THURSDAY, DECEMBER 14, 1899.

THE HISTORY OF GEOLOGY.

Geschichte der Geologie und Paläontologie bis Ende des 19.Jahrhunderts. Von Karl Alfred v. Zittel. Pp. xi + 868. (München und Leipzig: Druck und Verlag von R. Oldenbourg, 1899.)

WHEN the illustrious author of the "Handbuch der Palæontologie" undertook to write this history of geology and palæontology, he entered upon no light task, for special difficulties must attend the labours of any author who, in bringing together material to illustrate completely the rise and development of these wide-embracing sciences, would produce a volume acceptable to professionals and laymen alike. For such a task as this Prof. Zittel, by his wide scholarship and long experience as a teacher, no less than by his acquaintance with an abundant special literature and his proficiency as a linguist, is eminently qualified; and the work before us amply shows those evidences of patience, thoroughness, and indefatigable zeal, which have characterised the previous literary undertakings of its author. Some idea of the labour involved in the preparation of this volume may be gained from the fact that upwards of 2000 authors receive mention in its pages: it may be doubted indeed whether a single writer whose work has had important bearing on the development of geology in its various branches has been overlooked, while many, the significance of whose labours is unquestionably small, are here accorded recognition. As stated in the author's prefatory remarks, the original scope of the work, which was primarily intended to comprise a history of geology in Germany, was subsequently extended, in accordance with the necessity of treating from a wider standpoint the development and progress of a study to the growth of which all civilised nations have contributed.

The difficulties of expediently arranging so vast an amount of material as that embodied in this work have been perhaps most aptly met by the general plan, chronological and categorical, here adopted. The book is divided into four main sections, each dealing with a given period in the history of the science; and while these periods are of very unequal length, their limits have been so chosen that the mass of detail dealt with under more special headings may be advantageously grouped, thus enabling the reader to obtain the more readily a connected idea of the successive advances made in the study of the subject in its various departments.

The first section, comprising only a few pages, is principally devoted to the works of the ancient Greeks and Romans, and it is clearly shown in what small degree the labours of these early writers have furnished sound foundation for the development of geology in later times. In a short introduction to the second section the author points plainly to those causes which for so many years effectually retarded the progress of scientific thought and discovery, and gave rise to that intellectual lethargy which only became dissipated at the close of the middle ages. The early opinions regarding the nature of fossils, the origin and history of the earth, and the phenomena of volcanoes and earthquakes, are then successively discussed; and it may be well to indicate here the method adopted by the author in dealing with the work of the numerous observers and writers in these various branches of the subject, for the manner of treatment here employed is more or less closely adhered to throughout the succeeding portions of the book. For the most part under special sub-headings, the work of successive contributors to the science, when the names of these are deserving of more than mere mention, is concisely and impartially summarised, and numerous useful biographical footnotes have been appended. In many cases criticism is totally withheld, and the treatment of the material is in great measure purely objective. In illustration of the thoroughness and impartiality with which the author has carried out his work, we note the space accorded in this second period not only to writers such as Steno, Lehmann, Füchsel and Guettard, whose work has marked important points of progress in these earlier days of geological science, but also to others—for example, Fallopio, Burnet and Justi—whose almost valueless efforts consisted so largely in the proposal of wildly fantastic theories.

The third section, under the happily chosen title "Das heroische Zeitalter der Geologie von 1790 bis 1820," deals with a period which was witness of such remarkable activity in the study of geology; a period during which, indeed, the foundations of the science as we know it to-day may be said to have been laid. Here are to be found some of the most fascinating pages in the book, and the sketches of Saussure, Werner, v. Buch and Humboldt may be cited as examples of apt and terse delineation. But in a work of such wide scope as the one before us, brevity must of necessity characterise the condensed accounts in which are set forth the achievements of these and of other men whose influence has left its indelible mark in the onward march of the science, and we must not look for that degree of fulness and literary embellishment to be found in works of narrower limits, as, for example, in the admirable sketches furnished by Sir Archibald Geikie in his "Founders of Geology." If, in Prof. Zittel's account of Werner and his work, we perceive a certain reluctance to estimate at its true value the detrimental effect produced for a time by the hotly promulgated and falsely based theories of that influential teacher, we speedily find compensation in the eulogistic narratives of Hutton and Playfair, whose philosophical ideas were so effectually opposed to the baneful dogmatism of the Freiberg school.

The development of stratigraphy during this period is dealt with at considerable length, and the progress made in each country receives separate treatment. Prominent amongst the many workers whose labours here find ample record are Freiesleben, v. Buch, Ebel, Brongniart, Cuvier and William Smith. The early development of petrography is then traced, and the views held respectively by the neptunists, vulcanists and plutonists are briefly discussed. In following the progress of palæontology during this time, the author first draws attention to works of a more general character, such as those of Schlotheim, Defrance and Parkinson, and then proceeds to indicate the advances made by the publication of more special work confined to the consideration of single classes

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of animals. With the exception of the important labours and influence of Cuvier, to which both merited tribute and critical consideration are here accorded, this portion of the subject is dismissed with a scantiness of treatment that is somewhat disappointing. In this work geology and palæontology are dealt with together, in correspondence with the fact of their close association and concurrent development, for it is only of comparatively recent years that the study of palæontology has come to be rightly regarded in its true relation to that of zoology.

