characteristic constituents of whiskey, as distinguished from plain spirit. This process not only resulted in the production of a purer form of alcohol—that is, purer in the sense commonly understood by chemists—but it was more economical in use, and consequently materially cheapened the cost of production. This, of course, made the "patent still" a formidable competitor of the "pot-still," and those who had a vested interest in the pot-still naturally complained that this interest was jeopardised by the employment of a piece of apparatus which might make alcohol, but, it was contended, did not necessarily make whiskey.

In the autumn of 1905 the Islington Borough Council was induced to bring two test cases before a London stipendiary under Section 6 of the Sale of Food and Drugs Acts, in one of which it was held that a certain publican had sold, to the prejudice of a purchaser who demanded Irish whiskey, something which was not of the nature, substance, and quality of Irish whiskey; and, in the other, that another publican had sold, to the prejudice of a purchaser who demanded Scotch whiskey, something which was not of the nature, substance, and quality of Scotch whiskey. In each case the analyst had certified that what was sold as whiskey "consisted entirely of patent-still, silent or neutral spirit," and was not, therefore, in his opinion, whiskey.

The learned magistrate ruled that patent-still spirit alone is not whiskey; and that the produce of a patent still cannot be Irish or Scotch whiskey, although made in Ireland or Scotland. He further held that

Irish whiskey was to be made from a mixture of 75 per cent. of barley malt, with 25 per cent. of barley, wheat, oats or rye, or any of them; whereas Scotch whiskey was to be made wholly from barley malt. He specifically excluded maize, which is frequently used in connection with the patent still, as a cereal from which whiskey may be made. Accordingly he convicted the defendants as having sold articles to the prejudice of the purchaser.

Attempts were made to upset the convictions by appeals to quarter sessions, but the trials proved abortive. Whiskey manufacturers took a very serious view of the position in which they were thus placed, and eventually they induced the authorities to issue a Royal Commission to determine whether, in the general interest of the consumer, or in the interest of the public health, or otherwise, it is desirable (*a*) to place restrictions upon the materials or the processes which may be used in the manufacture or preparation in the United Kingdom of Scotch whiskey, Irish whiskey, or any spirit to which the term whiskey may be applied as a trade description; (*b*) to require declarations to be made as to the materials, processes of manufacture or preparation, or age of any such spirit; (*c*) to require a minimum period during which any such spirit should be matured in bond; (*d*) to extend any requirements of the kind mentioned in (*b*) and (*c*) to any such spirit imported into the United Kingdom; and, lastly, to make the like inquiry as regards other kinds of potable spirits which are manufactured in or imported into the United Kingdom.

It should be stated that the terms of the reference relating to public health arose from the character of the evidence needed to establish the count of "prejudice to the consumer," without which it would have been impossible to have obtained a conviction under Section 6 of the Food and Drugs Acts.

The real nature of the issues to be determined was at once seen from the character of the criticisms which were passed, mainly by Irish distillers or their representatives, on the constitution of the Commission. As a fact, the *personnel* of the Commission was very carefully chosen, and every legitimate interest was adequately represented. The printed evidence proves how competent the members were to inquire into the somewhat complicated questions which were raised, and how carefully and how impartially they sifted and weighed the statements of avowedly interested witnesses. It was, of course, to be expected that their findings would not give universal satisfaction, but every fair-minded critic will admit that they have been arrived at in good faith, and are abundantly justified by the weight of the evidence.

As regards the materials to be used in the manufacture of whiskey, the commissioners find no ground for any interference with existing practice. The contention that Irish or Scotch whiskey should alone be produced from cereals actually grown in those respective countries, or even from cereals capable of being grown there, found no favour in their eyes. Of course, the contention was really aimed at the exclusion of maize, which is largely used in the manufacture of patent-still spirit. The commissioners see no valid reason for excluding maize. There is no evidence to show that it is not a perfectly wholesome material, or that the spirit derived from it is not as wholesome as that derived from any other cereal.

Nor as regards processes of manufacture, that is, modes of distillation, does any sufficient ground exist, in the opinion of the commissioners, for any interference with established procedure. To have supported Mr. Fordham's finding would have effected nothing short of a revolution in the manufacture of whiskey, inasmuch as nearly two-thirds of the potable spirits produced at the present time in Scotland and Ireland are distilled in patent stills. Moreover, spirit produced in the patent still has long been employed for blending with or diluting whiskeys distilled in other forms of still, and most of the whiskey now sold in the United Kingdom contains more or less spirit which has been obtained by the patent still. Lastly, no evidence was tendered to show that the form of still had any necessary relation to the wholesomeness of the spirit produced.

Suggestions were made to the Commission either to "standardise" the mash or to "standardise" the blend with a view of ensuring that at least a certain minimum proportion of pot-still whiskey should ultimately find its way into the whiskey as sold, but here again the commissioners saw no reason to interfere with the discretion of the blender. In their opinion "the proportion of the different whiskeys to be employed in these blends is controlled by an influence stronger than that of the law. The taste of the consumer creates the demand which ultimately controls the trade. The public purchases the whiskey that meets its taste, and the blender must satisfy that taste or lose his trade. It is not for the State to say what that taste ought to be."

The general conclusion which the commissioners came to was that "'whiskey' is a spirit obtained by distillation from a mash of cereal grains saccharified by the diastase of malt; that 'Scotch whiskey' is whiskey, as above defined, distilled in Scotland; and that 'Irish whiskey' is whiskey, as above defined, distilled in Ireland." It is difficult to see how the commissioners could have escaped reaching this luminous and oracular conclusion. At the same time, to the scoffer the whole business is eminently suggestive of one of Molière's comedies. Monsieur Jourdain would have been profoundly impressed by the strict logic and admirable lucidity of such a finding.

After this the question of brandy, as may be anticipated, presented little or no difficulty. The commissioners define brandy as a potable spirit manufactured from fermented grape-juice, and from no other materials, and that the determination of the application of the term in this country cannot be controlled by the nature of the apparatus or process used in the distillation of the spirit. They are further of opinion that the compounded spirit long recognised by the name of British brandy is entitled still to be so named and sold as "British brandy."

The limitations of space preclude any attempts to deal with the other and less important matters dealt with in this report, but the general tenor of the conclusions in respect to these is on a par with the *laissez-aller* tone which pervades the whole.

As might have been expected, the report has not been received with a unanimous chorus of approval, and the Irish distillers, in particular, have not been slow to express their dissatisfaction. But it is to be hoped that on reflection even they will be led to the conviction that the conclusions to which the commissioners have been led represent the common-sense of the question. The conflict of the stills is one more illustration of the inevitable result of what is called the "march of improvement" in which a time-honoured process has eventually to succumb, by the mere force of circumstances, to the economic pressure of a mode of manufacture based upon more rational principles. The commissioners have evidently been fully alive to this aspect of the problem which has been presented to them. At all events, they have shown themselves as not unmindful of the advice of the old merchant, who, being consulted by Colbert about what he should do in favour of trade, said, "*Laissez nous faire.*"

T.

PROF. EMIL CHRISTIAN HANSEN.

It is with profound regret that we have to announce the death of Prof. Emil C. Hansen, director of the Carlsberg Laboratory, Copenhagen, which occurred after a brief illness on August 27. Born in 1842, he attended in his youth the art school at Copenhagen, but subsequently, between 1871 and 1876, devoted himself to the study of science at Copenhagen University. He entered the Carlsberg Institute in 1877, where he commenced his memorable researches on microbiology.

Hansen's life-work was practically confined to the study of the Saccharomycetes, but his researches in this domain of biological science stand out as a model of thoroughness. Prior to his time little was known concerning the different species of yeasts, although so early as 1857 Bail had observed that types of yeast existed giving rise to what he termed "wild fermentations." This did not, however, attract much notice among either scientific men or technologists, and even Pasteur—who must ever be regarded as the pioneer of biology as applied to the fermentation industries—regarded bacteria alone as the cause of diseases of beer. Rees, however, in 1870, had arrived at the conclusion from his experiments that brewery yeasts represent species which are quite distinct from wine yeasts, and that still other species are concerned in the secondary fermentation of beers and in so-called "wild fermentations." None of these observations were, however, convincing, and the truth only became apparent after the publication of the exact experimental data on the subject by Hansen.

In 1880, when Hansen first commenced his remarkable studies on the Saccharomycetes, biological methods of isolating micro-organisms were but little developed. The dilution method devised by Lister and employed by that observer, as well as by Naegeli and by Fitz, was the only one available, yet it was by an improved modification of this extremely tedious, not to say uncertain, method that Hansen succeeded for the first time in cultivating yeasts from a single cell. In his paper published in 1883 he described accurately six species of Saccharomycetes. The subsequent adoption by Hansen of the method of culture on a solid substratum—which had been developed by Koch—added much to the precision of his work, but he always insisted that in order to obtain absolutely pure cultures it was necessary in all cases to start from a single cell. Some might, indeed, think that he carried this injunction a little too far, in view of the results which have been obtained in the isolation of other micro-organisms by cultures from colonies; but it must be remembered that Hansen's researches were directed, not merely to the isolation of species, but of varieties.

Hansen's work consisted, however, not only in isolating distinct species of the Saccharomycetes, but he elaborated methods for their characterisation, and for this purpose he made use of film-formation, and more especially ascospore-formation, under definite conditions of temperature. By the sporulation test it is possible to detect 1/900th to 1/200th part of a wild yeast—such as a *S. Pastorianus* species—in admixture with *S. cerevisiae*. Thus the microbiologist was put in possession of a method for the quantitative as well as the qualitative analysis of yeast mixtures. Previously for the qualitative analysis of such mixtures morphological considerations alone were available, the results being rough and inconclusive, for one and the same species may under different conditions assume a different form.

Practical brewers have long known that yeasts in practice vary according to the system of fermentation adopted; it has even been suggested that a given type of yeast consists of more than one variety or race, and in this country, at all events, such a type is always associated with a certain number of cells of wild species. Whether these varieties, which seem to be the result of environment, are immutable is a moot point, and it may be pointed out that Hansen at first believed that the top-fermentation races of *S. cerevisiae* employed in this country were under no conditions convertible into bottom-fermentation races, but recently he found that the conversion was possible.

The employment of yeast grown from a single cell has met with great success in Continental bottom-fermentation breweries. Not so, however, in British breweries. One of the first to give the system a trial in this country was Dr. Horace T. Brown, who ultimately abandoned it since he was not able to obtain a satisfactory secondary fermentation; and in confirmation of Dr. Brown's results it has since been shown and fully admitted by Hansen that for the secondary fermentation of British beers, organisms other than the normal *S. cerevisiae* are needful. In this connection it should be mentioned that Schionning recently confirmed Clausen's observations that certain torulæ play an important *rôle* in bringing about the secondary fermentation and conditioning of British beers.

Few men of science since Pasteur's time can lay claim to a greater debt of gratitude from fermentation technologists all over the world than Hansen. His numerous papers are published in the *Comptes rendus* of the Carlsberg Laboratory, the *Centralblatt für Bacteriologie und Parasitenkunde*, the *Annals of Botany*, and the *Journal of the Institute of Brewing*.

ARTHUR R. LING.

NOTES.

MISS DOROTHEA BATE, already well known for her researches in the caverns of Cyprus and elsewhere, has had the good fortune to make a very remarkable and interesting discovery in a cave in Majorca. On her return home Miss Bate remarked that the cave contained only a few bones of goats, but on further examination these despised relics proved to indicate an entirely new type of an extraordinary nature—in other words, neither more nor less than a "rodent-goat." For the skull, which with certain other remains is described by its discoverer in the September number of the *Geological Magazine*, under the name of *Myotragus balearicus*, is characterised by its extreme shortness, and the presence in the front of the lower jaw of a single pair of incisor teeth, in place of the four pairs of incisors *plus* canines characteristic of ruminants generally. In all respects these incisors are rodent-like, growing from persistent pulps, having the enamel restricted to the front and outer surface, and presenting a terminal worn surface. To explain this worn facet almost seems to require the presence of a pair of upper incisors (the front of the skull is unfortunately imperfect), and if such were really the case a revision of the diagnosis of the Pecora would be rendered necessary. The cannon-bones in both limbs are remarkably short and wide, exceeding, apparently, in these respects those of the takin and white goat.

THE article by Mr. E. B. Iwan-Müller on "The Cult of the Unfit," recently noticed in these columns, has called forth a reply from Mr. Sidney Low in the *Fortnightly Review* for September. It was not to be expected that Mr. Iwan-Müller's arraignment of ill-considered sentimentalism in legislation should pass unchallenged, and Mr. Low's rejoinder, entitled "Darwinism and Politics," argues forcibly in favour of the collectivist principle as against unrestricted individual competition. Opinions will differ as to the practicability and desirability of the respective ideals of the two writers, but whatever may be the value of Mr. Low's political criticisms, they appear to miss what is the gist of his opponent's contention, viz. that the measures of statesmen should be constructed on the basis of scientific principle, and not, as is too often the case, with a hap-hazard disregard of natural laws and conditions. Mr. Low enlarges on the well-known fact that in some circumstances it is not the highest type that proves to be the best fitted to survive; but he appears to forget that, in spite of all counteracting influences, the net result of competition has been the evolution of forms possessing the most excellent qualities known in nature. Moreover, the struggle for life is not abolished by the association of individuals in altruistic communities. All Darwinians know this, and they also know that, as common sense teaches, there must be a limit to altruism. It is the business of scientific thinkers to determine the limit, and of politicians to shape their measures accordingly.

THE death is announced of M. L. Bouveault, assistant professor of organic chemistry at the Sorbonne, Paris, at forty-five years of age.

WE regret to see the announcement of the death of Mr. Thomas Southwell, for many years secretary, and twice president, of the Norfolk and Norwich Naturalists' Society, at the age of seventy-nine.

NEWS has reached us of the regretted death, unexpectedly, of Dr. Fritz Erk, honorary professor of meteorology in the University of Munich, and the first president of the Munich Meteorological Society.

THE Geneva correspondent of the *Times* reports that the Janssen Observatory on the summit of Mont Blanc is about to be demolished. It will be replaced by the Cabane on the Rochers Rouges. All the scientific instruments in the observatory, which was completed in 1894 under great difficulties, have been removed to the Vallot Observatory, which is at a lower altitude.

THE Scottish expedition to Spitsbergen under Dr. W. S. Bruce has arrived at Tromsö on board the steam yacht *Conqueror*, with all well on board. The expedition, which left Leith in July, is reported to have completed the survey of Prince Charles Foreland and made important geological and other investigations. An account of the constitution and proposed work of the expedition appeared in NATURE of July 15.

DR. A. DU PRÉ DENNING, for several years lecturer in experimental physics in the University of Birmingham, and principal of the Municipal Technical School, Smethwick, has been appointed by the Secretary of State for India to the newly created post of superintendent of industries and inspector of technical and industrial institutions in Bengal.

THE *Times* correspondent at Paris announces that the following members of the Bureau of Longitudes will represent France at the meeting of the International Geodetic Association to be held in London on September 21:—General Bassot, president; M. Henri Poincaré; M. Hanusse, director of hydrography in the French Ministry of Marine; M. Charles Lallemand, director-general of the French Ordnance Survey Department; and Colonel Bourgeois, chief of the surveying section of the Geographical Department of the War Office.

THE tenth meeting of the Astronomical and Astrophysical Society of America was held at the Yerkes Observatory, Williams Bay, Wisconsin, on August 18–21, Prof. E. C. Pickering, president, presiding. About sixty members, with a few guests, were in attendance, and forty papers, many of them illustrated with lantern-slides, were presented upon various topics. Reports were also made by the committee on comets and the committee on luminous meteors. The official account of the meeting, with abstracts of the papers, will be published, as usual, in *Science* a few weeks hence. The meeting was favoured with a cloudless sky, and the visitors had an opportunity for observing with the 40-inch telescope and inspecting all departments of the work of the Yerkes Observatory. The next meeting of the society will be held at the Harvard College Observatory in the latter part of August, 1910.

THE eighth International Congress of Zoology is to be held next year at Graz (Austria). As entomology plays only a subordinate part at such a congress, a movement has been started to unite entomologists in a congress entirely devoted to entomology in its various aspects, and to establish a permanent committee which may act as a central organisation in the interest of this subject. It is proposed that a congress of entomology be held every three years, about a fortnight before each triennial zoological congress, so that resolutions and conclusions of general importance could, if deemed necessary, be brought up for discussion at the ensuing zoological congress. The first International Congress of Entomology will be held on August 1–6, 1910, at Brussels, during the International Exposition which will be taking place there at that time. The subjects to be brought before the general or sectional meetings will comprise systematics, nomenclature, anatomy, physiology, psychology, ontogeny, phylogeny, œcology, mimicry, etiology, bionomy, palæontology, zoogeography, museology, medical and economic entomology. The chairman of the local committee for Great Britain is Dr. G. B. Longstaff, Highlands, Putney Heath, London, S.W.

NOTES on Cornish Crustacea, by Mr. J. Clark, form the subject of the chief article in the August number of the *Zoologist*, the author directing attention to the great richness of the coasts of Cornwall in animals of this class, even such far-off species as the gulf-weed crab being occasionally drifted into these waters.

THE July number of the *Emu* is illustrated by a very interesting plate, reproduced from a photograph, showing the feeding-grounds of the laughing kingfisher, cat-bird, and noisy pitta in the Coolabunia pine-scrubs near Kingaroy, to the south-west of Maryborough, Queensland. Near the centre of the photograph is shown a large flat stone, around which is strewn an enormous mass of shells of *Helix cunninghami*, a large species in which the shell measures more than a couple of inches in diameter. The shells of these snails are broken by the birds on the boulder, and their luscious contents eaten.