Fully three-quarters of the volume are occupied by the fourth section, dealing with the newer development of geology and palæontology, and for convenience of treatment the large mass of material here to be incorporated is divided into seven chapters. In the first three of these the more recent advances in the study of cosmic, physiographical and dynamic geology receive careful and detailed attention. In the third chapter we are presented with an excellent summary of the work of Lyell; while from a good epitome and brief criticism of Suess's "Antlitz der Erde" we learn in what high estimation that work is held by Prof. Zittel. The chapter on the development of dynamic geology is throughout exhaustive; but in attempting to give credit to the work of so many contributors, the author must often impose a tax on the attention of his readers. This will be noticeable, indeed, in all these later chapters of the book, when the historian has approached a period in the development of the science marked by an ever-increasing prolificacy in the production of special publications, and as a result of this effort to give recognition to a legion of authors great and small, the pages show a tendency to become burdened with the mere lists of names of many who have contributed to our knowledge in the respective branches of the subject. A chapter devoted to topographical geology, in which the most prominent position is accorded to Germany, gives useful information regarding the growth of geological surveys.

The three concluding chapters deal with the more recent development of stratigraphy, petrography and palæontology. In tracing the growth of stratigraphy, the several geological systems are separately treated, and the Triassic System is dealt with at greatest length. The development of study in the Alpine Trias here finds a prominent place, and in this connection it is noteworthy that Prof. Zittel, even when recounting the progress of a recent warmly-conducted polemic discussion on a question of nomenclature, has succeeded in preserving neutrality. Chapter vi. furnishes a brief though comprehensive account of the later development of petrography, in which the principal work of recent years, for the most part without criticism, is recapitulated.

The volume concludes with an account of more recent labours in palæontology, but it must be with a feeling akin to disappointment that we complete the perusal of this portion of the work. In a chapter dealing with that subject in which Prof. Zittel has acquired his well-merited reputation as the leading authority, the method and fulness of treatment fall below our expectations. The endeavour to refer, though it be by mere mention, to so much that has been of recent years accomplished in this department, and this at the risk of reducing a certain proportion of the text to the character of a mere compendium of authors' names, is here too plainly apparent. By this objective presentation of details the author must in great measure forfeit that interest which a broader and more critical treatment would have commanded.

Great care has been bestowed in editing this work, and such errors as the misspelling of the name "MacCulloch" on p. 165, and the omission of two reference numbers on p. 793, are of rare occurrence. Carefully quoted literature references have been appended, on the whole, with sufficient liberality; but the author's apology for devoting so much space to this purpose appears superfluous, and it must be obvious, especially when looked at from the student's point of view, that frequency in referring to original sources of information can only enhance the value of a book of this kind.

Little need be added in recommendation of this comprehensive work; the terse and lucid style of its author will commend it to English readers. By the completion of his arduous task, Prof. Zittel has well supplied a long-felt want, and all who interest themselves in the study of geology, towards the development of which Great Britain has so conspicuously contributed, will warmly welcome the appearance of this volume from the pen of one who takes rank among the ablest living expounders of a noble science.

F. L. K.

THE FLORA OF NEW ZEALAND.

The Student's Flora of New Zealand and the Outlying Islands. By Thomas Kirk, F.L.S. A Fragment. Pp. vi + 408. Large 8vo. (Wellington, N.Z., 1899.)

List of the Genera and Species of New Zealand Plants. By A. Hamilton. (Wellington, N.Z., 1899.)

IT was well known in botanical circles that the late Prof. Thomas Kirk, of Wellington, New Zealand, who died about a year ago, had long been engaged in the preparation of a comprehensive, descriptive, and illustrated work on the flora of that country; and it was a great disappointment when it transpired that he had left his work in an unfinished state, because it was felt that it would be extremely difficult, perhaps impossible, to find another botanist so well qualified for the task. Prof. Kirk spent some thirty years of his life in the investigation of the flora of his adopted country, and his various writings thereon betoken the careful and accurate botanist. From time to time he published the new species discovered by himself and others; but his fully illustrated "Forest Flora of New Zealand" gave evidence of the extent of his knowledge of his subject. A more remarkable and, in a scientific sense, a more important contribution to the botanical literature of New Zealand is contained in an address delivered before the Philosophical Society of Wellington, N.Z., a few years ago (see *Transactions* of the New Zealand Institute, vol. xxviii.). In this address he dealt with the "Displacement and Replacement of the Native Vegetation of New Zealand" in such a manner as to be of permanent value to science. He has there put on record facts connected with the introduction and colonisation of exotic plants in New Zealand that positively throw a new light, and suggest new ideas, on the present distribution of plants in cultivated countries generally. Fortunately the botanical investigation of New Zealand was begun before its settlement by Europeans; and it has been continued by a small band of them with such ardour and exactitude, that future workers in the field have a substantial foundation to build upon. In the absence of authentic records, the present conditions in the vegetation of the country could not have been understood. Kirk estimated that about 500 exotic species of plants had become more or less completely established in New Zealand; and they are spread all over the country, from the sea-coast almost to the altitudinal limits of vegetation. But the most surprising part of it is the extent to which vigorous native plants have been displaced by comparatively delicate foreigners; and it would indeed be incredible in the absence of indisputable evidence. However, I must not pursue this subject here, and I have only alluded to it in connection with the plan and scope of the fragment of Kirk's "Flora" before me. The Government wisely decided to publish so much of this work as was printed off, or ready for the printer, at the time of the author's death. This contains the natural orders Ranunculaceæ to Compositæ, in the sequence of Bentham and Hooker's "Genera Plantarum"; and its value only makes one wish that the author had lived to complete it. Perhaps the only serious criticism one could fairly bring to bear upon the work before having had considerable practical experience in using it for the determination of species, is its size and weight, which would preclude its being used in the field. Rather less than half of the known flowering plants (671), and 260 introduced plants, are described on some 360 pages. Completed on this scale it would make, with glossary, index, &c., at least 850 pages. By using a smaller type with less spacing, and a lighter paper, it would be possible to reduce the book to pocket dimensions. This objection has been raised here, because we believe the New Zealand Government is making arrangements with another botanist to write a complete Flora.

It might be suggested that the introduced plants should be left out; but, considering that they constitute something like a third of the number of species occurring in a wild state, that some of them are dispersed from one end of the islands to the other, and that in some districts or localities introduced plants preponderate, it is as absolutely essential that they should be included as that the European element should figure in any account of the present inhabitants of New Zealand. To begin with, the young student cannot distinguish between the introduced and indigenous elements. To the beginner, one is as good as the other, and, as a matter of knowledge, to know the one is of as much importance as it is to know the other; and we think it would be a grave mistake to exclude the foreign element from a book treating of the flora of the country. Kirk gives less detailed descriptions of them, and prints them in a smaller type, so there is no difficulty in distinguishing between the two.

When we come to consider the question, "What have the discoveries made since the publication of Sir Joseph Hooker's 'Handbook of the New Zealand Flora,' in 1864, added to our knowledge of phytogeography?" the answer must be "next to nothing." Perhaps the most interesting thing in this connection is the discovery of a number of Tasmanian species, especially on Stewart Island, in the extreme south. The outlying islands, such as Macquarie, Antipodes, and the Kermadecs, have been more fully explored; but the results merely go to strengthen the previously conceived idea that the highest southern vegetation, like the highest northern, is very much the same all round the world.

With regard to botanical discoveries in New Zealand since 1864, it may be truly said that they are of comparatively little interest. Only one new generic type (*Tetrachondra*) of a really distinct character has been found, and this is a minute herb, having the habit of *Tillaea*. It is of anomalous structure, and has been provisionally placed in the Boraginaceæ, though it has opposite leaves. Two new genera have been proposed for species formerly referred, in part, at least, to the curious leguminous genus *Carmichaelia*. The differential characters are chiefly in the form of dehiscence of the pods. Perhaps the very rare and imperfectly known *Siphonidium*, allied to *Euphrasia*, deserves generic standing, but it is almost certainly a congener of Hooker's section *Anagosperma* of *Euphrasia*, which has recently been raised to generic rank.

Coming to species, it is true that the number has been nominally increased by upwards of one-third. In other words, more than 500 species of flowering plants have been proposed in addition to the 935 described by Hooker; but of these probably not less than a third will prove untenable. For instance, in *Olearia*, Kirk retains thirty-four species, and reduces a dozen of the so-called new ones. As compared with what was previously known, there are few striking plants among the recent discoveries. The majority of the new species belong to such familiar genera, of almost world-wide range, as *Ranunculus*, *Epilobium*, *Senecio*, *Veronica* and *Carex*, and to such characteristic Australasian genera as *Coprosma*, *Olearia*, *Celmisia*, *Carmichaelia* and *Astelia*. Among Australian genera, not previously found in New Zealand (as distinguished from Australasian), new or old species have been recorded of *Actinotus*, *Liparophyllum*, *Caleana* and *Calochilus*.

I have not entered into strict criticism of the late Prof. Kirk's work, because, had he been spared, he might have corrected errors and made good many omissions; but I may mention that the derivation of generic names is partially given; the same of the native countries of introduced plants; several published names have been overlooked; and a key to the species of *Oxalis* is wanting.

The illustrations referred to in the opening sentence of this notice are to be issued in a separate volume. They will include the unpublished Banksian copper-plates of New Zealand plants, kindly placed at the disposal of the New Zealand Government by the Trustees of the British Museum. I may note in this connection that the Trustees have now made provision for the reproduction of the whole of the valuable collection of plates, about 700 in number, engraved at the expense of Sir Joseph Banks, but never printed; and illustrating the botany of Cook's voyages.

In conclusion, I may add that Mr. Hamilton's list of the flowering plants will be found useful, as it contains references to the place of publication, mostly in the

Transactions of the New Zealand Institute. In consequence of the want of a good botanical library, some species described in European publications are not included.

W. Botting Hemsley.

ENCYCLOPAEDIA BIBLICA.

Encyclopaedia Biblica. Edited by Rev. T. K. Cheyne, D.D., and J. S. Black, LL.D. Vol. i. A to D. Pp. xxviii + 572. (London: A. and C. Black.)