WE have received a copy of the report of the directors of the various museums in Cape Colony, namely, the South African, the Port Elizabeth, the Kimberley, the Albany, and the King William's Town Museum, for 1908. In the case of the South African Museum, Dr. Peringuey complains of the want of sufficient space in the exhibition galleries, more especially in the anthropological and ethnological department, where it has been found impossible to find room for a series of life-like models of native races recently prepared under his direction. It is interesting to note that a number of skulls and skeletons of the Hottentot races have been recently acquired by this museum.

TO the *Revue scientifique* for August 21 Dr. E. Trouessart communicates an article on African big game and big-game shooting, with special reference to the effects of the latter on the numbers of the animals in the country. Several paragraphs are devoted to the facilities for hunting expeditions from Nairobi, and to the fact that by obtaining licences for his wife and servant a sportsman is able to obtain more than the permitted number of specimens of the rarer species. Despite the effects of game reserves and shooting restrictions, Dr. Trouessart is inclined to take a pessimistic view of the prospects of the big game in East Africa, and hazards the prophecy that in less than half a century it will have vanished. To quote his words:—" Avant un demi-siècle, peut-être, de tout ce gros gibier si abondant à l'heure actuelle, il ne restera plus que souvenir." Special attention is devoted to the appalling destruction of elephants which still goes on in the heart of the continent, a statement of Mr. Schillings being quoted to the effect that the number of tusks annually imported into Antwerp alone represents the slaughter of no fewer than 18,500 elephants. The inaction of France in the matter of game-protection is strongly commented upon.

THE metamorphoses of the midges and gnats of the family Chironomidæ form the subject of an article, by Dr. A. Thienemann, in the second half of vol. lxv. of *Verhandlungen des Naturhistorischen Vereins der preussischen Rheinlande und Westfalens*. The developmental history of the Trichoptera has, according to the author, been well worked out, but that of the Chironomidæ is still imperfectly known. Although the greater number of chironomid larvæ, of which the so-called blood-worms are familiar examples, inhabit fresh water, it is pointed out that many are found in various situations on land, while a few dwell in brackish, and even in salt, water. Of the land-living forms, the larvæ of some species of Camptocladius are found in the droppings of animals, those of three kinds of Ceratopogon take up their quarters in ants' nests, while others of the same genus are nourished in the resin or beneath the bark of dead branches of pines, while another is found in decaying funguses. Larvæ of another genus select damp moss as their home. Larvæ and pupæ of several genera are figured.

PART iii. of the "Treasury of Human Inheritance," which forms No. 9 of the Memoirs published by the Francis Galton Laboratory for National Eugenics, furnishes a good example of the excellent work which is being done by that institution. The subjects here dealt with from the point of view of heredity are certain pathological conditions, such as angioneurotic œdema, insanity, and deaf-mutism. There are also sections devoted to the malformations of certain organs, and to the inheritance of special kinds of mental and physical ability. Cases available for the purpose in view have been collected and tabulated with great care, the respective pedigrees being clearly shown in diagrams, and the result is a mass of material which forms a valuable addition to the data now being rapidly accumulated under the guidance of Prof. Karl Pearson. The application of the principles deduced from such investigations will present special difficulties of its own, but whatever may be the practical outcome of the movement set on foot by Sir F. Galton, there can be no question as to the importance of the study of these and similar conditions in their bearing upon the racial qualities of future generations.

A NOTE by Dr. A. C. Hof on the action of iodo-eosin as a test for free alkalis in dried plant tissues is published in the *Bio-chemical Journal*, Liverpool. The substance required is a solution in ether of the dye-acid prepared by treating an alkaline solution of iodo-eosin with excess of acid. The presence of free alkali in a vegetable tissue is indicated by the red colour due to the formation of alkaline salts. Microscopic preparations can be permanently mounted in neutral Canada balsam.

OF the articles which appear in the Journal of the Royal Horticultural Society (vol. xxxv., part i.), the most generally interesting are the hints on French gardening, chiefly on the cultivation of lettuces, contributed by Mr. C. D. Mackay, and the note on *Solanum etuberosum* provided by the editor. It is observed that plants passing under the name of *Solanum etuberosum* do produce tubers about the size of walnuts, and also show a remarkable power of resistance to the potato disease induced by *Phytophthora infestans*. The latter property has suggested the possibility of raising disease-resistant hybrids with *etuberosum* as one parent; some experiments in crossing this species, the Chilian wild potato, *Solanum Maglia*, and cultivated forms of the ordinary potato are communicated by the Rev. J. A. Paton.

As a result of some months' botanical exploration in Sardinia, Dr. Th. Herzog presents in Engler's *Botanische Jahrbücher* (vol. xlii., part iv.) an attractive sketch of the vegetation on the island, accompanied by an illustrative map. The once extensive oak forests have been much reduced by ruthless cutting; *Quercus ilex* still flourishes in less accessible situations, notably round Mt. Gennargentu, where it is accompanied by *Paeonia officinalis*; *Quercus robur* also grows in the central districts, while the cork oak, *Quercus suber*, clothes the mountains in the north. A very wide area is covered by the formation known as "mâquis," where *Pistacia lentiscus*, *Rhamnus Alaternus*, *Myrtus communis*, and *Arbutus unedo*, with species of Cistus, form the dominant species. The solitary European palm, *Chamaerops humilis*, grows in the northwest, occasionally in pure stands.

AN important article dealing with the classification of the Scitamineæ, the monocotyledonous series comprising the Zingiberaceæ, Marantaceæ, Cannaceæ, and Musaceæ, as represented in the Philippine Islands, is contributed by Mr. H. N. Ridley to the botanical series of the *Philippine Journal of Science* (vol. iv., No. 2). The area of the Philippines is much poorer in species than the Malayan region, but four genera and five-sixths of the species are endemic. Alpinia, Globba, and Amomum furnish the majority of the Zingiberaceæ; Alpinia is typically eastern Asiatic, but ranges so far as Japan and Polynesia. A feature of the genus Globba is the preponderance of white over yellow flowers, this being the reverse of what occurs in India and Malaya. The Marantaceæ are represented by three genera, but no indigenous species of Cannaceæ or Musaceæ are noted, so that there is at present no record of any species of the curious tribe Lowioideæ.

PROF. BRÜCKNER returns to the vexed question of the development of the Rhine-Rhone divide in the *Zeitschrift* of the Berlin Gesellschaft für Erdkunde (1909, p. 387). His paper is a reply to that of Herr L. von Sawicki, published in the same journal early this year (p. 7), and deals in detail with the points on which the two authors differ.

PROF. J. CVIJIĆ contributes a further important contribution to our knowledge of the geology of the Dinaric coastal region in a memoir published in the June and July numbers of *Petermann's Mitteilungen* entitled "Bildung und Dislozierung der dinarischen Rumpffläche." Few parts of the earth's surface show a more complex and varied geological history than this, and the rapidly increasing literature dealing with it has scarcely reached a stage in which a short summary of results is possible. Dr. Cvijić's paper is accompanied by maps and sections and a number of excellent characteristic photographs.

WE have received the annual report of the Survey Department of British East Africa for the financial year 1907–8, by Major G. E. Smith, R.E., director of surveys. The report is divided into three sections, trigonometrical branch, cadastral branch, and Uasingishu Rapid Allotment, and each branch shows very good progress. The trigonometrical branch having completed the preliminary astronomical observations and base measurements on the Athi plains near Nairobi last year, has been able to make rapid progress with triangulation, 7320 square miles having been completed in 1907–8, as against 1375 in 1906–7. In the cadastral branch the arrears of farm surveys have been reduced to manageable proportions, and systematic mapping should get on rapidly next season.

THE director-general of Indian observatories reports that the monsoon appeared about a week before its normal date over the Bay of Bengal, and advanced inland with the usual rapidity; the Bombay current also arrived about the normal date, but did not penetrate inland in full strength until nearly the end of June. The aggregate rainfall of June and July in the plains of India was 13 per cent. in excess of the normal, excepting in the provinces of Central India, the Central Provinces, and Mysore, where there was a deficit, especially in the latter State. Abundant monsoon rainfall is, as a rule, preceded by high pressure in South America and low pressure in the Indian Ocean. These favourable conditions were fully maintained during June and July, and the director-general infers from this fact and other data that the total amount of rainfall in August and September will exceed the average.

MUCH useful information relating to aërial navigation and the physics of the upper air is contained in the reports of scientific lectures and papers published in the weekly review of the Frankfort Aëronautical Exhibition. The number for August 14, for instance, includes (1) an illustrated account of the use of pilot balloons by Mr. H. Bongards, which show the direction and velocity of the upper wind currents. Dr. de Quervain first constructed a special theodolite by which the motion of the balloons could be easily followed in clear weather up to an altitude of 15,000 metres. At Frankfort an apparatus by Dr. Assmann is used for the purpose. (2) A preliminary report of a lecture, by Dr. Pütter, on the development of flight in the animal kingdom, in which the different muscular motions are explained. The author stated that about 62 per cent. of some 420,000 objects, including insects, birds, bats, and fishes, were endowed with some means of flight, and his views of the future development of our present flying apparatus were very promising.

THE so-called Roman amphitheatre at Charterhouse-on-Mendip, about seven miles north-west of Wells, has recently been excavated by Mr. H. St. George Gray on behalf of the Somersetshire Archæological Society. It was certainly closely connected with the extensive Roman lead-mining operations in the Mendips, which, with the remains discovered from time to time, have been fully described by Prof. Haverfield in the "Victoria County History." So far as the discovery of relics goes, the present operations were disappointing. Flint implements are numerous, and when discovered associated with Roman remains it is safe to infer that the lead-miners found them on the surface and buried them in their excavations. The arena, according to Mr. Gray, may have been used by the Roman miners for games, combats, or cock-fighting, but it is ridiculous to style it an amphitheatre of the class of the Maumbury Rings at Dorchester. In fact, the use of such a term raises, as Prof. Haverfield says, "false ideas of space and grandeur"; and he goes on to say that "we cannot decide its precise use, but it is ill-suited to form a pond or water reservoir, and the notion of a tiny amphitheatre is not wholly absurd."

CONSIDERABLE progress towards the settlement of the ever-recurring controversy regarding the origin and date of the so-called dene-holes has been made in a paper contributed to the January–June number of the Journal of the Royal Anthropological Institute by the Rev. J. W. Hayes. This contribution is somewhat lacking in lucidity and logical arrangement, but the writer has pursued the investigation in a common-sense way, and has collected a mass of facts necessary to the settlement of the problem. It is essential to know the various qualities of chalk, and the uses to which it was put in ancient and modern times. The export of the material began in pre-Roman time, and the character of it varied. It was essential for the purposes of home and foreign trade that it should be excavated in solid blocks, and the occurrence of strata of this quality accounts for the grouping of a number of pits in the same neighbourhood. It was and is raised in buckets or baskets, and difficulties of carriage suggested the construction of fresh shafts in close proximity to each other. These considerations seem to dispose of the objection that excavation for the material was only one of the objects of the construction of the dene-holes as we find them. One of the strongest reasons against the theory that they were used as granaries or hiding places lies in the fact that they contain cores of sand, which could not have arisen from attrition of the sides of the pits or from collapse of the mouths of the excavations. These cones could only have resulted from the deposit in the worked-out pits of débris from those of later construction. Mr. Hayes has collected a mass of reports from persons engaged in the chalk trade in recent times which show the methods by which the material is excavated and utilised. These raise a strong presumption that the same considerations which now influence the workers prevailed also in the British and Roman periods.

IN the *Electrician* for August 20 Mr. Morris-Airey makes a suggestion which may prove the correct explanation of the discordant results obtained when two lights of different colours are compared together by photometers of the Bunsen and of the flicker type respectively. The three groups of nerve fibres in the retina, which respond respectively to red, green, and violet light, behave, according to Mr. Morris-Airey, in different ways when the stimulus is first applied, the red group, *e.g.*, responding more quickly than the violet, so that the true degree of excitation of the nerves corresponding to a stimulus is attained by the red nerves before it is by the violet. If the speed of the flicker photometer is such that the stimulus is not applied long enough to allow the three sets of nerves to attain the proper degrees of excitation, the results of comparisons of lights of different colours will vary with the speed, and will only agree with the Bunsen results when the speed is reduced sufficiently.

ACCORDING to the July *Bulletin de la Société d'Encouragement pour l'Industrie nationale* of France, the society is in a most flourishing condition. It has 650 members and an annual income of more than 100,000 francs, part of which is derived from the Department of Agriculture of the country. The society further possesses about thirty endowments, amounting together to more than a million francs, the income from which it utilises in various ways, as, for example, in prizes to inventors who benefit industry, in assisting inventors or artisans who have come down in the world, &c., all calculated to forward the object of the society. In addition, in its monthly bulletin, which is a quarto volume of two hundred pages, it gives its members well written and illustrated articles on industrial questions of the day. In the July number, leaving out of account the shorter articles, there are reports on the breweries and distilleries of the north of France, on recent girder bridge-work, on the position of the electrical industry in France, and, lastly, forty pages of a serial article on the economic situation in Great Britain.

THE *Engineer* for August 27 comments on the reasons for the success of the French in following up new lines of research, and says that it is probably to be found in the fact that they often allow themselves to be influenced by imagination rather than by the practical aspect of the problems they are trying to solve. The remark is called forth by the interest which is being taken on the other side of the Channel in the evolution of the aëroplane, as evidenced by the meeting at Rheims. We agree with our contemporary that, not only the possession of a healthy imagination, but also unbounded enthusiasm, are qualities which go to make a good inventor. Can the fact that this country is taking so small a part in the development of aërial machines be accounted for by the absence of inventive faculties? We prefer to believe that it is rather the lack of financial support which is causing the stagnation, a lack which may be explained by the well-known desire of British manufacturers to see commercial success and profit within reach before taking up any industrial development. Given funds, there is no doubt that we have men of ability sufficient to bring this country into line with our neighbours.

THE leading article in *Engineering* for August 27 is devoted to the address of the president of the British Association. Many of the statements in the address are of particular interest to engineers, and one appeals very forcibly. Sir Joseph Thomson quotes Helmholtz as saying that often in the course of a research more thought and energy are spent in reducing a refractory piece of brass to order than in devising the method or in planning the scheme of campaign. This is exactly in accord with engineering practice. For example, in developing a certain steam turbine, the thermodynamic and kinematic questions involved occupied not a tithe of the time and thought which had to be expended on such questions as the mere form of the casing. Should it, for instance, open at a transverse joint or a longitudinal one? Would the governor fit in better at one end or at the other? These and other apparently trivial, but really very important, details absorbed the greater part of the time at the designer's disposal. The mathematician seems often to have a difficulty in appreciating this matter, but the experimental physicist is nearer akin to the engineer, and has to face many of the same problems. Both suffer from a certain apparent perversity in the materials they use, to which, however, the engineer has commonly the added burden of often wayward and intractable human nature.

MESSRS. H. F. ANGUS AND CO., 83 Wigmore Street, London, W., have submitted to us a specimen of a very useful supplementary lens which they have placed on the market for attachment to a naturalist's telescope. The telescope sent with the lens is of the usual short-focus pattern made for observing birds or other objects, and by placing the supplementary lens over the objective the instrument can be used to watch insects or similar small forms of animal life at any convenient distance down to about 20 inches, at which distance the magnification is about five diameters. The combination thus provides the naturalist with a very handy means of studying the characteristics and movements of insects, spiders, and so on at a convenient distance, and without disturbing the creatures. Similar caps can be adapted to the ordinary tourist telescope and the monocular prismatic field-glass. The attachment is inexpensive—the price being 3*s*. 6*d*. for any size or power lens required—and it certainly increases the optical capacity of any instrument with which it is used. For the observation of minute forms of animal life in the open air, and for the examination of details of objects placed beyond the distance of distinct vision in museums, the additional lens will be found a great advantage. As, however, accessory parts of instruments are often misplaced or not at hand when desired, we suggest that the attachment should be fixed upon the telescope by a band or other means which would permit the lens to be brought in front of the objective or turned away from it as desired. A simple swivel arrangement would probably enable this to be done, and the naturalist could then immediately convert his glass into an instrument for the observation of objects near or far.

OUR ASTRONOMICAL COLUMN.

CHANGES ON MARS.—Further changes in the south polar regions of Mars are recorded by M. Jarry Desloges in No. 4350 of the *Astronomische Nachrichten* (p. 95, August 25). Observations, made at the observatory installed on the Revard plateau, on August 20, 11h., showed that the Mare Cimmerium was divided obliquely by a bright band between Eridania and Electris, whilst a large gulf was distinguished on Zephyria, and numerous changes were seen to have taken place on the northern plains. Since its separation, observed on August 11–12, the bright oval region in longitude 320° has become more and more separated, and the dark regions of the planet, so pale in June and July, are changing, and becoming darker, almost daily. A greyish region seen at the eastern side of the polar cap on August 13, 2h., is diminishing rapidly, and apparently disaggregating in all directions.