IN this work we have an illustration of the fact that similar ideas spring up contemporaneously in different minds. In the same year in which Dr. Hastings' "Dictionary of the Bible" reaches its second volume extending to the letter K, we have the first volume of the work here under review issued to the public. Both have their source and publishers in Edinburgh, testifying to the high interest which Scotland has ever shown in Biblical criticism and Biblical subjects. To us it appears that both works are very much on the same lines, though the writers of the articles are for the most part different, and include those of other nationalities besides British. It would be difficult to say why one of these works takes the title of an "Encyclopædia" and the other of a "Dictionary," as the articles in both are equally elaborate and comprehensive. Perhaps, in the case of the latter, the idea of a dictionary, as first contemplated, gradually expanded in the minds of the editors, and under force of circumstances, till it became merged in that of an encyclopædia; the more recent work has had the advantage of starting with the more ambitious title. Both works, however, have had their origin in the late Dr. Smith's invaluable "Bible Dictionary," which for many years past has been a companion to students of Holy Scripture. But so great has been the advance in the critical study of the sacred pages, as well as in our knowledge of Bible lands, for which we are largely indebted to the labours of the committee of the "Palestine Exploration Fund," that a new work embodying these investigations has become a necessity which the authors of both the Dictionary and Encyclopædia have endeavoured to meet.

In looking over the subjects bearing upon natural history and topography within the compass of this volume, extending to the letter D, we observe little that requires criticism. The word "adamant" is considered to be corundum rather than the diamond, which was unknown out of India till the time of Alexander's successors; at the same time it is not impossible that the stone translated diamond in Exodus xxviii. may have been simply quartz, or rock crystal, which is inferior in hardness to either corundum or the diamond, and, therefore, capable of being engraved with the name of one of the tribes. Needless to observe that the rendering into Greek, Latin or English of the precious stones of the Old Testament will ever be attended with much uncertainty.

The description of the Dead Sea by Prof. Gautier is lucid and correct as regards its present condition; and we are glad to observe that he gives no countenance to the view that the waters of the Jordan once ran into the Gulf of Akabah, which would have required that their surface n the position of the Dead Sea must have risen, not only to the level of the Red Sea and Mediterranean, which was the case, but higher by about 650 feet; of this supposed high level there is no evidence in the form of old terraces in the Arabah Valley, as is the case with regard to the Mediterranean level. The geological changes which have brought about the formation of the Dead Sea basin may be looked for in a future volume, under the head of Palestine.

Under Deluge the various myths and legends found in countries widely separated are related in much detail by Dr. Cheyne and Prof. Zimmern. That the Hebrew tradition, as contained in Genesis, had its origin in Babylonia there can be no doubt, as the late Mr. George Smith has shown in his remarkable work, "The Chaldean Account of Genesis" (1876). But the question still remains to be decided—whether the original story had its origin amongst a myth-generating people or in the tradition of an actual physical catastrophe, such as a great inroad of the sea due to subsidence of the land in prehistoric times. This latter is the view taken by Lenormant in "Les Origines de l'Histoire," supported by Sir J. William Dawson, and more recently by Sir Joseph Prestwich. The Biblical story of the Deluge is necessarily restricted to the Euphrates Valley; but the more widely extended tradition seems to imply a more extended region wherein there was a submergence of the lands during the human period. Of such submergence we have ample evidence in many countries, including the British Isles, Northern Europe and Scandinavia, the Nile Valley, and Western Palestine. Such movements have left their vestiges in the high-level gravels with existing shells, and are certainly of more recent date than the early Glacial stage, the close of which may be assigned as the age of man. According to Dawson, this subsidence of the land after a period of high elevation brought about the extinction of palæocosmic man, an inhabitant of caves, and a mighty hunter before the Lord, like Nimrod. We must beware of watering down what is really founded on a historic basis in the Bible into legend. When we find the patriarch Abraham treated "not so much an historical personage as an ideal type of character, on the ground of the 'dreamy, grand, and solemn' impression which this patriarch makes upon us," we may well pause and ask whether this process of idealism is to extend to succeeding characters, such as Isaac, Jacob, Moses, David and the rest; and whether the whole of the Old Testament is not to be regarded in the same light as the "Æneid," the "Odyssey," or "Paradise Lost"? We protest against this extravagance of criticism. Whatever may have been the mythical origin of the earlier chapters of Genesis, the historical narrative clearly commences with the call of Abraham, and the history of that "grand personage" claims to be treated with as much scrupulous deference as any personality of ancient history. As Prof. H. E. Ryle observes—

> "the endeavour to find in Abraham's story a philosophical description of abstract qualities seems to presuppose a stage of literary development to which the materials of the Hexateuch can make no claim, and to desiderate a literary unity which those materials emphatically contradict."

With such exceptions as the above the work must be accorded very high literary merit coupled with wide research.

E. H.

OUR BOOK SHELF.

Statistical Methods; with special reference to Biological Variation. By C. B. Davenport, Ph.D. Pp. vii + 149. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1899.)

THIS little volume is a kind of "Molesworth" for the statistical biologist. Some two-thirds of the book are taken up with numerical tables (ordinates of normal curve, probability integral, gamma functions, squares and cubes, logarithms, &c.), a brief introduction, giving an outline of methods and formulæ, occupying only the first fifty pages.

The idea is a good one, and the tables, collection of formulæ, &c., are arranged in a handy form. The introduction should, however, be subjected to revision before the next issue. The sentence on p. 19, "Here x is the actual deviation from the mean expressed in the unit of the maximum," appears to be an abbreviation of "x/σ is the deviation from the mean expressed in the unit of the standard deviation, and y/y_0 the ordinate in the unit of the maximum," or some such sentence. The y_0 on p. 22 should be defined as the ordinate at the origin, not the mode; it is not the modal ordinate, *e.g.*, in Type IV. The methods of measuring correlation do not necessarily depend on the assumption that the frequency-distribution is normal (p. 30). The author does not appear to have fully grasped the physical meanings of correlations and regressions, as he speaks of them as interchangeable (p. 36), for the correlation coefficient always measures the approach towards a single linear law true for every case, and ranges only between ± 1, while the regression coefficient measures the average alteration in one variable corresponding to unit alteration in the other, and may take any value. The word "binomial," on p. 38, appears to be a misprint for bimodal. On p. 33 we notice a lengthy method, quoted from Duncker, given for reducing the product-sum; this should be replaced by the ordinary straightforward process of reduction to the mean. The definition of the probable error, on p. 14, needs revision; it is not a measure of "closeness of approximation to the truth," but of degree of unreliability.