THE ABSORPTION OF LIGHT IN SPACE.—A suggestion recently made by Prof. Turner, in regard to M. Tikhoff's researches on the absorption of light in interstellar space, is discussed by Mr. J. A. Parkhurst in the July number of the *Astrophysical Journal* (vol. xxx., No. 1, p. 33). Prof. Turner's suggestion was that photographs of stars should be taken using only the visual rays, and then other photographs should be taken in the same way to determine the increase of exposure necessary to get stars of a definite number of magnitudes fainter. If these photographs were more in accordance with the theoretical law connecting exposure and intensity than are those where the violet rays are not excluded, they would afford evidence that the discordance between visual and ordinary photographic magnitudes is due rather to cosmical than to photographic causes. Evidence of this nature has already been adduced by M. Tikhoff.

Mr. Parkhurst shows, however, from a number of experiments carried out at the Yerkes Observatory, that his results are contradictory to those of M. Tikhoff, and suggests that the cause of the difference lies in the instruments and plates employed; probably, in the main, in the plates and light-filters, for the same effect has been obtained by him both with a reflecting telescope and a doublet camera. Thus it would appear that the proposed experiments with photographic colour-filters would furnish no definite evidence either for or against the cosmical absorption or scattering of the violet rays.

In the same journal Mr. Paul R. Heyl also discusses the question of the apparent dispersion in space, and, whilst preferring Nordmann's monochromatic-photometry method, suggests that too great an importance has been attached to the parallax values used in measuring the dispersion; this would possibly account for the considerable differences between the values obtained by Tikhoff and Nordmann. Mr. Heyl also indicates that the objections urged by M. Lebedew against the methods are not unanswerable.

PLANETS AND THEIR SATELLITES.—In a note appearing in No. 4351 of the *Astronomische Nachrichten* (p. 97, August 27), Prof. Lowell shows that throughout the solar system there exists a remarkable parallelism between the ratios obtained by comparing the speeds of the satellites, about their primaries, with the velocities of the latter in their own orbits. A table showing the ratios for the systems of Jupiter, Saturn, Uranus, and Neptune displays relations which are too systematic to be merely fortuitous. In a brief discussion as to the effect of the calculated speeds, during the time the systems were evolving, in determining the relations between the satellites and the interplanetary particles through which they were passing, Prof. Lowell shows that the total effect of the particles on the large satellites was to retard the latter and cause them to approach the primaries. For retrograde satellites the effect was greater than for the direct, which may account for the preservation of the latter. Incidentally, this is shown to be antagonistic to the planetesimal hypothesis, wherein it is reasoned that the impact of the interplanetary particles on a direct satellite would accelerate it and thus prevent it being drawn down on to the planet; this is exactly contrary to the fact with any of the major satellites.

METEOR OBSERVATIONS.—As in previous years, organised observations of the Perseids were carried out by the members of the Belgian Astronomical Society at seven different stations, and the results are briefly reported in No. 21 of the *Gazette astronomique*. Each observing party kept watch from 10h. to 14h., each night, from August 7 to August 15, and the detailed discussion of the collected observations should provide some very useful information concerning this important shower. At Antwerp two observers recorded 492 meteors, 129 of which were of the first magnitude, or brighter, and the maximum display, both there and at Uccle, appears to have taken place on August 11; the horary numbers were 51·4 and 44·2 respectively.

Observations of the Perseids in 1908, and the Lyrids in 1909, were made at the Kasan Observatory, and the results are published in detail in No. 4350 of the *Astronomische Nachrichten*. Altogether, the paths of 132 Perseids and 59 Lyrids, with notes on their appearances and the values determined for the radiants, are given.

NEW SPECTROSCOPIC BINARIES.—No. 19, vol. i., of the Publications of the Allegheny Observatory contains the preliminary announcement that spectrograms taken with the Mellon spectrograph show the following five stars to be spectroscopic binaries:—(1) 30 H. Ursæ Majoris; range of 100 km. and period of 11·6 days. (2) B.D. + 3·2867°; 134 km. range and short period. (3) B.D. + 6·2875°; range of 80 km. (4) 25 Serpentis; range of 90 km. and a short period. (5) ι Coronæ; range 40 km., period short.

OBSERVATIONS OF PERRINE'S COMET.—Photographic observations of Perrine's comet, 1909*b*, were made at Greenwich on August 14 and 16, and at the Königstuhl Observatory on August 12, 15, and 19; on the latter date the magnitude was 15·0.

These observations show that, between the extreme dates, the ephemeris published by Prof. Kobold was nearly correct, the corrections in R.A. varying from +5s. on August 12 to −6s. on August 19; those for declination increased from −10·8′ to −14′ (*Astronomische Nachrichten*, No. 4350, p. 96).

THE BRITISH ASSOCIATION AT WINNIPEG.

SECTION D.

ZOOLOGY.

OPENING ADDRESS BY A. E. SHIPLEY, M.A.CANTAB., HON. D.SC.PRINCETON, F.R.S., PRESIDENT OF THE SECTION.

I.

Charles Darwin.

THIS is the year of centenaries. Perhaps in no other year in history were so many men born destined to impress their genius on the literature, the politics, and the science of the world as in 1809. The number of literary men who first saw the light in that *annus mirabilis* is almost too long to mention—Mark Lemon, the genial editor and one of the founders of *Punch*; "Crimean" Kinglake; John Stuart Blackie, until lately a well-known figure in Edinburgh; Monckton Milnes, the first Lord Houghton, "poet, critic, legislator, the friend of authors" and the father of Lord Crewe, who at present presides over that most important of all Government offices—that of the Colonies. One could prolong the list; and one must at least mention the names of Louis Braille, the inventor of the Braille type for the blind, of Fanny Kemble and of Elizabeth Barrett Browning, before passing on to remind you that this year is also the centenary of Tennyson, who, with Browning, formed the twin stars of poetry during the reign of Queen Victoria, and who from his intimate knowledge of natural history and his keen power of observation was essentially the poet of Darwinism. Of his life-long friend, born the same year, Edward Fitzgerald, the translator—one feels almost inclined to say author—of Omar Khayyám, and of the gifted musician Mendelssohn there is no time to speak.

On this side of the Atlantic, and yet not wholly on this side, for he spent five impressionable school years at Stoke Newington, we have that "fantastic and romantic" genius Edgar Allan Poe.[1] Later he studied at West Point, where surely he must have been as incongruous a student as James Whistler himself. We have also that kindly, humorous physician Oliver Wendell Holmes, a nature "sloping towards the southern side" as Lowell has it. Amongst many recollections of literary men I cherish none more dearly than that I once entertained him in my Cambridge and once visited him in his.

Three other names stand out. William Ewart Gladstone, that leader of men, a politician and a statesman capable more than most men at once of arousing the warmest affection of his followers and the bitterest hatred of those who went the other way. Cultured as he was and widely read, he had his limitations, and although his tenacious memory was stored with the humanities of all the ages, he was singularly devoid of any knowledge of science. If we may paraphrase the words of Lord Morley in his estimate of Gladstone's writings, we would say that his place is not in science, "nor in critical history, but elsewhere."

Abraham Lincoln, the greatest man born on this continent since the War of Independence, was some ten months older than Gladstone. Both men were great statesmen, both men were liberators; for we must not forget that in many minds the help Gladstone gave to Italy in her struggle for freedom and union remains the most enduring thing he achieved.

Yet in externals how different! One the finished, cultured product of the most aristocratic of our public schools and the most ancient of our universities, the other little read in the classics or in mediæval and ecclesiastical lore, yet deeply versed in the knowledge of men and how to sway them. Rugged, a little rough if you like, humorous and yet sad, eminently capable, a strong man, and at heart "a very perfect gentleman."

On the same day, February 12, upon which Lincoln first saw the light, was born at the "Mount," Shrewsbury, a little child destined as he grew up to alter our conceptions of organic life perhaps more profoundly than

[1] Poe lived from his eighth to his thirteenth year at the "Manor House School," Stoke Newington, at that time a village, now swallowed up by the metropolis. Poe described the place as he knew it, and his schoolmaster, Dr. Bransby, in "William Wilson."

any other man has ever altered them, and this, not only in the subjects he made his own, but in every department of human knowledge and thought.

Being as I am a member of Charles Darwin's own college, coming as I do straight from the celebration in which the whole world united to do his memory honour, it would seem meet that I should in this year of the centenary of his birth devote this address to a consideration of his life and of his work, and of such confirmation and modification of his theories as the work of the last fifty years has revealed.

As to the man, I can but quote two estimates of his character, one by a college companion who lived on terms of close intimacy with Darwin when at Christ's, the other the considered judgment of one who knew and loved and fought for Darwin in later life.

Mr. Herbert says:—

"It would be idle for me to speak of his vast intellectual powers . . . but I cannot end this cursory and rambling sketch without testifying, and I doubt not all his surviving college friends would concur with me, that he was the most genial, warm-hearted, generous, and affectionate of friends; that his sympathies were with all that was good and true; and that he had a cordial hatred for everything false, or vile, or cruel, or mean, or dishonourable. He was not only great, but preeminently good, and just, and lovable."

Prof. Huxley, speaking of his name, says:—

"They think of him who bore it as a rare combination of genius, industry, and unswerving veracity, who earned his place among the most famous men of the age by sheer native power, in the teeth of a gale of popular prejudice, and uncheered by a sign of favour or appreciation from the official fountains of honour; as one who, in spite of an acute sensitiveness to praise and blame, and notwithstanding provocations which might have excused any outbreak, kept himself clear of all envy, hatred, malice, nor dealt otherwise than fairly and justly with the unfairness and injustice which was showered upon him; while, to the end of his days, he was ready to listen with patience and respect to the most insignificant of reasonable objectors."[1]

It has been somewhat shallowly said—said, in fact, on the day of the centenary of Darwin's birth—that "we are upon very unsafe ground when we speculate upon the manner in which organic evolution has proceeded without knowing in the least what was the variable organic basis from which the whole process started." Such statements show a certain misconception, not confined to the layman, as to the scope and limitations of scientific theories in general, and to the theory of organic evolution in particular. The idea that it is fruitless to speculate about the evolution of species without determining the origin of life is based on an erroneous conception of the true nature of scientific thought and of the methods of scientific procedure. For science the world of natural phenomena is a complex of procedure going on in time, and the sole function of natural science is to construct systematic schemes forming conceptual descriptions of actually observed processes. Of ultimate origins natural science has no knowledge and can give no account. The question whether living matter is continuous or not with what we call non-living matter is certainly one to which an attempted answer falls within the scope of scientific method. If, however, the final answer should be in the affirmative, we should then know that all matter is living; but we should be no nearer to the attainment of a notion of the origin of life. No body of scientific doctrine succeeds in describing in terms of laws of succession more than some limited set of stages of a natural process; the whole process—if, indeed, it can be regarded as a whole—must for ever be beyond the reach of scientific grasp. The earliest stage to which science has succeeded in tracing back any part of a sequence of phenomena constitutes a new problem for science, and that without end. There is always an earlier stage, and to an earliest we can never attain. The questions of origins concern the theologian, the metaphysician, perhaps the poet. The fact that Darwin did not concern himself with questions as to the origin of life nor with the apparent discontinuity between living and non-living matter in no way diminishes the value of his work. The broad, philosophic mind of the great master of inductive method saw too fully the nature of the task he had set before him to hamper himself with irrelevant views as to origins.

No well-instructed person imagines that Darwin spoke either the first or the last word about organic evolution. His ideas as to the precise mode of evolution may be, and are being, modified as time goes on. This is the fate of all scientific theories; none are stationary, none are final. The development of science is a continuous process of evolution, like the world of phenomena itself. It has, however, some few landmarks which stand out exceptional and prominent. None of these is greater or will be more enduring in the history of thought than the one associated with the name of Charles Darwin.

I cannot, indeed, attempt to weigh or estimate the influence and the far-reaching import of the work which all the world has been weighing and estimating during this year, the centenary of his birth and the jubilee of the "Origin of Species." I cannot, to my intense regret, give you any personal recollections of Darwin, for though I think I once saw him in the streets of Cambridge, I have to my sorrow never been absolutely sure that this was so.

But in reading his writings and his son's most admirable Life, one attains a very vivid impression of the man. One of his dominant characteristics was simplicity—simplicity and directness. In his style he was terse, but he managed to write so that even the most abstruse problems became clear to the public. The fascination of the story he had to tell was enhanced by the direct way he told it.

One more characteristic. Darwin's views excited at the time intense opposition and in many quarters intense hatred. They were criticised from every point of view, and seldom has a writer been more violently attacked and abused. Now what seemed to me so wonderful in Darwin was that—at any rate so far as we can know—he took both criticism and abuse with mild serenity. What he wanted to do was to find the truth, and he carefully considered any criticism, and if it helped him to his goal he thanked the critic and used his new facts. He never wasted time in replying to those who fulminated against him; he passed them by and went on with his search.

In the development of the theories associated with Darwin's work the New World played a prominent part. Darwin's "Wanderjahre" were spent on this side of the Atlantic. The central doctrine of evolution through natural selection was forced upon his mind by the studies and researches he made in South America during the voyage of the *Beagle*. The numerous observations in all departments of natural science and the varied forms of life he came across in this classical journey were the bricks with which he built many of his later theories. The storm of controversy which the "Origin of Species" awoke was at least as violent in America as in Great Britain, and we must not forget the parts played by men like Hyatt, Fiske, Osborn, and many others, and above all by Asa Gray and by Brooks of Baltimore, whose recent death has robbed America of perhaps her greatest Darwinian.

It is a somewhat remarkable fact that whilst the works of Darwin stimulated an immense amount of research in biology, this research did not at first take the line he himself had traced. With some exception the leading zoological work of the end of the last century took the form of embryology, morphology, and palæontology, and such subjects as cell-lineage, "Entwickelungsmechanik"; the minute structure of protoplasm, life-histories, teratology, have occupied the minds of those who interest themselves in the problems of life. Along all these lines of research man has been seeking for the solution of that secret of nature which at the bottom of his heart he knows he will never find, and yet the pursuit of which is his one abiding interest. Had Frank Balfour lived we should, I think, have sooner returned to the broader lines of research as practised by Darwin, for it was his intention to turn himself to the physiology—using the term in its widest sense—of the lower animals. Towards the end of the nineteenth century, stimulated by Galton, Weldon began those series of measurements and observations which have culminated in the establishment, under the guidance

[1] "Life and Letters of Charles Darwin," vol. ii., 1887, p. 179.

of his friend and fellow-worker, Karl Pearson, of a great school of eugenics and statistics in London. With the beginning of the twentieth century came the re-discovery of Mendel's facts, and with that an immediate and enormous outburst of enthusiasm and of work. Mendel has placed a new instrument in the hand of the breeder, an instrument which, when he has learnt to use it, will give him a power over all domesticated animals and cultivated crops undreamt of before. We are getting a new insight into the working of heredity, and we are acquiring a new conception of the individual. The few years which have elapsed since men's attention was re-directed to the principles first enunciated by the Abbot of Brünn have seen a great school of genetics arise at Cambridge under the stimulating energy of Bateson, and an immense amount of work has also been done in France, Holland, Austria, and especially in the United States. As the work has advanced, new ideas have arisen and earlier formed ones have had to be abandoned; this must be so with every advancing science; but it has now become clear that mutations occur and exist especially in cultivated species, and that they breed true seems now to be established. In wild species also they undoubtedly occur, but whether they are so common (in uncultivated species) remains to be seen. If they are not, in my opinion a most profitable line of research would be to endeavour to determine what factor exists in cultivation which stimulates mutation.

To what extent Darwin's writings would have been modified had Mendel's work come into his hands we can never know. He carefully considered the question of mutation, or, as they called it then, saltation, and as time went on he attached less and less importance to these variations as factors in the origin of species. Ray Lankester has recently reminded us that Darwin's disciple and expounder, Huxley, "clung to a little heresy of his own as to the occurrence of evolution by saltatory variation," and there must have been frequent and prolonged discussion on the point. That "little heresy" has now become the orthodoxy of a number of eager and thoughtful workers who are at times rather aggressive in their attacks on the supporters of the old creed. "That mutations occur and exist is obvious to everyone, but that they are of frequent occurrence under purely natural conditions is," Sir William Thiselton-Dyer thinks, "unsupported by evidence." The delicate adjustment between an organism and its natural surroundings suggests that sudden change of a marked kind would lead to the extinction of the mutating individual. So far as I can understand the matter in dispute, Darwin and his followers held that evolution had proceeded by small steps, for which we may accept de Vries's term fluctuations; whilst the Mutationists hold that it has advanced by large ones, or mutations. But it is acknowledged that mutations are not all of the same magnitude, some, *e.g.* albinism, brachydactyly in man, dwarf habit or glabrousness in plants, may be large; others, *e.g.* certain differences in shade of colour or in size, are insignificant, and indeed Punnett has suggested that under the head of fluctuating variation we are dealing with two distinct phenomena. He holds that "some of the so-called fluctuations are in reality mutations, whilst others are due to environmental influence." He thinks the evidence that these latter are transmitted is slender, and later states that "Evolution takes place through the action of selection on these mutations. Where there are no mutations there can be no evolution." The disagreement about the way in which evolution has proceeded has perhaps arisen from a misunderstanding as to the nature of the two kinds of variation described respectively as mutations and fluctuations. Mutations are variations arising in the germ-cells and due to causes of which we are wholly ignorant; fluctuations are variations arising in the body or "soma" owing to the action of external conditions. The former are undoubtedly inherited, the latter are very probably not. But since mutations (using the word in this sense) may be small and may *appear* similar in character to fluctuations, it is not always possible to separate the two things by inspection alone. The whole matter is well illustrated by the work of Johannsen on beans. He found that while the beans borne by any one plant vary largely in size, yet if a large and a small bean from the same plant are sown, the mean size and variability of the beans on the plants so produced will be the same. The differences in size are presumably due to differences of condition, and are not inherited. But if two beans are sown, one from a plant with beans of large average size, and one from a bean of small average size, the bean plant the parent of which had the high average will bear larger beans than the one from the parent with small average beans. The faculty of producing a high or low mean size is congenital, is a mutation in the sense used above, and is inherited. It is no doubt unfortunate that the word mutation has been used in several different senses, for it seems to have led to most regrettable confusion and misunderstanding.