In a subsequent issue the author might reconsider the question of retaining some sections. New and untried suggestions of measurements and indices are, in our opinion, somewhat out of place in a reference pocket-book. These remarks apply to some sections of chapter i. and chapter iii. ("Index of Isolation"), &c., and from the same point of view the brief chapter v. is hardly necessary.

The selection of tables seems very good; the only addition we would suggest is a brief table giving probable errors of the correlation coefficient.

Evolution of General Ideas. By Prof. Th. Ribot Translated by Frances A. Welby. Pp. xi + 231. (London: Kegan Paul and Co., Ltd., 1899.)

PROF. RIBOT is a leading exponent of the newer experientialism which, having mastered the lesson of evolutionist theories, declares for continuity through transformism. All that he writes is lucid and suggestive, and the course of lectures here translated is a characteristic contribution to psychology.

A dissociative act of attention brings some one element in a presentation into high relief, while reducing the rest by impoverishment to a residual form. This is abstraction, and, where we have a fusion of abstracted resemblants, we get generalisation. These processes have three stages: first, that to be found in brutes, infants, and deaf-mutes. With these we have the generic image, best known through the composite photograph. We have what is sometimes called inference from particulars to particulars, and we have analogy. But there is no use of the sign, no method involving substitution. Second, a phase of mean abstraction, where the image is associated with the word, increasing stress being laid as we proceed upon the latter, though it never becomes a pure symbol. Third, a stage of advanced abstraction, where the accompanying perceptual imagery is already symbolic, while at last there is no consciousness of any.

The second stage is introduced by a chapter on speech, which is of some interest. The third is discussed in relation to Prof. Ribot's personal inquiries into types of ideation. When asked for replies within a few seconds as to what they experienced when such terms as "cause" and "animal" were suggested, more than a hundred persons gave answers, of which the visualisation of the printed word, the sound of the spoken word, and alleged vacuity were the farthest from unsymbolic picturing. He seems not to have come across the "Je ne pense qu'en parlant" type. His connection of the *flatus vocis* of extreme nominalism with verbal imagery reminds us of his clever association elsewhere of Berkeley's idealism with visualisation. In his insistance that symbolic or substitutional thought implies the actual existence of that for which it is substituted, he shows the dependence for him of psychological appearance upon a wider psychophysiological reality, and effects the transition to a future treatment of the unconscious. In a further chapter Prof. Ribot traces the development of such concepts in the algebra of thought as space, time, cause. Here, as in his account of the universal as such, he is handicapped by the exclusion of epistemological and metaphysical considerations. A short paragraph would have shown the irrelevance of Kant's apriorism for a psychology such as the present. The notes on metageometry are too short if they are to find a place at all. Some of his terms trespass on other people's rights, *e.g.* "the *logic* of images," "schema." The translation is well done, though probably "experiential" would be better than "experimental" in more than one place.

H. W. B.

Handbook of Optics for Students of Ophthalmology. By Prof. William Norwood Suter, B.A., M.D. Pp. viii + 209. (London: Macmillan and Co., Ltd.)

Optics: A Manual for Students. By A. S. Percival, M.A., M.B. Pp. x + 399. (London: Macmillan and Co., Ltd.)

PROF. SUTER gives a simple and yet clear account of the science of optics, as applied to the most important problems connected with ophthalmology. The study of the eye as an optical system has many points of interest, both for the physicist and for the medical student. In many works on optics only scant consideration is given to this part of the subject, so that the book before us may be said to fill a recognised gap in scientific literature. Its value would have been greatly enhanced, however, if measurements in connection with the various optical constants of the eye had been considered in greater detail. Mr. Shelford Bidwell's researches on the formation of multiple images in certain circumstances, due to the cellular structure of the eye, might have been mentioned with advantage; but it is, perhaps, hardly fair to criticise a book of the dimensions of the one before us for errors of omission. A serviceable index has been provided.

In a few cases, the descriptions might have been improved. Thus, on p. 42, line 7, the expression "the planes perpendicular to the curved surfaces" should read "the planes tangential to the curved surfaces." On p. 37, line 10, the term "centre of the refracting surface" might be altered, with advantage, to the "centre of curvature of the refracting surface." Mathematical expressions such as the following (see p. 44) are likely to cause unnecessary trouble:—

$$AF_1 = \frac{r}{n-1} = F_1$$

where the symbol F_1 is used, in a single formula, to denote both the position of a point on the diagram, and the distance of that point from another point A. With a few such exceptions, however, Prof. Suter's book handsomely fulfils the purpose for which it was written.

The aim of Mr. Percival has been to supply the reader, within reasonable compass, with such a knowledge of optics as would be of use to an ophthalmic surgeon. The author further expresses a hope that mathematical students may find it useful as an introduction to more advanced works on geometrical optics. The subject is treated throughout, from a mathematical point of view, in a manner that leaves little to be desired. An ophthalmic surgeon might possibly prefer to have the subject presented less from the mathematical, and more from the physical point of view; whilst a student of physics would probably wish to see greater prominence given to experimental methods. Lord Rayleigh's investigation on the advantage of stopping out the middle of a lens, in preference to its peripheral region, is not mentioned. Further, the name of Helmholtz is not mentioned in connection with the ophthalmoscope. But the most serious blemish is the total absence of an index; this absence is particularly damaging to a book which, from its nature, should serve as a work of reference. The type and general structure of the book are otherwise admirable. A few sentences, such as the following, could be improved:—

"The *first principal focus* (F_1) is the point on the principal axis where the incident rays intersect, or would intersect if produced, which emerge from the system parallel to the axis" (p. 253, lines 6-9).

"The two nodal points are mutually the image of each other" (p. 253, lines 30-31). E. E.

A Practical Introduction to the Study of Botany; Flowering Plants. By Prof. J. Bretland Farmer, M.A. (London: Longmans, Green and Co., 1899.)

PROF. FARMER'S work is that of an expert dealing with a science with the details of which he is thoroughly familiar, both as a student and as a teacher. Its pages show the firm grasp that enables him to make clear even abstruse parts of the science, and that gives confidence to those who use the book with the care and close attention that it deserves. The plants employed as examples are excellently selected, and the necessity of verifying each point described upon the plant itself is constantly enforced. The discipline and information gained by any one that works honestly through the course of study here planned out will be found most valuable as a sure base on which to build up a thorough knowledge of botany. The woodcuts are good, but might have been more numerous with advantage to those that use the book without the aid of a teacher. In the absence of figures a beginner may, if unaided, find it difficult to obtain some of the plants named, though the selection has been very largely made from species that ought to be known to most people of ordinary education. The use of technical terms is restricted within due limits, and their meanings can be gathered from the examination of the specimens in connection with which each is first employed. The procedure to be followed in the examination of the specimens and in the experiments in physiology is simply and clearly explained, though here and there one meets with evidences of haste or pressure.

Primeval Scenes; being some Comic Aspects of Life in Prehistoric Times. By Rev. H. N. Hutchinson, B.A. Illustrated by J. Hassall and F. V. Burridge. (London: Lamley and Co., 1899.)

THE drawings in this volume are similar in character to the amusing "Prehistoric Peeps" contributed to *Punch* by Mr. E. T. Reed a few years ago. In preparing his drawings, Mr. Reed worked to produce striking effects; and as there is artistic as well as poetic licence, he was justified in introducing into his pictures any objects which would appeal to the sense of the ludicrous. But to the mind of the palæontologist, a picture containing prehistoric humans in company with such old forms of life as Pterodactylus and Stegosaurus, and creatures which had their origin in the artist's imagination, appears a trifle grotesque, though it may afford amusement to thousands of persons who do not understand the incongruity of the arrangement of characters depicted.

In the present volume an attempt is made to combine instruction and amusement by representing creatures in various comical aspects which were possibly all seen by some of our primeval ancestors. In other words, the drawings are in keeping with the discoveries of prehistoric archæology and the facts of geology. Twenty scenes are depicted, and adjacent to each is a brief description of the chief characteristics. The pictures are, in the opinion of the writer, not to be compared as regards their diverting character with Mr. Reed's inimitable sketches, and the descriptions which accompany them are of too general a character to call for criticism. But the scientific accuracy of the drawings in so far as they represent animals which are known to have been contemporaries of man is certainly a merit; and for this reason the book is a suitable present for a boy with scientific predilections and a lively imagination.

A Treatise on Surveying. Compiled by R. E. Middleton, M.Inst.C.E., and O. Chadwick, M.Inst.C.E. Part i. Pp. xiii + 283. (London: E. and F. N. Spon, Ltd., 1899.)

THIS work seems to have had its origin partly out of consideration for the needs of surveyors whose home-training is too restricted to qualify them for colonial appointments, where a knowledge of geodetic work is required, and has in addition no less an object than the raising of the standard of qualification for English diplomas in surveying. We are told that the Council of the Surveyors' Institute was approached by the authors and others interested in these matters, and agreed to adopt this text-book if satisfied with it, but we are left in doubt as to whether it has received the approval of that body.

A general idea of the scope of the present volume may be gathered from the titles of the chapters, namely, "chain surveying; optics, magnetism, &c.; description and adjustment of instruments; traverse surveying; minor triangulation; the plane-table and methods of using it; levelling and contouring." Geodetical and astronomical determinations, as well as marine, route, and other special surveys are left for the companion volume, so that the form of publication is well suited to the requirements of the two chief classes of students. We find the explanations of the various instruments, processes, and principles sufficiently full and clear, while sound practical methods of making and entering observations and presenting the final results are given throughout. No particular originality is claimed, but the special merit of the book lies in the great care with which the compilation has been made, and the thoroughly practical spirit which pervades it. It certainly makes a good bid for a place among standard text-books.

The X-Ray Case Book, for Noting Apparatus, Methods and Results. By David Walsh, M.D. (London: Baillière, Tindall and Cox, 1899.)

FORMS are provided for recording the electrical and photographic conditions under which Röntgen photographs of medical and surgical cases are obtained, and for the entering of notes on the points brought out by an examination of the photographs, or by visual observations with a fluorescent screen. Full diagrams of the human body are given for convenience in recording observations.