As I have said, in such a year, and in my position, I ought perhaps to have devoted the whole of this address to the more philosophical side of our subject; but, in truth, I am no philosopher, and I can only say, as Mr. Oliver Edwards, "an old fellow-collegian" of Dr. Johnson's, said to the "great lexicographer" when they met after nearly half a century of separation: "I have tried too in my time to be a philosopher, but I don't know how, cheerfulness was always breaking in."

II.

Organising Zoology.

I now turn to a subject of the greatest moment and of the greatest difficulty, and one on which there is little general consensus of opinion. The question I wish to raise is this—are the zoologists of the world setting about their task in an economic and efficient way?

We live surrounded by a disappearing fauna. Species are disappearing from the globe at a greater rate than even the most ardent mutationist claims they are appearing. To mention but a few striking cases: The European beaver has almost gone, though a few linger on around the periphery of the Continent. Norway, the lower Danube, Eastern and Arctic Russia still harbour them, and a very few are said still to inhabit the Rhine and the Rhone. The European bison is now represented by a few wild specimens in the Caucasus. The American bison is reduced, and that by the deliberate and calculated action of man, to a few herds most carefully preserved by Government; the largest of these, containing some 600 heads, is now at the National Park at Wainwright. Equally deliberate and equally calculated is the destruction of the fur-seal, which threatens soon to be complete. The Greenland sealing is almost a thing of the past. In 1860 British vessels killed 68,278 seals; in 1866, 103,578; and this went on until 1895, when the pursuit was abandoned by the British, it being no longer found to pay them, though Norwegians still continue "sealing." In 1859 19 vessels sailing from British ports killed 148 whales; in 1881 12 vessels killed 48 whales; last year 6 Dundee vessels killed but 15, and the year before that but 3. The whalers sailing from Newfoundland ports killed 1275 whales in 1904, 892 in 1905, and only 429 in 1906.

At the present time certain Norwegian whaling companies have been for the last few years actively at work in the Shetlands, and are killing off as fast as they can the common rorqual (*Balaenoptera musculatus*, L.), the lesser rorqual (*B. rostrata*), Sibbald's rorqual (*B. sibbaldi*, Gray), the cachalot (*Physeter macrocephalus*, L.), the humped-back whale (*Megaptera boops*, L.), and, when they can reach him, the Atlantic right whale (*Balaena mysticetus*, L.). These are killed primarily for their blubber, but the economy of the factories rivals that of the Chicago pork-packing industries. Nothing is wasted; the flesh is made into sausages, which are readily eaten in Central Europe, and the bones are ground up to make manure. No animal which produces but few young can withstand such persistent and organised attacks on the part of man, and I fear, before many years are passed, many species of whale will be extinct. At the present moment the two right whales seem almost on the verge of extinction, and *Balaena mysticetus* will probably go before *B. australis*. Nothing shows this more clearly than the price of whalebone, which has gone up in the last eighty-four years from 56*l*. per ton to 2100*l*. per ton, or from 12 cents a pound to 4·90 dollars, and in some years to 5·80 dollars a pound. The number of pounds on sale in the United States has dropped from 2,916,500 in 1851 to 96,600 in 1906. With the whales will disappear the whale-lice and the whole of the very interesting parasitic fauna which inhabit their vast interiors.

The disappearance of the large game from enormous tracts of country in Africa is too well known to delay us. The elephant, except where preserved in the Litzikama Forest, near Mossel Bay, and in the Addo Bush, near Port Elizabeth, is exterminated south of the Limpopo. The price of ivory, again, is a measure of the nearness of its extinction. The best pieces, which are used for billiard balls, have risen in price from 55*l.* a cwt. in 1882 to an average of 100*l.* a cwt. in 1908. The common and the brindled gnu (*Connochoetes taurinus*) are fated to follow the extinct quagga. The blesbok (*Damaliscus albifrons*), formerly found in thousands in Cape Colony, the Transvaal, and Bechuanaland, is now very rare, and seems doomed. The giraffe has long been driven out from South Africa, though it still roams over large tracts of country in East and Central Africa.

Perhaps the most striking case of the disappearance of a mammalian fauna is that presented in Western Australia. Here many districts are now said to be entirely devoid of indigenous mammals, and this depletion is in the main an affair of only the last thirty years, and many of the local extinct forms are still remembered by the older natives and colonists. Mr. Shortridge, a collector who has worked for some years in South-west and Western Australia, writes in a letter: "The entire disappearance of so many species over such large tracts of country is generally considered to be due to some epidemic perhaps brought into the land by introduced animals. It is to be noted that they have died out chiefly in the dry regions, where, except for the introduction of sheep, there has been very little alteration in the natural conditions. Rabbits, although already very numerous in the Centre and South-east, have not as yet found their way to the North-west." Amongst the mammals which have almost, if not quite, disappeared from West Australia are the banded wallaby (*Lagostrophus fasciatus*), the hare wallaby (*Lagochestes hirsutus*), the rat-kangaroos (*Potorous gilberti* and *P. platyops*). The indigenous rats and mice of Australia are disappearing even faster than the marsupials, and it seems probable that many will not be heard of again.

A very few years ago the ship employed by the company which is exploiting the phosphates of Christmas Island introduced the brown rat (*M. decumanus*) there. Within a short time the two indigenous rats first collected by Mr. C. W. Andrews, of the British Museum, named *Mus macleari* and *Mus novitatis*, were wiped out of existence. The same animal having been introduced in North America is gradually spreading, and as it spreads the native fauna of Muridæ is slowly vanishing.

To adorn our ladies' heads some of the most beautiful of birds are being systematically exterminated. In the London market alone were sold last year some 50,000 sooty terns (*Sterna fuliginosa*, *S. anaestheta*, and *S. bonata*), 20,000 specimens of the crowned pigeon (Goura) from New Guinea, their sole habitat, immense numbers of "osprey" feathers, egret and heron, and more than 50,000 birds of paradise, or more than double the number of the year before.

I have no time to continue this melancholy record, but it could be prolonged almost indefinitely.

When we reflect how greatly we treasure every scrap of knowledge we can glean about such recently extinct animals as the Rhytina—Steller's sea-cow—the dodo, the great auk, we must see that if it be impossible to check the gradual disappearance of those animals doomed to extinction, we should at least monograph them and take every care that what can be permanently kept of their structure should be kept. In respect to the recording of the habits and physical features of a disappearing race, the anthropologists are setting an example which the zoologists would do well to follow.

We are living with a disappearing fauna around us, and numerous as the museums of the world are, and skilled and painstaking as the curators of these museums are, they are both wholly inadequate to deal with the material at hand. Some dozen years ago Dr. Günther made a very careful estimate of the number of species of animals which were known in the years 1830 and 1881. I summarise his table:—

Number of Species known in the years 1830 and 1881.

	1830	1881
Mammalia	1,200	2,300
Aves	3,600	11,000
Reptilia and Batrachia	543	3,400
Pisces	3,500	11,000
Mollusca	11,000	33,000
Bryozoa	(40)	120
Crustacea (year 1840)	(1,290)	7,500
Arachnida	1,408	8,070
Myriapoda	450	1,300
Insecta	49,100	220,150
Echinodermata (1838)	(230)	1,843
Vermes (1838)	(372)	6,070
Cœlenterata (1834)	500	2,200
Porifera (1835)	(50) *say*	400
Protozoa (1838–44) *say*	(305) ,,	3,300
	73,588	311,653

Taking an average year between 1881 and the present date, but rather nearer the latter, because each year the number of newly described species becomes larger, Dr. Sharp tells me that, according to the zoological record, 12,449—let us call it 12,450—new species were described in the year 1897.

Number of new Species described in the year 1897.

Mammalia	285
Aves	105
Reptilia and Batrachia	140
Pisces	148
Mollusca	1,077
Brachiopoda	7
Bryozoa	6
Crustacea	239
Arachnida	659
Myriapoda	275
Insecta	8,364
Echinodermata	491
Vermes	294
Cœlenterata	164
Porifera	95
Protozoa	100
	12,449

This number, however, includes fossils which I do not think were included by Dr. Günther. We might deduct 450 for them if we wish to confine our attention to living animals. This leaves us 12,000. If we multiply this by 27, the number of years which have elapsed since Dr. Günther made his estimate, we find a total of 324,000. This number is possibly too large, as it makes no allowance for synonyms; still, it is a rough indication that since 1881 the number of described species has been doubled. Isolated groups, such as the mammals, treated in the same way, give us fairly similar results, so that now we may, I think, say that there are more than 600,000 described species of living animals.

It thus appears that during the fifty-one years in the middle of the last century the number of known species grew by some 238,000, giving an average increase of a little less than 5000 per annum. At the present day there are far more workers in the field than there were thirty years ago, museums have multiplied, and there are many more zoologists, and it is now estimated that the number of species annually described and named amounts to some 12,000.

The number, large as it seems, is, however, but small in comparison with the number of species collected and deposited in museums where no one has time to work them out. It is still smaller in comparison with the vast numbers of species as yet uncaptured. Dr. Sharp, in 1895, calculated that there were a quarter of a million known and described insects. This was an increase of 30,000 over Günther's figures of fifteen years before, but he states that in his opinion this quarter of a million is but one-tenth of those which exist.

With the exception of the larger Mammalia—though the Okapi warns us the exception may yet prove the rule—there is no group of animals which may not yield us new surprises—no group which we can regard as well worked out, though naturally some are better known than others. What, then, are the zoologists of the world doing to record the animal life around them? One thing of late is certainly an improvement. During last century the great zoological collections were in the main increased and augmented by the chance gifts of hunters and sportsmen, whose chief object in their expeditions was not zoology, but what is termed "sport." Many valuable gifts are still received from such sources, but it is now recognised that we must not in these matters trust to the sportsman alone. The plan of attaching trained naturalists and experts in taxidermy to an expedition avowedly meant for other purposes is good, and is well exemplified by Mr. Roosevelt's "safari" in East Africa at the present time. We may hope that we may never again see an expedition without a single trained naturalist on its staff, such as the last Stanley led across Africa. A still better plan is to send out expeditions of trained naturalists to do definite pieces of work. Such expeditions as Andrews and Foster Cooper and Osborn to the Fayum for fossils, of Cunnington and Boulenger to the same region to investigate the fauna of the lake, or Wollaston and his companions to the Ruwenzori district, yield a harvest one hundred times more abundant than the best of other schemes.

Yet even here I would plead for a little more organisation. One must not suggest too rigid a scheme, and it is to be hoped that in the future, as in the past, there will always be found wealthy men willing to devote their energies to the advancement of zoology. Such work has been done by Mr. Godman on the fauna of Central America, one of the richest regions in the world, and now, owing to his munificence, one of the best known. The stately array of volumes embodying these results is paralleled by the magnificent monographs in which the results of the Prince of Monaco's marine researches are recorded, and by the monographs of the Princeton Expedition to the Argentine, financed by one of the richest of the millionaires of the United States. We trust that such enterprises will always continue.

With regard, however, to expeditions financed from public funds which are sent out officially, it might be possible to have more international cooperation. Just as the members of the Geodetic Survey meet from time to time and determine the next step to be taken in the triangulation of the world, so it seems to me might the members of the chief museums of the world meet, say, triennially, and draw up certain thought-out plans for the exploration of the zoological world.

With regard to working out the material when collected, the existing museums of the world are too few, and their staffs are too small to deal, not only with the huge collections which are constantly pouring into their buildings, but even with the accumulated stores already housed there. In our smaller State museums it is not uncommon to find men who are responsible for the whole of the Arthropoda. Only within the last few months I have had to try to find for a Metropolitan museum a curator who was expected to be a specialist in fishes, molluscs, and arachnids. Now is it possible to expect such men, able and zealous as they are, accurately to determine species in these vast and complex groups? My own feeling is—but I fear I shall carry no one with me—that we must specialise still further. I should like to see each of the great classes of the animal kingdom assigned to one of the great museums of the world. Just as an example—which is only an example, possibly a bad one—I suggest that all the type-specimens of Amphibia be sent to one museum, say, if you like, that of Berlin or St. Petersburg; in return for this that museum should distribute to others its types of fish, birds, &c. Then, at this museum there would arise a series of specialists capable of deciding swiftly and accurately on the validity of the claims of any new species of amphibian that may be advanced. Again, a student of Amphibia, instead of wandering round the museums of the world if he wishes to study species, would find all he wants within the four walls of one building. When once the type is described and deposited, it would be the duty of the museum to distribute co-types and accurately named specimens of the same species to other museums in some recognised order. Smaller groups might be allocated to smaller museums, *e.g.* the fleas to Tring and the ticks to Cambridge—at both these places there are now specialists working out world collections of these pests. What I want is a world's Clearing House for animals. I know I shall be told that my suggestions can never be realised, that international jealousies would prevent such a scheme being adopted, that I am proposing to fetter research. I admit the difficulties, but do not regard them as insuperable. When you recall the international Clearing Houses for the Postal and Telegraphic service, for the banking of the world, and when we reflect what private enterprise does, under the name of Lloyd's, for the shipping of the world, how it registers and describes and certifies, with a minuteness not surpassed by any maker of species, each ship in the world; how, through its signal stations and by other means, it follows the daily course of each vessel, so that at any hour of any day it can state where, in normal circumstances, that vessel is, it does not seem to me impossible to come to some understanding as to dealing with the animals of the world. Only by some such means can we hope to cope with the problem before us.

One other fruitful source of "waste of time" I will mention. That is the debatable matter of zoological nomenclature, more especially the questions of synonymy. The British Association at their last meeting passed a resolution on the proposal of Mr. G. A. Boulenger in the following sense:—

"The undersigned zoologists, whilst fully realising the justice and utility of the rule of priority in the choice of scientific names for animals, as first laid down by a committee of the British Association in 1842, wish to protest against the abuse to which it has been put as a result of the most recent codes of nomenclature, and consider that names which have had currency for a great number of years should, unless preoccupied, be retained in the sense in which they have been universally used. Considering the confusion that must result from the strict application of the rule of priority, they would welcome action leading to the adoption of a scheme by which such names as have received the sanction of general usage, and have been invariably employed by the masters of zoology in the past century, would be scheduled as unremovable."

Mr. G. A. Boulenger expressed disapproval of the extreme application of the rule of priority in zoological nomenclature on the ground that it had already produced much mischief under the pretence of arriving at ultimate uniformity. The worst feature of the abuse of this rule is not so much the bestowal of unknown names on well-known animals as the transfer of names from one to another, as in the case of Astacus, Torpedo, Holothuria, Simia, Cynocephalus, &c., so that the names which were uniformly used by Cuvier, Johannes Müller, Owen, Agassiz, Darwin, Huxley, and Gegenbaur would no longer convey any meaning; very often they would be misunderstood, and the very object for which Latin or Latinised names were introduced would be defeated.

The International Congress of Zoology takes, I believe, a somewhat sterner view, but they are engaged in drawing up a list of names which they hope will be accepted for all time. I for one am prepared to accept them, and I am prepared to go further. I would ask the International Congress if, instead of drawing up a list of single species, or perhaps in addition to it, they would draw up a list of systematic monographs, the names in which may be regarded as final. After all, modern classification began with a book, and it would take no longer, or very little longer, to sanctify a book which may contain diagnoses of hundreds of species than to sanctify the single species. The idea is due to Mr. Cyril Crossland, and he suggests—he was working at Chætopods—that such works as Claparède's "Annelides Polychètes du Golfe de Naples," Ehler's "Die Borstenwürmer," McIntosh's "Monograph of the British Annelids" be accepted. Possibly whole categories of books might be considered, such as the "*Challenger* Reports," and especially "Das Tierreich," the admirable volumes of which we owe to the enterprise of the Berlin Zoological Society. Such a scheme would certainly cause some minor injustices, but every scheme does that. The immense advantage of allowing a researcher readily to determine and give an accepted name to an animal he is investigating without waiting weary days in struggling through a vast and scattered literature for the sake of synonymy would surely far out-balance any temporary injustice.

One last phase of my subject and I have finished with what I want to say on the subject of organising zoology. In Europe the great museums of our metropolitan towns are State museums, endowed by the State, managed by the State, and in Great Britain and Ireland staffed and curated by the State; that is to say, the officials at the museums are Civil Servants. Let us consider for a moment what that means, and let us take the British Museum, which, in its entirety, is second to none in the world as an example of a State museum.

The British Museum was established by an Act of Parliament in the year 1753 (26 Geo. II. cap. xxii). This Act sanctioned the purchase of collections and library of Sir Hans Sloane, that prince of collectors, for the comparatively insignificant sum of 20,000*l*. In fact, Sir Hans left his magnificent collection of natural objects, which, twenty years before his death, amounted to just under 70,000 specimens, his library of 40,000 printed volumes and 4100 manuscripts, to the nation, on condition that 20,000*l*., about one-fourth of the estimated value of the collections, be paid to his executors. Under the above-mentioned Act 10,000*l*. were paid to each of Sir Hans Sloane's daughters, Mrs. Stanley and Lady Cadogan. The same Act provided 10,000*l*. for the purchase from the Duchess of Portland, heiress of the second Earl of Oxford, of the Harley collection of charters and manuscripts, which were then in the market, and other moneys for the purchase and repair of Montagu House, Bloomsbury, and for maintenance. The Act incorporated with the Museum the Cottonian Library at Westminster, which, by an Act of Parliament of William III.'s reign, was under the care of trustees, chief amongst whom were the Archbishop of Canterbury, the Lord Chancellor, and the Speaker; the money was raised by a lottery, and the museum was opened in January, 1759, just 150 years ago.