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.*]

Proposals of the Stockholm Fisheries Conference.

As one closely connected with scientific fisheries work on the North Sea, I cannot help taking a keen interest in the proposals that emanated from the Stockholm Congress, and in the criticisms that have appeared in NATURE on those proposals. These criticisms have been decidedly adverse, and readers of this journal who take an interest in fishery questions and research, but who have not been in a position to obtain the knowledge necessary to judge fairly the points in dispute, will naturally feel somewhat perplexed over the difficulties that have arisen. As the matter is of the greatest importance to Great Britain, with its large fishing industry, this perplexity is to be regretted, because it is very necessary that something like unanimity should obtain amongst those who have charge of affairs. This unanimity will come with greater clearness on the points at issue, and in order to aid towards this clearness I would ask your permission to allow me to continue the discussion.

The criticisms on the proposals of the Stockholm Congress may be resolved into two portions—direct criticisms of an adverse kind on the proposals in part or as a whole, and counter-proposals which it is considered the British Government should accept in preference.

Under the first heading come the criticisms of Prof. Herdman, and with them we may begin. Prof. Herdman considers that too much stress is laid on the hydrographical and meteorological work than on the biological. Two reasons may be given for this criticism. Firstly, at the present time, the biological investigations of the fisheries in the North Sea are in certain respects in a more advanced state than the hydrographical and meteorological. On such questions as those of migration, for example, many facts have been accumulated and theories founded thereon, but we are at a loss to follow up the investigations and test the theories because trustworthy statistics of the meteorological conditions—direction of the surface and deep water currents, temperatures in different places at different depths, fluctuations in salinity, and so on—are utterly lacking. Hence, biologists should really welcome this work, and not object to its seemingly greater prominence. This work, however, was not intended to hinder the further prosecution of strictly biological research, and here we come to the second reason for Prof. Herdman's criticism.

He does not seem to have fully appreciated the scheme proposed by the Congress under the heading of "The Biological Work." He says: "Surely what we need most at the present time in the interest of more exact fisheries knowledge, is the nearest possible approximation to a census of our seas—beginning with the territorial waters. Most fisheries disputes and differences of opinion are due to the absence of such exact knowledge. . . . The Stockholm report unfortunately says nothing to the point in regard to all this."

Now, the Stockholm report states clearly and definitely what is wanted, and how we are to obtain it. Under "Biological Work," in addition to other practical recommendations for the taking of this "census," under Parts I. and II., III.(*a*) and III.(*b*), run:—

"It is desirable to collect uniform statistics of the number, weight, and value of the fish landed, of the means of capture, and of the persons engaged in the industry; for example, as in the General Reports of the Scottish Fishery Board."

"It is desirable to collect material for the preparation of maps, showing the fishing grounds and the kinds of fishing there practised."

Under "A.—The Hydrographical Work," further recommendations are given under VI.–X. as to the taking of the "census." As these recommendations are quite clear, and fully cover the ground of all research into the total numbers of fish, the varying numbers at different times and places, as well as the total quantities of the different forms of fish-food and their fluctuations at different places and seasons, it seems impossible to ask for anything more. What more does Prof. Herdman see under the word "census"?

That Prof. Herdman has not fully weighed the scheme proposed is again shown in his statement, "Part of the report is called a programme of work, but it contains no definite programme of biological work." It is needless to discuss this until we have Prof. Herdman's conception of a "definite programme" before us, and then we shall be able to compare the two. If Prof. Herdman can show a better, more definite and workable programme, it is only right that he should do so after passing such criticism on the other.

"In my opinion," says Prof. Herdman, "what we want is not conferences, or committees, or a central bureau, so much as boats and men, *and work at sea.*" This catches the eye at once as being eminently practical, but surely Prof. Herdman does not mean that the Congress did not contemplate the use of "boats and men, *and work at sea*"? But he fears evidently that an "opportunity" is being lost because the Congress has advocated the formation of the central organising body before starting to actual work. But where so much has to be done, so many different studies to be organised, so many different arrangements and experiments to be made, we should rather approve of the methodical and calculating arrangements of the Congress, even though for the moment progress is *seemingly* slow, just as we approved of the slow but certain progress of General Kitchener to Khartoum.

As Dr. Murray has ranged himself with Prof. Herdman in his criticisms, and as his proposals can be discussed under those of Mr. Allen, I trust he will not think it from disrespect that I pass on now to the points raised by Mr. Allen. These have been thought out with great care, and one cannot but acknowledge his fair and generous method of treating the subject. The general plan of the investigations is approved of, and only on minor points can there be differences of opinion. The matter of the areas of investigations will assuredly come under reconsideration, as he suggests. The only question—and the chief one—that will repay discussion, is that of the "central bureau."

Mr. Allen recommends that the British Government, in order to give effect to the proposals of the Congress, should first of all co-ordinate the work of the different stations in the British Isles. (Would this not harm their "originality"?) When this is done, the "essential requirements" are a sufficient number of capable naturalists and sea-going steamships efficiently equipped. The experts of the different countries would meet once a year in order to co-ordinate the investigations and insure uniformity of method This scheme is contrasted with that of the Congress, and it is maintained that the establishment of a "central bureau" is too elaborate and expensive.

Now, if Mr. Allen had restricted himself to asking further particulars regarding the central "laboratory," one would have taken no exception to his remarks; but since he objects to what seems very necessary—namely, a central body to organise and keep the different researches and departments in actual touch with one another, to do the secretary work and look after the printing of reports, &c.—one must turn and ask what he intends to put in its place. Mr. Allen surely does not think that a meeting of experts once a year is equally adequate?