Now it will be noticed that at its formal birth the museum consisted of about two equal parts—on the one hand books and manuscripts, and on the other what used to be called "natural objects."

The "General Repository," as the Act of George II. called it, was placed in the hands of a body of trustees, now forty-nine in number, three of them relics of William III.—namely, the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons, are trustees by virtue of office. These three are known as the principal trustees; there are twenty-one other trustees in virtue of their office—*e.g.* the Bishop of London, the Presidents of the Royal Society and Royal Academy, and so on—one is appointed by the Crown, nine represent the families of donors, and fifteen are co-opted. So large and unwieldy a body cannot, as a whole, transact the business of a great museum, and they have largely delegated their functions to a standing committee of the three principal trustees and fifteen annually appointed representatives.

Now the manner of appointing to the museum is this. The junior members of the staff are selected as the result of examination, and when appointed they become Civil Servants. Not a bad thing in itself, but bad for a man of science. He, through no fault of his own, becomes entangled in red tape; above all, he must not make himself a nuisance; *trop de zèle* must be avoided, his enthusiasms tend to become checked, he is perpetually observing what is called "official reticence," and he perforce spends his days in performing routine work during routine hours. No amount of skill and ability—and the staff at the museum is both skilled and able—hastens his promotion. This is a matter almost entirely of seniority. In fact, the conditions of the Civil Service are incompatible with that freedom to research in any line that proves most suggestive, and with that absence of outside control which alone makes scientific research on a large scale possible.

The appointment to the senior staff, the keepers or heads of departments, the Director of the Natural History Museum, and the chief librarian, are vested in the three chief principal trustees. This takes us back to the reign of William III. and the Cotton Library at Westminster. No doubt the then Archbishop, the then Lord Chancellor, and the then Speaker, both from propinquity and from their abilities and training, were quite the best men who could be found for this position of trust towards this library. Probably the present holders of these exalted positions—positions which they most worthily fill and which give two of them precedence after royalty in all Britain—are most fully endowed with the qualities which fit them to elect the senior staff for the library and for the collections of works of art and of antiquities at Bloomsbury. I doubt if the same eminent qualities enable them to deal equally satisfactorily with the higher posts in the Natural History Museum. If Parliament, or indeed any other body, were framing a scheme for the management of a great museum of science at the present time, I do not think it would occur to anyone that the holders of the exalted offices I have mentioned were specially fitted, either by the knowledge of the pressing scientific needs and problems of the moment or by their intimacy with the men of science of to-day, to be the most competent electoral body to choose keepers in geology, mineralogy, botany, and zoology. And, indeed, the existing arrangement has broken down. I do not know how long before Sir E. Ray Lankester's resignation of the joint posts of Director and Keeper in Zoology, in December, 1907, it became known to the trustees that that resignation was imminent, but I do know that it was talked about and written about months before that date. Yet after the resignation took effect one whole year elapsed before the trustees appointed a Keeper in Zoology; for twelve months there was no head of a department which contains collections unrivalled in the world. It took the trustees about six months longer to find a Director, and for about eighteen months the charge of this great museum of natural history was vested, under the trustees, in the Chief Librarian at Bloomsbury.

As Prof. Ronald Ross could testify, after scientific research has placed it within the power of man to exterminate so deadly a disease as malaria, the real fight begins; and the real fight is to persuade the authorities to adopt and enforce the measures which are offered them gratis. There is a case in point, if I am not misinformed, on this continent at the present time. It has been known since the time of the making of the St. Gothard Tunnel that lasting and often fatal disease is caused by a small intestinal worm, known as the tunnel-worm or hook-worm. Within the last few years Dr. Wardell Stiles has shown quite clearly that the unhappy condition of "poor white" of the Southern United States is due largely to their being affected by this hook-worm. Their bodies and their intellects are arrested in their development, and the adults amongst them are unable to understand the prophylactic measures he advocates, but the children could be taught if the proper organisation existed for teaching them. Many of the Southern States are friendly to the movement, and I know of no greater service that the central Government of the United States could confer upon the inhabitants of these southern States, in which, as is well known, President Taft takes the deepest interest, than that of detailing Dr. Stiles for several months a year to organise and control this movement. If this could be done, I believe—and I am here speaking of those things that I do know—the United States Government would confer on their own people a benefit as great as they conferred on other nations when they freed Havana of yellow fever and Panama of malaria.

In concluding this part of my address I wish to say as emphatically as I can that if science is to take its proper place in the polity of the nation we must endeavour to have men of scientific training, or at least of scientific sympathies, in the Government and also in the Government offices.

I cannot recollect the name of one single Minister trained in natural or physical science amongst the numerous members of His Majesty's Governments of the last thirty-five years. It is not so very long ago—I am glad to say that one of the actors of my little story is still with us—that Sir Joseph Hooker, then Director of the Royal Gardens at Kew, was walking through the grounds with Mr. Ayrton, President of the Board of Works, which in those days was the Government Department responsible for Kew.

They happened to run across Mr. Bentham, the great authority upon the classification of plants. Sir Joseph introduced him to the President, adding, "he works in our herbarium." "Dear me," said the President, "I hope you don't get your feet wet." Now I do not want for a moment to suggest that our present genial President of the Board of Works—whose official connection with Kew has been long severed—would not readily distinguish between an herbarium and an aquarium, but what I do wish to emphasise is that this ignorance of some of the most elementary details of scientific method exists in many of our rulers and in many of our permanent officials—not in all by any means; I know of some most notable exceptions—but in many. It is but human to distrust what we cannot understand, and it is this lack of understanding which is largely retarding progress at the present day.

III.

International Ocean Research.

As an example of international cooperation in scientific research I may take the investigations which have been going on for the last seven years in the Baltic Sea, in the North Sea, and in that greater Norwegian Sea which stretches from the western coast of Norway north to Spitsbergen and westward beyond Iceland and the Færöes. In this inquiry no fewer than ten nations—in fact, all those the shores of which touch these seas—have had a share—England, Scotland, Norway, Sweden, Finland, Russia, Germany, Denmark, Holland, and Belgium—and since most of these countries have a special steamer equipped for research and under the command of men trained in scientific methods, it has been possible to collect a mass of facts connected with the seas of Northern Europe such as has never been got together before for any similar area of the ocean.

The aim of those responsible for the scheme of work was to obtain as complete a survey as possible of the physical and biological conditions of the seas in question. They wanted to know the direction of ocean currents, both superficial and along the bottom; the variations in the degree of salinity of the water in time and in space; the nature of the sea-bottom, and whether this could be correlated with the fauna, sessile or moving, found upon it, and whether this fauna reacted on the prevalence or absence of food-fishes; the influence of depth, salinity, and temperature on the fauna; the seasonal variations and fluctuations of the small floating organisms often called the plankton; the life-history of our food-fishes, where and when they deposited their ova; what became of the ova; the distribution of the larval stages; the age at which the fish become mature, and their average length of life.

Then, again, it was hoped that much could be learned about the influence of man's activity on the sea. The relative depletion of the fish population caused by different modes of fishing; the intensity of trawling; how often does the trawl pass over the same ground in a given time? The question whether or no the seas are being over-fished, and, if so, what measures can be taken to lessen this evil, either by close time, limiting the size of fish captured, or by artificial fish-breeding. Many of these last-named problems concern the legislator as much as the man of science. The function of the latter is to provide facts upon which the administrator may act.

Such a vast task as was set out by the International Council in 1902 has necessitated an immense organisation. Some eight or ten steamers are employed making periodic voyages, under the direction of trained men of science. Enormous numbers of temperature-readings, investigations into the speed and direction of currents, and chemical analyses of sea-water have been recorded, and thousands of samples of the bottom, of the animals and plants living thereon, of fish in all stages, millions of fish ova, have been collected and accurately determined. To work up such an amount of material has occupied the attention of a large number of naturalists. Each country has at least one large laboratory devoted to this work, and their results are coordinated and generalised by the central bureau. The English part of the work was entrusted by the Lords of the Treasury to the Marine Biological Association, and has been carried out under the direction of Dr. E. J. Allen and Prof. Walter Garstang at our laboratories at Plymouth and Lowestoft.

Although all the ten countries are working upon what is, broadly speaking, a common plan, each has had its own special problems. In addition to carrying out the broad outlines of an international scheme, they have specialised along lines indicated by their own needs, and have attacked problems the solution of which affected their own special food supply. Thus Norway, where the old open fishing-boat is being replaced by the modern, decked trawler, has especially studied the cod and the saithe, the haddock and the herring, and has devoted much time and labour to the discovery of new fishing grounds, and has successfully done this along the Norse coast, in the Arctic circle, and on the banks between the Færöe Islands and Iceland. They have further established a trade in *Pandalus borealis*, allied to the prawns, which are taken in the deep waters off Norway, and are now to be bought in most fishmongers' shops in Great Britain.

In a similar way the Danes have tracked the eels as they leave the estuaries of the great rivers of Central Europe across the North Sea to the deep Atlantic off the West of Ireland, just beyond the 1000-fathom line. In these depths they spawn, and the resulting larval form, the Leptocephalus, long thought to be a separate genus, lives there for a while, until, gradually changing into an elver, it retraces by some mysterious instinct its parents' path across the ocean and regains the fresh-water rivers which those parents had left.

The English share of the investigation is limited to that part of the North Sea which lies south of the latitude of Berwick, and for the most part to the western half of these seas and to the English Channel; the latter, as we shall see, is a very important area. The work, so far as it has been specialised, deals, in the North Sea, largely with the plaice, with the food of fishes generally, and with the character of the deposits forming the sea-floor, with the creatures growing thereon. In the Channel the English worker is entirely responsible for the study of the hydrography of the water, which, entering the North Sea through the Straits of Dover, contributes greatly to its mass.

As a result of Prof. Garstang's investigations, an important spawning ground of the plaice has been located in the southern bight of the North Sea; the migration of both sexes has been traced to these grounds on the advent of the spawning season, and their return to their feeding grounds in the spring has been followed. During the spawning season it is usual to catch more males than females on the spawning grounds, possibly because at this time the female is inert and elusive, whilst the male is unusually active.

The course of the ova has been traced, chiefly by the Dutch investigators, as they drift towards the shallow fringe of coastal water, by far the greater number along the continental coast. Here the young fry grow up, and after attaining a certain size they leave the shallow coastal waters for the deeper seas off shore. Comparatively few of these, however, reach the feeding ground of the Dogger Bank, and Garstang has been able to show that by carrying the young plaice in steamers and transplanting them at the proper time on to this rich feeding ground, their rate of growth can be greatly accelerated and thus their market value largely increased, just as Dr. Petersen has done in the case of plaice on Thisted Bredning.

A few years ago there was no trustworthy method of determining the age of fish. Petersen's method of arranging the measurements of a large number of specimens in a scale according to size, when they resolved themselves into certain groups, which were considered to coincide with age-classes, has been superseded by the discovery of Reibisch, Heincke, and others, that many of the bones, the scales, and the otoliths of fishes show annual age-rings, like those found in the trunk of a tree or in the horns of cattle. By laboriously counting the rings on the otoliths of thousands of plaice, Dr. Wallace and others have been able to determine their rate of growth, and to show that some specimens attain the age of twenty-five and even twenty-nine years. Similar investigations have shown that the sexes have a different rate of growth. The age at maturity is found to differ in different regions, but in the majority of cases Wallace found that the males are sexually mature (four to five years) a year before the female is capable of spawning (five to six years). We can now correlate age with size and with weight.

The migrations of the plaice and of other fish and their rate of growth depend, amongst many other factors, upon their food supply. And the nature of the food of fishes has recently been re-investigated in the North Sea. I give some of Todd's results, which were made by the examination of some thousands of fish of thirty-one species. Of these I select three—the cod, the plaice, and the dab.

Percentages of stomachs containing various kinds of food.

Cod.

Size of fish in cm.	0–15	15–30	30–60	60+
Pisces ...	0 p.c.	11 p.c.	52 p.c.	67 p.c.
Mollusca ...	0	2	16	4
Crustacea ...	100	95	67	63
Polychæta ...	0	9	9	26

Plaice.

Size of fish in cm.	0–10	10–20	20–30	30+
Pisces ...	0 p.c.	1 p.c.	5 p.c.	5 p.c.
Mollusca ...	17	66	76	84
Crustacea ...	57	16	13	11
Polychæta ...	38	37	51	42
Echinoderma.	0	20	13	6

Dabs.

Size of fish in cm.	0–10	10–20	20–30	30+
Cœlenterata..	0 p.c.	18 p.c.	18 p.c.	20 p.c.
Echinoderma.	0	26	25	2
Polychæta ...	30	22	20	10
Crustacea ...	70	30	35	61
Mollusca ...	2	48	57	65

These tables show what, of course, was more or less known before, that as a rule the young fry live very largely, and in many cases solely, on crustacea. To a great extent the supply of suitable food dominates the movement of the young fry, for nowhere is the truth of the Frenchman's definition of life, "I eat, thou eatest, he eats," with its terrible correlative, "I am eaten, thou art eaten, he is eaten," more true than in the sea. Later in life the fishes' taste alters, and with increased size they can tackle animals the calcareous deposits of which would seem to render them highly indigestible.

Very careful investigations have been made, and are being made, by Mr. Borley and Mr. Todd as to the distribution of the fauna of the middle and southern parts of the North Sea, and its relation to the depth of water, the varying degree of salinity, and to the texture of the bottom deposits. These results, however, have not been published, but I may go so far as to say that the inquiry shows that within the area investigated the texture of the sea floor has, on the whole, more influence on the distribution of the invertebrates of the bottom fauna than has depth, and that depth in the area in question seems to have more influence than salinity.

With regard to the character of the bottom deposits, it has been found by Mr. Borley that off shore and on the gently shelving continental coast the sea bottom is of a uniform character over wide areas, though on the western side it is more patchy; and it has proved possible to divide the samples taken into some nineteen main types, each characteristic of one or more of the areas into which the region has been split up. Only one or two details of this laborious work can be mentioned. One is that the texture or degree of coarseness of the ground in various parts of the sea is such as to suggest that the distribution of the finer grades of material, the finer sands and silts, is greatly influenced by the joint action of currents and tides. It is, for instance, known that in the southern part of the North Sea the main direction of the bottom current is to the north and then to the east; and examination of the deposits shows a regular diminution in the proportion of the coarser sands, a regular increase in the proportion of finer material, as we proceed from the Straits of Dover in a north-easterly direction. A remarkable fact in this connection is the complete absence of silt from the sandy bottom west of the mouths of the great rivers Rhine and Maas. There can be no doubt that the presence of broad and shallow stretches of sand on the Continental, but not on the English, side of the North Sea is one of the factors which has determined the distribution of the small plaice, which on the Continental shores are so extraordinarily abundant, and on the English shores are relatively so scarce.

By means of bottles weighted with shot, so as to have about the same specific gravity as the surrounding sea water, Mr. G. P. Bidder has been able to trace slow currents moving over the bottom of the sea The bottles are closed, and contain a postcard in many languages offering a reward to whosoever returns the postcard, recording the latitude and longitude of the place it was trawled at, to our laboratory at Lowestoft. Attached to the neck of the bottle is a copper wire 1½ feet long. This wire trails along the bottom, the bottle itself floating about 1¼ feet above the level of the ground. Slowly as the bottles are swept along yet the distance they cover is sufficient to sharpen the free end of the wire to a needle point.

By these and by other methods it has been possible to trace the almost imperceptible but steady flow of waters along the bed of the sea. Without doubt these currents influence the distribution of the larval and young forms of all the creatures which live near the bottom, and especially influence the migration of food-fishes in their younger and less active stages, when they are swept helplessly along.

But these bottles have a double lesson to teach us: not only do they enable us to chart the slow streaming of the bottom water, but they give us to some extent a measure of the intensity of trawling in the North Sea. They have been re-fished in really surprising numbers. Commercial trawlers have re-taken them at the rate of 58 per cent. per annum. In one area these bottles cast upon the waters were re-taken, not after many days, but after very few. Out of 390, eighty-five were recovered in six weeks, and fifty out of 270 were trawled in five weeks, representing a local intensity of fishing which, if continued, would give us between 80 per cent. and 90 per cent. of recaptures in a year.

Marked fish which have been liberated and re-captured tell the same story of intensity of fishing.

The intensity of fishing as indicated by the percentage of re-captures within twelve months of liberation is shown by the following table [1]:—

	Percentage	
Off shore	Fish under 25 cm.	Over 25 cm.
Dutch coast...	23·7	20·3
Deep water, Southern Bight ...	13·0	26·6
Leman Ground (liberated April and May)	18·7	17·4
Leman Ground (liberated December) ...	—	21·0
Horn Reef outer ground	33·3	23·0

Obviously, since some fish are known to have been captured but not returned to the laboratory, the method gives a minimum estimate.

By applying the same method to the marking experiments of other countries as well as our own, Garstang [2] gave the percentage recovered within twelve months of liberation of fish more than 25 cm. in length as from 4 per cent. on the Fisher Bank to 56 per cent. in the Skager Rak.

When we reflect on the chances of these marked fish dying or being eaten or losing their labels, it is surely a most remarkable fact, full of significance to the practical man, that in the North Sea marked fish of marketable size are recaptured at the rate of between 20 and 30 per cent. each year, and sometimes at a greater rate. It would seem that each square yard of the fishing grounds is swept by the trawl, not once, but again and again each year.

Mr. Borley has conducted a large series of experiments to determine the vitality of fish after they have been captured by both the beam and the otter-trawl. It was necessary to determine the degree of injury caused by the actual trawling, the raising of the trawl, and the subsequent exposure on deck. The larger fish of both sexes

[1] Garstang, "North Sea Fisheries Investigation Committee Southern Area," Report No. 1.

[2] "Provisional Report on the Natural History of the Plaice" (Committee B). *Procès verbaux*, vol. iii.

were capable of resisting the damage to a greater extent than those of smaller size, and the relative resistance of the two sexes varied at different sizes, the male showing a decline in the increase of its vigour as it approaches maturity. One factor which is very deleterious to the fish is the presence of jellyfish in the trawl; these either smother the fish or possibly sting them to death; at any rate, the mortality of the fish is enormously increased when medusæ are present in any numbers. The otter-trawl is also far more harmful than the beam-trawl, and exposure on deck to a hot sun is another constant source of death, one hour's such exposure in one series of experiments killing 99 per cent. of the smaller fish. In the ordinary commercial operation of trawling, whilst the fish are being sorted those that have no market value lie about on the deck of the vessel for at least an average period of one hour; hence it is extremely probable that when shovelled overboard practically all are dead or dying.

The work which has been done by our own special steamer has been supplemented by records carefully kept by certain selected captains of commercial trawlers, which sail from Grimsby or from Lowestoft. In this way the details of some 20,000 hauls have been examined, and their results tabulated by Miss Lee.

I have left myself no time to describe the important hydrographical investigations carried on by Mr. Mathews into salinity, temperature, &c., which show us the conflicting currents at the mouth of the English Channel and how the North Sea in its southern part is supplied with water from the Atlantic through the Channel. The curious ebb and flow of the Gulf Stream, its periodic welling up and subsidence, closely connected as they seem to be with the migrations of the herring, cod, and haddock shoals, is another most important matter of investigation.

Neither can I tell you in detail of the immense amount of work which is being done by the other countries which share in the international scheme, by the Scottish Fishery Board, the pioneer in Great Britain of this sort of research. To the west our Channel work is beginning to get into touch with the more recently established Irish Fishery Board, and with the work carried on under the direction of Prof. Herdman in the Irish seas.

The outcome of all this minute and continuous investigation will, in time, tell us whether or no the North Sea fisheries are being exploited in the most profitable way—a very important question for our country, for with a fishing fleet of 27,000 vessels, manned by 90,000 fishermen, who land 900,000 tons of fish a year, valued at 10,000,000*l.*, Great Britain takes 90 per cent. of what is caught in the North Sea. Some statistics indicate that there is a falling off. The steam trawlers in 1905 landed 25,000 tons of fish less than in 1904, and in 1904 there was a similar shortage on the total of 1903. And yet 1903 was a year in which some crisis took place; the growth of the haddocks and the number of young haddocks were far less than normal, the Norwegian cod fisheries sank to a minimum, the French statistics showed the same feature in their fisheries off Iceland. In 1903, however, there were unusually large numbers of small plaice. The polar ice-field pressed down south, and seals, cetacea, and arctic birds left their usual quarters, and came south in some cases so far as Shetland. The gigantic climatic changes indicated by the above undoubtedly disturbed for a time the rate of increase and the rate of growth of the fish population of the North Sea, but they soon returned to their normal state. Compared with such mighty influences the fishing activity of man seems almost negligible, and Dr. Hjort for one thinks that "the productiveness of fish" "may be regarded as independent of the interference or fisheries of man." I am not sure that this is so. Taking large areas and all fish into consideration, it may be true; especially it would seem to be so of some species, such as the herring, the saithe, and the cod; but in certain areas and with certain fish, such as the sole and the plaice, man's activity has undoubtedly decreased the number.

Although the researches of the last few years have immensely increased our knowledge of what is going on in the sea, they have, like an ever-widening circle, but increased the number of problems which await solution. It is earnestly to be hoped that the work may go on on at least its present basis. The business man, always on the outlook for a dividend, has sometimes complained that some of our inquiries do not seem to him practical, but he must have patience and faith. A few years ago no knowledge could seem so useless to the practical man, no research more futile than that which sought to distinguish between one species of a gnat or tick and another; yet to-day we know that this knowledge has rendered it possible to open up Africa and to cut the Panama Canal.

And here, if I may quote the words of the author of the Maccabees:

"And here will I make an end."

"And if I have done well, as is fitting the story, it is that which I desired; and if slenderly and meanly, it is that which I could attain unto. . . . And as wine mingled with water is pleasant and delighteth the taste: even so speech, finely framed, delighteth the ears of them that read the story."

"And here shall be an end."

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY COLONEL SIR DUNCAN JOHNSTON, K.C.M.G., C.B., R.E., F.R.G.S., F.G.S., PRESIDENT OF THE SECTION.

IT has been usual for Presidents of this Section to make some allusion in their addresses to the principal matters of geographical interest which have occurred during the preceding year, and I propose to follow this custom before proceeding with the rest of my address, which would hardly be complete without some allusion to the great geographical achievements of the past year.

I doubt if there has ever been a year in which more important additions to geographical knowledge have been made than those resulting from the journeys of Dr. Sven Hedin, Dr. Stein and Lieut. Shackleton.

Dr. Sven Hedin's previous explorations had deservedly gained him such a high reputation as an explorer that it seemed almost impossible for him to increase it, yet his recent expedition in Tibet, extending over two years, has enhanced his already great reputation.

Refused permission to enter Tibet from India, he was not to be deterred. Travelling round to Leh and making that place his starting point, he entered Tibet and traversed in various directions a considerable tract, previously unexplored, of that country, making a good reconnaissance survey of the country he passed through.

A large part of his journey was through a bleak and inhospitable region, where he encountered intense cold and very great privations. At one time he went for eighty-three days without meeting a living soul, and the cold and hardships were such that out of ninety-seven ponies and mules with which he started only six came through. Yet in the following year, in the depth of winter, Dr. Sven Hedin again traversed this terrible country. In doing so he ran imminent risk of starvation, as his last sheep was killed a considerable time before he got through to country where he could obtain fresh supplies.

Dr. Sven Hedin's tact and resource were as great as his fortitude and courage. He made friends wherever he went, and, although the Tibetan Government sent orders over and over again that he should be turned back, he succeeded in spending two years in exploring the country, maintaining the most friendly relations with the Government officials and others whom he met. Besides exploring and surveying a large tract of previously unexplored country, he investigated the sources of the Brahmaputra, the Indus, and the Sutlej, and in the course of his journeys he accumulated a mass of geographical and other scientific information.

Next comes Dr. Stein's expedition to Chinese Turkestan, by which he has made a most noteworthy contribution to geographical knowledge and antiquarian research.

Dr. Stein, accompanied by that capable surveyor Rai Ram Singh, who was later on relieved by that equally skilful and energetic surveyor Rai Sahib Lal Singh, travelled from India *viâ* Chitral and Kashgar. He commenced survey work in the eastern part of the Mustagh-ata range, and carried it along the Kun Lun Mountains, skirting the southern side of the Takla Makan Desert and the Lob Nor Desert to Suchou and Kan-chou. He surveyed a large area of the mountainous region lying westward of Kan-chou, then crossing the desert from Anshi to Hami he returned north of the Tarim River, skirting the southern slopes of the Tian Shan range, to Kashgar. During this very long journey Dr. Stein came across the ancient frontier wall, built about the second century B.C. He traced it west of Suchou, until lost in the desert, for some 250 miles, and he made various incursions into and across the desert, making discoveries of the greatest antiquarian interest.

After his return to Kashgar he surveyed the last unexplored portion of the Kun Lun Mountains and the country containing the sources of the Khotan or Yurungkash River, which proved to be flanked on the south by a magnificent range of snowy peaks rising to more than 23,000 feet; thence passing the sources of the Keriya River he skirted the southern slopes of this snowy range and finished by connecting this survey with that to the north of this range. The privations and hardships undergone by Dr. Stein and his party were very great, and, just as he completed his last bit of survey, he was unfortunate enough to get his foot badly frost-bitten, and had to hasten to more civilised parts for medical treatment.

Dr. Stein, during his expedition, displayed all the best qualities of an explorer—enthusiasm, determination, skill, and tact. The modest account he has so far given us of his travels, which gives a mere outline of his work, shows that the geographical as well as the archæological results of his expedition are of the greatest value.

The last completed exploration I propose to mention is Lieut. Shackleton's great journey in the Antarctic Circle, which has raised him to a high position among the gallant explorers of the Polar regions.

Lieut. Shackleton personally arranged and supervised all arrangements for the expedition, his experience in the British Antarctic expedition under Captain Scott standing him in good stead.

Having landed in McMurdo Sound, a party consisting of Lieut. Adams, Prof. David, and others ascended Mount Erebus, which is more than 13,000 feet high, all above snow-level.

Later on Lieut. Shackleton and a sledge-party set off southward, and after an arduous journey succeeded in reaching 88° 33′ south latitude, more than six degrees nearer the Pole than any previous explorer. His party travelled altogether about 1700 miles, including relays, in 126 days, a splendid performance in a rough and difficult country under very trying climatic conditions. Soon after passing 83° 33′ south latitude they lost their last pony, and from this point they had to drag their sledges themselves, although their journey involved the ascent of a plateau 10,000 feet high. They only turned back when their diminishing stock of provisions rendered it imperatively necessary to do so. They were for a considerable time on short rations, and found several times that they had expended their food supplies before reaching their next depôt. Had they missed one of these depôts—no unlikely contingency in such a country—they must have perished by starvation. Altogether the sledge journey was a great feat of pluck and endurance.

Lastly, Lieut. Shackleton's colleague, Prof. David, with others, made a sledge journey to the north-west, reaching the South Magnetic Pole. A good deal of triangulation was carried out, many geological specimens were collected and much scientific information was obtained.

Whether we consider Lieut. Shackleton's skill and energy in organising the expedition, the courage and determination displayed in carrying it out, or the results obtained, his expedition will stand out as one of the greatest of the many great efforts to reach the Poles, and as a British expedition it is one that specially appeals to us.

At first sight it would seem that these great journeys belie the opinion so often expressed of late years that the days of the explorer are numbered, and that in future geographers will have to deal with surveys rather than exploration; but, in fact, these splendid achievements only strengthen this opinion. These explorers have considerably reduced the comparatively small area still unexplored, and other expeditions are helping to diminish the unexplored area.

Among those which are in progress I may mention the following:—Colonel Kozlof's expedition to Mongolia, which has already visited Kuku Nor and which is exploring the upper course of the Huang Ho and other parts of Mongolia. Lieut. Boyd Alexander is exploring in West Africa. The Duke of the Abruzzi is investigating part of the mountainous region across our Indian frontier; Dr. Longstaff is exploring another part of that mountain system; Captain R. E. Peary, U.S.A., and Captain E. Mikkelsen are leading expeditions in different parts of the Arctic regions, and M. Charcot is exploring in the Antarctic Circle. Lastly, an important British expedition will start before long to explore part of the Island of New Guinea, one of the largest still unexplored land areas. There are other expeditions, either in progress or projected, too numerous to mention.

The best modern explorers are not now content with exploration or even with a rough route traverse and an occasional observation for latitude; they either themselves make careful reconnaissance surveys of the country adjoining their route or they are accompanied by trained surveyors, who make such surveys.

Again, every year the area surveyed on correct scientific principles is extended. The interesting address of my predecessor, Major Hills, will have told you what is being done in this way in the British Crown colonies. In the British self-governing colonies and in the colonies and dependencies of other Powers the area of regular survey is being continually extended, and in more remote regions surveys are being carried out by Boundary Commissions or for railways or other purposes. Along with the increasing appreciation of the value of geography which has taken place of late years, there has been an increasing recognition of the need for regular surveys, and it is probable that the next generation will find that not only is no considerable area of the earth's surface unexplored, but that the area not yet surveyed at least geographically, or for which a regular survey has not been projected, is getting limited.

I propose in the rest of my address to deal with the regular survey and mapping of new areas, and to discuss various questions connected therewith; if I am right in believing that large areas will be regularly surveyed in the near future, such questions merit careful consideration. I shall state on these points the practice of some of the great national surveys, because their experience seems the best guide for future work; but I recognise that methods suitable for rich and populous countries, such as Germany, France, or Great Britain, may be too costly for many countries and provinces the survey of which has still to be made, and mention will be made of less expensive methods which are likely to be much in demand in future.

It would be difficult to say anything new on the subject I propose to deal with, and I lay no claim to do so, still less do I wish to dogmatise as to the best methods. When I express opinions I shall also state the practice of some of the principal surveys of the world, and my hearers having weighed the matter can accept my opinions or not according to their judgment. In either case my object will have been attained if careful consideration is given to the points raised.

Maps may be roughly divided into three classes:—

(1) Geographical maps—*i.e.* those on very small scales.

(2) Topographical maps. The dividing line between these and geographical maps is not very clearly defined. For the purpose of this address maps between the scales of 4 miles to the inch and $\frac{1}{250000}$ scale will be considered as topographical.

(3) Cadastral maps—*i.e.* maps on large scales mainly for property purposes.

As the time at my disposal will not admit of my discussing all three classes of maps, and as I have on a previous occasion read a paper to this Association on "Cadastral Surveying," I propose to limit my remarks to topographical surveys and maps.

In most of the older countries topographical surveys have originally been made to meet military needs, and as a rule they are carried out under military supervision.

In order that they may be useful in case of war such surveys must have been made before war breaks out. The use, however, of topographical maps is not limited to military purposes; on the contrary, they have invariably proved of great value for civil requirements. In one respect they are more useful for civil than for military purposes, as a state of war occurs rarely, and hence while the maps are only occasionally used in connection with war, they are constantly used in connection with civil administration and with public and private business of all kinds. The topographical maps of the Ordnance Survey, prepared originally solely for military requirements, have proved extremely useful for civil purposes. Directly or indirectly all the numerous maps prepared by the trade in Great Britain for civil use are based on them. I believe the experience of all other countries is similar to that of the Ordnance Survey. In most countries in which land is of any value, a cadastral survey for land transfer purposes is needed, as well as a topographical survey. In some cases indeed, the need for a property survey has first made itself felt; thus in the Transvaal and in the Cape Colony, neither of which yet has a topographical survey, there has for many years been a Government Survey Department for making property surveys. The question arises whether there should be two separate surveys, one for topographical and one for cadastral maps, or whether there should be only one survey, the topographical maps being prepared by reducing the cadastral survey. Incidentally the further question arises whether, if two separate surveys are made, they should be under one head.

In most countries—the Ordnance Survey of the United Kingdom being an exception—not only are entirely separate surveys made for these two classes of maps, but these surveys are generally under different departments. In some cases the cadastral surveys are isolated farm surveys, showing little detail except property boundaries. Such surveys would, of course, not answer as a basis for topographical maps. In other cases, however, the cadastral surveys show all necessary detail except ground forms, which can be added by a separate survey. The only cadastral survey, so far as I know, which shows ground forms is the Ordnance Survey, the 6-inch maps of which are contoured.

A difficulty in the way of utilising the cadastral survey for the smaller scale maps arises from the fact that a cadastral survey is, from its large size, much slower than a topographical survey. It is often found advisable to take up the survey of the former somewhat irregularly, while it is important for the proper progress of the latter that it should be taken up regularly and methodically. The Ordnance Survey 1-inch map has, since 1824, not had a separate survey of its own, but has been based on the cadastral survey. Ordnance Survey experience has shown that the delays in completing the topographical map, due to this course, have been much greater than one would have expected, and that there are grave disadvantages in having the scale of survey very much larger than that of the finished map. These objections do not apply, or can be overcome, if the cadastral survey of any locality is completed before the topographical map is taken up. This is a condition not likely to be often fulfilled in the case of future topographical surveys. I advocate therefore that, following the general practice, there should be entirely separate topographical and cadastral surveys. I should advocate this even where it is essential to keep the expense as low as possible. More economy would probably result from the adoption of a fairly small scale for the topographical map, from curtailing the small detail to be shown on it, and from showing on the cadastral maps only such detail as is needed for property purposes, than would result from making one survey do for both classes of maps.

On the other hand I consider that, even when separate surveys are made for the two classes of maps, it is advantageous that both should be made under the same head. The more usual course is, however, to have the two surveys independent, and in some cases local circumstances may make the course I advocate inadvisable.

Triangulation.

The first preliminary to any survey should be a triangulation. It is the most satisfactory course, and the best economy in the long run, to carry out with the greatest accuracy possible the primary triangulation on which the survey is to be based. Such a triangulation will remain good for a very long period. For example, the primary triangulation of the Ordnance Survey was commenced in 1791; while some doubts have been expressed whether it is accurate enough to combine with other more recent work for the purpose of investigating the figure of the earth, no one has questioned that even the earliest part of this triangulation is amply accurate enough for map-making purposes.

On the other hand I do not advocate carrying out a primary triangulation until arrangements have been made for basing a survey on it. In South Africa an excellent and very accurate primary triangulation has been carried out. This triangulation was undertaken largely no doubt for scientific purposes. While answering its purpose in that respect it has so far had no surveys of any great extent based on it. An accurate triangulation is now a much quicker and less expensive operation than it used to be. The introduction of Invar tapes and wires has largely expedited and simplified the accurate measurement of base lines, while the improvements effected in theodolites enable equal or greater accuracy to be obtained with the comparatively small and handy instruments now made than could be got formerly with large and cumbrous instruments, such as the 36-inch theodolites, with which most of the primary triangulation of Great Britain and Ireland was carried out. Unless observations are rendered difficult by numerous buildings, by trees or by a hazy or smoky atmosphere, a good primary triangulation should not now be very expensive. It is usual to base on the primary triangulation a minor triangulation of several orders, the object being to have an accurate framework of trigonometrical points on which to base the survey. If it is important to keep the expense low, the trigonometrical points may be rather far apart, intermediate points being fixed by plane table; but it should be remembered that it is the truest economy to make the best triangulation which funds admit of. In forests or in wooded and rather flat country, where triangulation would be very expensive, lines of traverse made with every possible accuracy, and starting and closing on trigonometrical points, may be used instead of minor triangulation.

Detail Survey.

Provided the detail survey is based on triangulation, it may be made by any recognised method. Plane tabling is now almost universally resorted to, and is probably as cheap and convenient as any other method. The vertical heights of the trigonometrical points will have been fixed by vertical angles with reference to some datum. The height of intermediate points can be fixed by clinometer lines, especially down spurs and valleys, and even by aneroid, and from these heights the contour lines can be sketched in. Altitudes can be more accurately fixed by spirit-levelling, but this is an expensive method not likely to be much used in the case of topographical surveys. It is possible that in exceptional cases photographic surveying may be resorted to with advantage, and undoubtedly photographic methods sometimes enable work to be done which would not otherwise be feasible. The photographic method suggested by Captain F. V. Thompson, R.E., is an advance on previous methods. In Canada, I understand that a good deal of photographic surveying has been done, and presumably the conditions in Canada have been found suitable for this method. It has been little used elsewhere.

Scale of Map.

The next point for consideration is the scale on which the map is to be published, and it is an important one. Speaking generally, the cost increases with the scale, and cost is therefore one of the main determining considerations. The physical and artificial character of the country, the amount of detail it may be decided to show on the map, the method adopted for representing hills and other detail, and the method of reproduction to be used, all affect the question.

Clearness and legibility are among the first essentials of a good map, and it is desirable that the scale should be such that all detail it may be decided to show on the map can be inserted without overcrowding, or conversely, if the scale is fixed, the amount of detail and method of showing it should be such as to avoid the common fault of overcrowding the map.

In populous countries, such as Belgium, France, and Germany, where buildings, roads, railways, &c., are numerous, a larger scale is, *caeteris paribus*, desirable, than in less populous countries.

All important detail such as roads, railways, canals, forests, woods, &c., should appear on the map, as should the more important names, but it is a matter for consideration how far minor detail such as orchards, marshes, rough pasture, state of cultivation, &c., should be inserted on the map, and to what extent the less important names should be omitted.

In hilly country hachures and contours, especially if in black, tend to obscure the detail and names, and the smaller the scale the greater this tendency.

Methods of reproduction will be dealt with later, but I may here say that more detail and names can be shown clearly on a given scale if the map is engraved on copper than if reproduced in any other way. The scales adopted by different countries vary very much—I give below the scales adopted by some of the principal surveys.

$\frac{1}{25000}$ scale—Switzerland (the more populous parts), Prussia, Baden, Saxony, Bavaria, and Würtemberg (these German maps, although called maps of position, are practically topographical).

$\frac{1}{40000}$ scale—Belgium and Denmark.

$\frac{1}{50000}$ scale—France (the new topographical map), Algeria, Tunis, Holland, Japan, Spain, Switzerland (the less populous parts).

$\frac{1}{62500}$ scale—the United States (the more populous parts).

$\frac{1}{63360}$ scale (1 inch to a mile)—Great Britain and Ireland, and Canada.

$\frac{1}{75000}$ scale—the Austrian Empire.

$\frac{1}{80000}$ scale—the old staff map of France.

$\frac{1}{100000}$ scale—the German Empire, Italy, Norway, Portugal, Sweden, and Switzerland (Dufour atlas).

$\frac{1}{125000}$ scale—the United States (the less populous parts).

$\frac{1}{126000}$ scale—Russia.

$\frac{1}{250000}$ scale—the United States (barren districts).

The introduction of cycles, motors, and other rapid means of locomotion has led to a demand for a scale which will show a considerable tract of country on a sheet of moderate size. If the standard map is already on rather a large scale, this demand is best met by publishing a reduction of the standard map. This course is followed by Great Britain and Ireland and by Canada, the 1-inch map of which is reduced to and published on the ½-inch scale; but if only one scale is used a compromise must be arrived at which will meet the reasonable requirements of rapid locomotion, as well as the other essentials of a topographical map.

If I may venture an opinion in a matter in which practice varies so much, it is that for countries using British measures in which, owing to dense population, the detail is close the 1-inch scale ($\frac{1}{63360}$) is a very good one, and that for more open parts the ½-inch scale may with advantage be adopted. For countries using metrical measures I should advocate $\frac{1}{62500}$ and $\frac{1}{125000}$ respectively. These scales do not differ largely from those adopted by most of the principal countries, the majority of which use scales between $\frac{1}{50000}$ and $\frac{1}{100000}$ for fairly close countries.

Where it is important to keep the cost down I should advocate a half-inch to the mile or a $\frac{1}{125000}$ scale. All except the most closely populated country can be shown clearly on such scales provided the maps do not show too many names or too much small detail.

The United States have scales of $\frac{1}{62500}$, $\frac{1}{125000}$, and $\frac{1}{250000}$, the general closeness of detail in any area determining which of these three scales is adopted. This arrangement is a good one, and would be still better if the areas published on the $\frac{1}{62500}$ scale were also reduced to and published on the $\frac{1}{125000}$ scale, and if the whole country were published on the $\frac{1}{250000}$ scale. The principle here advocated of having each scale so far as possible complete for the whole country has been carried out by Great Britain, where the whole country, except some uncultivated areas, is published on the 25-inch ($\frac{1}{2500}$) scale, and the whole country on the 6-inch, the 1-inch, the ½-inch, the ¼-inch, and other smaller scales.

Scale of Field Survey.

It is usual to make the field survey for small scale maps on a larger scale than that on which the map is to be published with the view of securing greater accuracy of detail, but this should not be overdone. If the field survey is on too large a scale it entails needless expense, also when the surveyor is working on too large a scale he is apt not to realise the effect of reduction on his survey, and is likely to survey so much detail as to overcrowd the map, thus increasing the cost of the work and injuring the map.

When the map is reproduced by photographic methods the fair drawing is usually on a larger scale than the finished map, so as to get finer results on reduction; but in this case also, for somewhat similar reasons to those stated above, there are limits to the amount of reduction which can be made with advantage.

In these respects the practice of different countries varies considerably.

In Austria the field survey is on the $\frac{1}{25000}$ scale; this is reduced to and drawn on the $\frac{1}{50000}$ scale, and this drawing is reproduced by heliogravure on the $\frac{1}{75000}$ scale.

In France the field survey is on the $\frac{1}{10000}$ or $\frac{1}{20000}$ scale. The survey is reduced to and drawn on the $\frac{1}{40000}$ scale. In Algeria and Tunis, both field survey and drawing are on the $\frac{1}{40000}$ scale. In all cases the French maps are now reproduced by heliogravure on the $\frac{1}{50000}$ scale from the $\frac{1}{40000}$-scale drawings.

In Germany the field survey is on the $\frac{1}{25000}$ scale. This is reduced to the $\frac{1}{100000}$, on which scale the maps are engraved on copper.

In Great Britain the 1-inch map is based on the 25-inch and 6-inch survey. These were reduced, and a fair drawing was made on the 2-inch scale in a manner suitable for reduction to the 1-inch scale—*i.e.* the detail lettering, &c., were drawn so that when reduced to the 1-inch scale they should be in proper proportion. This drawing was reduced and printed by heliozincography on the 1-inch scale, and from these prints was engraved on copper.

In America the field surveys are on the scales of $\frac{1}{45000}$, $\frac{1}{90000}$, and $\frac{1}{180000}$ for the $\frac{1}{62500}$, the $\frac{1}{125000}$, and the $\frac{1}{250000}$-scale maps respectively. The drawings, on the same scale as the field survey, are reduced by photography and engraved on copper.

I consider that the best results are obtained when the field survey is made on double the scale of the finished map; that if reproduction is to be by engraving, the fair drawing should be on the same scale as the finished map; that if, on the other hand, reproduction is to be by photographic methods, the fair drawing should be on the same scale as the survey, *i.e.* double that of the finished map. The reduction I advocate should conduce to accuracy of detail and, if reproduced photographically, to fineness of detail, while it is not so great that the surveyor and draughtsman should be unable to realise the effect of reduction.

Detail.

The need of considering the amount of detail, &c., to be shown is not always sufficiently realised. The way in which detail is to be represented also needs consideration, as on small scale maps much detail has to be represented conventionally.

Railways have to be shown conventionally, and should be so marked that they catch the eye without being too heavy.

Roads also should be clearly marked. Where different classes of roads exist they should be distinctively shown, main roads being more prominent than others. It is important to know what roads are fit for fast wheeled traffic in all weathers, and which are fit only for slow traffic. The exact classification of roads must depend on the conditions obtaining in the country. The most elaborate classification is that shown on the French maps, and next that shown on the maps of Great Britain. Provided that important distinctions are represented, the simpler the classification the better.

Forests, woods, marshes, and in some cases pasture, rough pasture, orchards, vineyards, gardens, &c., are shown by conventional signs. While forests, woods, and marshes should certainly be distinguished on the maps, I incline to the opinion that the state of cultivation is better omitted, and that the less small detail shown the better. Such small detail increases the cost and often overcrowds the map. The German $\frac{1}{100000}$ scale shows much small detail, and although the maps are beautifully and delicately engraved on copper, the detail is rather crowded on some sheets. The French Carte Vicinale is, in my opinion, rather crowded with names.

The most difficult question, and that on which opinions differ most, is the method of representing ground forms. Methods which answer well on steep ground are less satisfactory on gentle slopes, and *vice versâ*, and each method is open to some objection.

Ground forms may be indicated by contours, hill shading in stipple, vertical hachures, horizontal hachures, the layer system, or by a combination of some of these.

Ground forms are represented by contours on the $\frac{1}{25000}$-scale maps of the German States, the Swiss Siegfried Atlas, the maps of the United States, the 1-inch map of Canada, the $\frac{1}{40000}$-scale map of Denmark, and the maps of Japan. Where the slopes are steep the contours give almost the effect of hill-shading. Some of these maps give a very good representation of the ground, the best being those in which the contours are in colour.

Hill features are shown by stipple shading on the French Carte Vicinale and the Ordnance Survey four-mile map. In mountainous country stipple shading gives a good pictorial representation of the ground, but it fails in flatter country, and it is often difficult to tell from it which way slopes run.

The Swiss Dufour Atlas ($\frac{1}{100000}$ scale) is a good example of vertical hachuring, as are some of the German $\frac{1}{100000}$-scale maps. Vertical hachures are also used on the Austrian and Swedish maps, and in conjunction with contours on the maps of several other countries.

Vertical hachures when well executed give an artistic and graphic representation of the hills. In the Swiss and British maps the pictorial effect is enhanced by assuming a light from the left-hand top corner. In steep ground, especially when the hachures are in black, these are apt to obscure detail and names. I think hachures are better when printed in colour, but many will disagree with me on this point.

Horizontal hachuring, while having some advantages, is less effective and is little used.

The system generally known as the layer system has been used in Great Britain by the well-known Scotch firm of J. Bartholomew and Co., has recently been adopted by the Ordnance Survey for its ½-inch maps, and is used in the ½-inch maps of Canada. It consists in indicating by various shades of colour the area lying between certain contours; thus one shade may be given to all ground below the 50-feet contour, another shade to ground between the 50-feet and 100-feet contour, and so on. This system gives a general indication of ground form and enables the contour lines to be followed more easily. Its shades of colour enable the eye to pick out more easily all land lying at about the same level. It is most effective in ground with a small range of vertical height, as the vertical depth of layers can then be small and the distinction in colour between successive layers marked. In hilly ground the depth of the layer must be increased, which means that many ground features are ignored on the map, or the number of layers on the map must be large, in which case the distinction in shade between successive layers will be less marked. This method is popular in Great Britain, and enables those who are not versed in reading contours and hachures to realise something of the nature of the ground forms.

A combination of these methods has been used as follows:—

France on her $\frac{1}{50000}$-scale maps shows ground forms by contour lines and stipple shading. This gives a very fair representation of the ground, but where the contours are very close together the effect of the coloured contours on the stipple is not pleasant. Nor does the stipple always look well when it falls on colour.

The German coloured $\frac{1}{100000}$-scale map, the Italian $\frac{1}{100000}$, and the British 1-inch show both contours and vertical hachures.

The Norwegian $\frac{1}{100000}$-scale map shows the features by contours, vertical hachures and shading.

The new British ½-inch scale map has both contours, layers and stipple shading.

Opinions differ so much on this subject, and there is so much to be said for and against each method, that I will confine myself to the opinion that contours reasonably close together should form the principal feature of any method of representing ground forms; that contours by themselves give a very fair representation of the ground; that vertical hachures, if printed so as not to obscure the detail and names, or stipple shading when there is not too much colour on the maps, increase the pictorial effect and are useful additions to contours; that ground forms should preferably be in colour, and that where hachures or stipple are used as well as contours both should be in the same colour.

The German coloured $\frac{1}{100000}$-scale map (brown hachures and contours), the British 1-inch scale copper-plate printed map (brown hachures and black contours), the British 1-inch coloured map (brown hachures and red contours), and the French $\frac{1}{50000}$-scale (grey stipple and brown contours), all give a good representation of the ground, and there are other maps which might be named almost, if not quite, as good.

Vertical Interval of Contours.

The vertical interval between contours should depend partly on the scale, partly on the steepness of the ground. Practice varies considerably in this matter.

The $\frac{1}{25000}$-scale maps of Switzerland and of Germany, except Prussia, are contoured at 10-metre intervals.

The $\frac{1}{50000}$-scale maps of France are contoured at 10-metre intervals.

The $\frac{1}{50000}$-scale maps of Japan and Spain are contoured at 20-metre intervals.

On the Swiss $\frac{1}{50000}$ scale contours are 30 metres apart.

On the United States $\frac{1}{62500}$ scale the contour interval varies from 20 to 100 feet.

On the British 1-inch map there are contours at 50 feet, at every 100 feet up to 1000 feet, and thence at 250-feet intervals.

On the Canadian 1-inch and ½-inch maps the contour interval is only 25 feet, but the sheets published have been in ground with only moderate elevations.

On the German $\frac{1}{100000}$-scale the contour interval is 50 metres.

I consider that if the contours are printed in colour the vertical interval may with advantage be such that on steep ground the contours are reasonably close together, every fourth or fifth contour being printed heavier so as to be more easily followed. If the contours are in black they cannot with advantage be so close.

It is, in my opinion, best if the contour interval is uniform all over a country. Failing this, it seems desirable that it should be uniform over considerable areas and at least throughout a sheet; but this view is not universally held. I do not like the varying interval adopted by the Ordnance Survey. The contours on the Ordnance Survey maps are surveyed with great accuracy and at great expense. For topographical maps much cheaper and more rapid methods will suffice.

Cartography.

I have, with a view to clearness, kept the question of the method of reproduction separate, but it has a bearing on some of the points already considered. Thus the fine engraving of the German $\frac{1}{100000}$-scale map enables an amount of small detail and ornament to be shown on that map which could not have been clearly shown if any other method of reproduction had been used.

The older maps were generally engraved on copper, or sometimes on stone, and printed in black and white. Subsequently photographic methods, such as the photogravure of the Austrian and the more recent $\frac{1}{50000}$-scale French maps, were used, and colour printing is now largely resorted to.

In some cases the colour-plates are prepared by engraving on copper, stone, or zinc. The maps of the United States and Switzerland are engraved on copper. In other cases, for instance, the 1-inch Ordnance Survey, colour-plates are prepared on stone by transfers and offsets from the engraved copper plate. In other cases—*e.g.* the $\frac{1}{50000}$-scale map of France—the colour-plates are prepared by photographic methods.

For clearness, delicacy of outline, and artistic effect nothing equals engraving on copper. It forms also the best basis for colour-printing. Unfortunately it is very slow and costly.

Engraving on stone is quicker and less expensive than copper engraving. It is inferior in delicacy to the latter, but some of the best stone engraving is very good.

Photographic methods are the most rapid and the cheapest, and with care give very fair results. As good examples I may quote the $\frac{1}{75000}$-scale maps of Austria, prepared by heliogravure, and the 6-inch maps of the Ordnance Survey, prepared by heliozincography, both black and white maps.

Of colour-printed maps I may instance the new $\frac{1}{50000}$-scale map of France prepared by heliogravure, and the ½-inch Ordnance Survey map hitherto prepared by photo-etching, although I understand that in future the outline will be engraved on copper.

When rapid reproduction and moderate cost are desired I do not hesitate to recommend photographic methods which, although not so good as engraving, give, when carefully executed, reasonably good results.

Opinions differ as to the extent to which colour should be used, the modern tendency being to use it very freely. I can hardly be accused of prejudice against colour, as during my tenure of office at the Ordnance Survey colour-printing was largely developed, but I think it is often overdone. I consider that a moderate amount of colour is a great improvement to a map. Ground forms, however indicated, can, in my opinion, be better shown by colour than in black; it is advantageous also to distinguish water by colour, to give prominence to main roads by colouring them, and to colour woods and forests, but I do not advocate going much beyond this. It is difficult to choose colours which are suitable, distinctive, and harmonious, and the more numerous the colours used the greater the difficulty of doing so.

Colour-printing introduces possible sources of error. Colour maps are based on a drawing on which all detail to appear on the map is shown. A plate is prepared for each colour on which there should be only such detail as shall be printed in its particular colour. In preparing this plate there is a risk that detail which should appear may be omitted, or that detail be inserted which should be on another plate, or that the detail may be slightly out of position. Again, owing to change of temperature and to the varying amount of moisture in the air, paper contracts or expands. Registration can rarely be mathematically correct, and with every care may sometimes be appreciably out. While with care errors such as I have indicated can be minimised so as not appreciably to affect the map, it is difficult to ensure that they should be altogether absent.

To recapitulate my views, I advocate for a topographical map a scale between $\frac{1}{62500}$ and $\frac{1}{126720}$ (½ inch to a mile), according to circumstances. The scale of survey to be double that of the finished map; ground forms to be shown by contours reasonably close together, the exact interval depending on the scale of the map and the nature of the country, also, if funds are available, by vertical hachures; both contours and hachures, if shown, to be in colour, the same colour being used for both. If considerations of time and cost do not admit of reproduction by engraving on copper, the map to be reproduced by some photographic method and printed in not more than five colours. I put forward these opinions rather as a basis for consideration than as having special weight in themselves. With the increasing recognition of the importance of geography an increasing demand for maps is sure to come, and good maps can only be satisfactorily designed after considering the points here discussed.

It is not yet, I think, generally recognised that a really good topographical map, based on triangulation, may be produced on a scale of about ½ inch to the mile at very moderate expense if unimportant detail is left out and survey and reproduction carried out as economically as possible. Such a survey has recently been carried out in the Orange River Colony, a country mainly agricultural with generally poor land. There must be few parts, other than barren and mountainous regions, under settled government where such a survey would not be of value. I believe that in future still further economy in surveying and mapping will be attained, and this will stimulate the undertaking of fresh surveys.

Meeting, as we are privileged to do this year, in Canada, I should like to say a few words on the surveying and mapping of the Dominion. Until recently the only maps published have been on very small scales and have shown no ground forms. During the last few years, however, a regular topographical survey has been undertaken by the Militia Department. I am glad that for this topographical survey the scales of 1 inch and ½ inch to the mile, both standard scales in Great Britain and Ireland, have been adopted. They are, in my opinion, suitable scales for Canada, and it is to be hoped that for any new mapping within the British Empire these or similar scales may be adopted as they have been in many parts. Uniformity in scales is very desirable.

Without committing myself to praise in every respect of the maps prepared by the Militia Department, I may say that they appear to me excellent, well-executed maps. Not many sheets have yet been issued, and they are probably not yet well known even in Canada; but I have little doubt that when known their value will be appreciated, and that the area mapped will be rapidly extended. There are no doubt large areas in Canada for which a smaller scale than 1 inch will suffice, but there can be few, except waste and barren regions, for which maps on some scale will not be needed. To a country like Canada, which has made wonderful progress already, and which has a great future before it, adequate mapping must be of importance, specially so in view of the vast area of the country. I have misread the character of the Canadian people if they will be content with any except first-rate maps for the whole settled area of the Dominion.

I should like to have said a few words on the aid which good maps give to geographical education, but my address is already too long. I will only say that while good maps and geographical education are of use to all countries, they are of special value to the British Empire, the different parts of which are geographically so scattered, but which are so closely bound together by common ties of kinship, interest, sentiment, and loyalty.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE issues of the *Lancet* for August 28 and *British Medical Journal* for September 4 are "educational" numbers, and give full information for those desirous of entering the medical profession and of the various services with medical officers attached.

A NEW mathematical professorship has been created, we learn from the *Revue scientifique*, in the University of Paris with the title of the Chair of the Theory of Functions. Prof. E. Borel has been appointed to the new post, which brings the number of mathematical professors in the University up to twelve.

A CIRCULAR from Principal Miers announces that an Appointments Board has been constituted by the University of London. The terms of reference to the Board are "to assist graduates and students of the University in obtaining appointments, and to coordinate and supplement the work done by the schools and institutions of the University with this object." The aim is to encourage the selection of university men for all posts in the work of which the possession of a university training on scientific methods is an advantage. The Board wishes to assist graduates to find employment, and to assist employers to find, in the university ranks, suitable men for vacancies.

AMONG the names of the distinguished persons upon whom the University of Birmingham has decided to confer the honorary degree of Doctor of Laws by way of commemorating the recent Royal visit, we notice the following:—Mr. W. N. Atkinson, H.M. Superintendent Inspector of Mines, South Wales; the president of the Royal College of Surgeons; Sir William Crookes, F.R.S.; Mr. Maurice P. Fitzmaurice, C.M.G., chief engineer to the London County Council; Sir Archibald Geikie, K.C.B., P.R.S.; Mr. Haldane, F.R.S.; Dr. J. S. Haldane, F.R.S., reader in physiology at the University of Oxford; Sir A. B. W. Kennedy, F.R.S.; Sir Joseph Larmor, F.R.S., Lucasian professor of mathematics in the University of Cambridge; Sir R. D. Powell; Sir William Ramsay, K.C.B., F.R.S.; Lord Rayleigh, F.R.S.; Prof. E. Rutherford, F.R.S., professor of physics in the University of Manchester; Prof. Silvanus P. Thompson, F.R.S.; Dr. W. A. Tilden, F.R.S.; Sir J. J. Thomson, F.R.S.; Mr. C. S. Tomes, F.R.S.; Dr. T. Herbert Warren, Vice-Chancellor of Oxford University; and Dr. B. C. A. Windle, F.R.S., president of Queen's College, Cork. The degrees are to be conferred on October 20.

THE calendar for the session 1909–10 of the Manchester Municipal School of Technology shows how thoroughly the education committee of the city has, by the courses of instruction sanctioned in the school, met the requirements of the industries of south-east Lancashire, of which Manchester is the commercial centre. A prefatory statement to the calendar points out that the object of the school is to provide instruction and training in the principles of science in their application to the industrial arts, with the view of a right understanding of the foundations upon which these arts rest, and to promote their effective development. The essential aim of the instruction is the training of faculty through a systematic course of sound theoretical study, and the development of resourcefulness and habits of self-reliance by means of an exact, thorough, and progressive course of laboratory and shop work, so as to prepare the student after due experience for positions of responsibility. Courses of three years' duration have been arranged, for day students of sixteen years of age and upwards, in each of the following branches of technology:—mechanical engineering; electrical engineering and technical physics; municipal and sanitary engineering; applied chemistry in each of the six aspects—general chemical technology, chemistry of textiles, manufacture of paper, metallurgy and assaying, brewing, and electrochemistry; manufacture of textiles; photography and the printing crafts; and architecture and the building trades. It is interesting, in view of the distinguished success with which the work of the school has been crowned, to direct attention to the fact that the subcommittee which administers the school consists of three classes of members, viz. representatives from the city council, members representative of educational and other institutions of various grades, and co-opted members consisting of men distinguished in the district for their knowledge of manufactures or science.

ATTENTION has often been directed in these columns to the amount of State aid provided for the purposes of university and other higher education in this country. It has been pointed out repeatedly that the financial assistance forthcoming from the Treasury in this direction compares very unfavourably with the sums of money provided for similar purposes by the Governments of other great countries. An examination of the Civil Services Estimates for the past eleven years shows, however, that there has been a steady increase year by year in the annual amounts voted by Parliament for higher education. The total amount for this purpose for the financial year 1899–1900 was 108,338*l.*, made up as follows:—universities and university colleges of Great Britain, 85,000*l.*; the Royal College of Science, London, 18,388*l.*; and Queen's Colleges in Ireland, 4950*l.* In 1905–6 the total amount had increased to 201,773*l.*, allocated thus:—universities and university colleges of Great Britain, 174,000*l.*; the Royal College of Science, London, 22,723*l.*; and the Queen's Colleges in Ireland, 5050*l.* For the present year the total amount has grown to 215,700*l.*, the items under the respective headings being 191,000*l.*, 20,000*l.*, and 4700*l.* The grant in aid of *Scottish* universities (included under Great Britain) is 42,000*l.*, which is in addition to an annual sum of 30,000*l.* payable to these universities from the Local Taxation (Scottish) Account. The local education authorities in England and Wales give grants amounting to about 100,000*l.* annually to universities and university colleges. It may be said, therefore, that roughly the State grants in aid of universities and colleges in Great Britain amount now to nearly 220,000*l.* annually, and the local taxation grants to about 130,000*l.*, making an annual sum of about 350,000*l.* It is instructive to point out in connection with the amount thus arrived at that the total for grants in respect of public elementary schools in England and Wales in connection with the Board of Education amounts for the present year to 11,162,405*l.*, and that 555,000*l.* is paid for the training of teachers, 791,800*l.* to secondary schools, and 537,505*l.* in connection with technical institutions, schools of art, and evening schools.

IN an article on the position of higher education published in the issue of NATURE for July 22 (vol. lxxxi., p. 113), attention was directed to an article by Prof. Guido H. Marx on the remarkable growth and spread of interest in higher education in various countries. The opportunity was taken on that occasion to point out that Prof. Marx's figures, so far as the numbers of students in institutions of university standing in Great Britain are concerned, were not quite trustworthy. Referring to this article by Prof. G. H. Marx, Prof. B. Menschutkin, of St. Petersburg, writes to correct the statistics given in respect of Russia. He says:—"The statistics with regard to Russia (23,000 students) are very antiquated. This number of students was reached some fifteen years ago, but at present the students of the higher colleges number at least about 77,000, as can be seen from the following data, showing how many students there were in the different institutions in 1908 (in some cases, as for St. Petersburg, the numbers refer to the present year):—

St. Petersburg (University 9800, Academy of Law 350, Philological Institute 150, Medical Academy 800, Technological Institute 2000, Polytechnik Institute 4200, Institute of Ways of Communication 1200, Institute for Engineers 700, Electrotechnical Institute 650, Mining Institute 650, Institute of Forestry 550, the three higher colleges for women 6000, Lyceum and three Military and two Nautical Academies 1200, Academy of Theology 300), 28,550; *Moscow* (University 9000, Institute of Oriental Languages 150, Academy of Theology 200, Technical Institute 2500, Agricultural Institute 850, Engineering Institute 550), 13,250; *Kharkov* (University 5300, Technological Institute 1200, Veterinary Institute 500), 7000; *Kiev* (University 3200, Academy of Theology 200, Polytechnic Institute 2500), 5900; *Kazan* (University 3000, Academy of Theology 170, Veterinary Institute 430), 3600; *Tomsk* (University 800, Technological Institute 1900), 2700; *Warsaw* (University and Polytechnic Institute), 1500; *Odessa* (University), 3300; *Novocherkask* (Polytechnic Institute), 700; *Yuryev* (Dorpat) (University 3000, Veterinary Institute 350), 3350; *Helsingfors* (University 2400, Technical College 350), 2750; *Riga* (Polytechnicum), 1700; *Novaya Alexandria* (Agricultural Institute), 400; *Yaroslavl* (Lyceum), 1050; *Yekaterinoslav* (Mining Institute), 500; *Něžin* (Philological Institute), 150; *Saratov* (University, established this year), 200; *Vladivostok* (Institute of Oriental Languages), 300. The total number is therefore 76,900. There are also many *private* higher colleges in different towns, the number of students of which it was impossible to ascertain; it is surmised that this number is about 20,000."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 30.—M. Bouchard in the chair.—The improvement of the theory of partial equations of the first order: N. **Saltykow.**—A demonstration of the phase rule: M. **Boulouch.** A criticism of the demonstration of the phase rule by M. Müller, in which thermodynamical considerations are excluded. The author regards some of M. Müller's assumptions as unjustifiable.—The hydrolytic dissociation of bismuth iodide: René **Dubrisay.** The effects of temperature and dilution have been studied. Two oxyiodides have been shown to exist, the red compound being BiOI; the second black oxyiodide gives a ratio of bismuth to iodine corresponding to $Bi_2O_3 : 5HI$.—A simplified method and apparatus for determining the calorific power of gaseous combustibles: P. **Lemoult.** The method is based on the fact that the combustion of molecular proportions of hydrogen and oxygen or carbon monoxide and oxygen gives nearly the same heat evolution, and after absorption of carbon dioxide formed in the latter case, the contractions are the same. If carbon monoxide, hydrogen and methane are present, the contraction (*a*) after combustion and absorption of CO_2 is measured, and also the oxygen consumed (*b*). The approximate calorific value is $P = 0{\cdot}914a + 3{\cdot}405b$.—The pseudopolychroïsm of sphærolites: Paul **Gaubert.**—The extension and retrogression of the virgin forest of tropical Africa: Aug. **Chevalier.**—The Mesoplodon of la-Hougue (November 2, 1908): R. **Anthony.**—The proof of experimental ammoniuria in epilepsy: J. E. **Florence** and P. **Clément.** Ammonium acetate, administered in 4-gram to 6-gram doses, is in healthy individuals excreted mainly as urea. In epileptics under the influence of bromides the method of elimination is similar; in epileptics not under bromide treatment a marked elimination of ammonia coincides with the very frequent attacks.—Alcoholic fermentation in presence of sulphurous acid: P. **Martinand.**—The specificity of oxydases: J. **Wolff.**

NEW SOUTH WALES.

Royal Society, June 2.—Mr. H. D. Walsh, president, in the chair.—A pitchblende probably occurring in New South Wales: T. H. **Laby.**—The viscosity of water: R. **Hosking.**—A contribution to the experimental study of the large ions in the air: S. G. **Lusby.**—The mobility of the large ions in the air: Prof. J. A. **Pollock.**—"Lope de Vega": L. **Hargrave.**—Note on the determination of the free acid in superphosphates: F. B. **Guthrie** and A. A. **Ramsay.**

July 7.—Mr. H. D. Walsh, president, in the chair.—Description of a new hæmoprotozoa from birds in N.S. Wales: Dr. J. B. **Cleland** and T. H. **Johnston.**—A new melanin-producing hæmatozoon from an Australian tortoise: T. H. **Johnston** and Dr. J. B. **Cleland.**—A new reptilian cestode: T. H. **Johnston.**—The discrepancy between the results obtained by experiments in manuring, &c., in pots and in the field: L. **Cohen.**

Linnean Society, July 28.—Mr. C. Hedley, president, in the chair.—New Australian Lepidoptera belonging to the family Noctuidæ: Dr. A. J. **Turner.** One genus, and twenty-five species referable to twenty-two genera, are described as new, and new habitats are recorded for a number of species previously known.—Notes from the botanic gardens, No. 14: J. H. **Maiden** and E. **Betche.** Three species, referable to the genera Halorrhagis, Bæckea, and Olearia, are described as new; *Rutidosis leiolepsis*, F. v. M., *Ageratum conyzoides*, L., *Prunella vulgaris*, L., var. *laciniata*, Benth., *Gleichenia flagellaris*, Spreng., *Angiopteris erecta*, Hoffm., and *Cassytha filiformis*, L., are recorded as new for New South Wales; it is suggested that *Acacia Dorothea*, Maiden, should be transferred from the Uninerves to the Juliflorae; and notes on, or new records for, certain rare or interesting plants are appended.—Studies of the life-histories of Australian Odonata. No. 2. The life-history of *Diphlebia lestoïdes*, Selys: R. J. **Tillyard.** The genus Diphlebia contains the only Australian representatives of the family Calopterygidæ. The discovery of the larva is of great importance to ontogenists. The ova were found in the tissue of water-weed one foot below water, the female having deposited them by descending the reed under protection of an air-film. Larvæ were successfully hatched out in October, and some of them were kept until March. In November four exuviæ were found clinging to rocks in the stream-bed of the Rodriguez Pass, at Blackheath. The larva is of most remarkable form, quite unlike any other calopterygid larva known, and having some points in common with agrionid larvæ. It must be regarded, not as a synthetic type, but as a highly specialised and successful development from the main calopterygid stock, such development having taken place on lines parallel to that of the agrionid type.—Some hæmogregarines from Australian reptiles: T. H. **Johnston.** Four Australian species of Hæmogregarina have been described. Three additional species, from snakes or from a tortoise (Chelodina), are described as new, and some observations on *H. shattocki*, Samb. and Seligm., are offered.—The influence of the dilution of serum upon the phagocytic index: Dr. R. **Greig-Smith.** Several factors have each an influence in modifying the nature of the curve representing the opsonic and phagocytic effects obtained upon progressively diluting normal serum. It would be possible to obtain the phagocytic indices so that their ratios lie upon a straight line, by using a 1·0 per cent. to 1·1 per cent. solution of sodium chloride for making the dilutions and suspensions. With weaker strengths of normal saline the curve rises above, and with increased strengths it falls below, the straight line. The thickness of the bacterial suspension, the nature of the phagocytes, and the time of incubation influence the results, and have to be taken into account.

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