Until Mr. Allen unfolds this part of his scheme a little further, we may regard certain other aspects of it. No one will deny that the co-operation of the various marine stations in England for definite fisheries work would be of immense value; but why has this not been considered and done before? Again, if this scheme were effective and less expensive than that proposed by the Congress, would the representatives of the other countries not have taken it into consideration? These representatives have had much greater experience of fishery work than Mr. Allen has had, and a much better notion therefore of what is needed, and it is unlikely that they would ask their Governments to pursue a course which is more expensive than another equally effective. This is said without intending any disrespect for Mr. Allen; it is merely drawing a comparison between two experiences, and the comparison tells against Mr. Allen.

Again, is Mr. Allen's scheme workable and adequate to the work that is wanted? It should be remembered that Great Britain has not been asked to co-ordinate its various small marine stations, however desirable this may be. It has simply been asked to carry on a certain programme of work for a period of five years at least. The course of events, let us imagine, will be somewhat as follows:—The Scottish Fishery Board will be asked by Government to carry on a certain amount of routine hydrographical work, with the instruments suggested and the methods proposed, at certain periods of the year over the area prescribed, also biological plankton investigations similarly. What extra expense this will be to the Board it is not for me to say; but with its staff and knowledge of the methods to be employed, the experience and equipment it has at its command, this will not be anything very great. There is no necessity here for co-ordinating, first of all, the work that might be done at St. Andrews, Millport, and Granton. These places will carry on their own work in their own way, because biological research must always be acceptable. But, if the Fishery Board should desire any special work to be done at those stations, it has the staff, the knowledge of ways and means, and the funds at its disposal, and the work will be done.

England, unfortunately, is not prepared to the same extent. It has no central body whose knowledge and experience of fishery work in this and other countries could command the co-operation of the different stations. It is doubtful also whether the biologists in England have worked on the methods suggested by the Congress. If so, they have not yet published any results. They are so far removed, further, from the centre for work, viz., the North Sea, that their work is formed on a different plan; they have not the same aims, and they do not look at fishery problems as the biologists along the coasts of the North Sea do. And it is a curious comment on this condition of England, that on its East Coast—from which as much fishing is carried on, and where the value of the fisheries is as great, as in all those of the other countries round the North Sea combined—it is curious that there is no station there which can adequately take up the work proposed, and that a great part of this coast is ascribed to Holland as within its area of investigation. All this is said without intending any disrespect whatsoever to Mr. Allen, but it comes to one's mind in reading over his proposals.

The co-operation of the marine stations in England would not remedy this. "A central bureau" for England alone would require to be established, with experienced trained men at its head. This would take much time and money, and when Great Britain has been offered a "central bureau" of more power and value at a less cost, there can be little doubt for which the Government will decide.

Without intruding further upon your space by entering into the advantages of the organisation proposed by the Congress, and of co-operation with foreign countries, let me, in conclusion, express my earnest desire to do justice to both sides. If Prof. Herdman can prescribe a better programme of work, if Mr. Allen can show a better organisation, then let us have them by all means. The British Government will then have two definite schemes to consider, and if it finds it cannot decide between the two, then let us have two definite rival organisations, each doing its best with the means at its disposal to add to the knowledge and power of our country. Here we should be at one, and rivalry will not be tinged with envy or bitterness, but stimulate to greater exertions, and breed that respect and community of sentiment which springs from a common ideal and hard work well done. H. M. KYLE.

Naples, December 8.

Supposed Daylight Leonids.

THE interesting details referred to by Dr. W. J. S. Lockyer (NATURE, December 7) of a shower of Leonids having been witnessed by Miss Jeans and others at Swindon, and by Mr. E. Shaw at Aveley, in Essex, on the afternoon of November 15 last are corroborated by several other descriptions of a similar nature which recently appeared in the newspapers. One of these referring to a later date, was published in the *Liverpool Echo* of November 21, and runs as follows:—

"SIR,—Not having seen any account in the papers concerning the arrival of the meteoric showers, I beg to state that I saw them on Thursday afternoon, the 16th inst. I first noticed them at 12.15; they were shooting in all directions and kept on until about 4 o'clock. Then on Friday, the 17th, I again saw them at the same time. I called the attention of several people, with the result that they could also see them. Owing to the bright sky, one had to stare for a few seconds before perceiving the stars, as they were very dazzling to the eyes.

"Yours, &c.,

"Liverpool, November 20." "MIMA ARDEN.

I need not quote any further descriptions, for there is not the slightest doubt that the objects were illusory and had nothing whatever to do with the November meteors. On November 15 the radiant of the Leonids sets at 2.30 p.m., so that the observations of Mr. E. Shaw (quoted by Dr. Lockyer), Miss Arden and some others are entirely put out of court, for we cannot have a shower of Leonids with the radiant below the horizon.

The objects seen must have been purely imaginary, and they may be easily produced by bending the neck and gazing intently for a few minutes at a bright sky. I have observed many of these spectral meteor showers on occasions when I have been looking for Venus or some other object in bright daylight.

It is astonishing that if one calls the attention of people to imaginary phenomena of this kind and asks them to look, they will, in ninety-nine cases out of one hundred, see the same thing and encourage similarly mistaken ideas! Yet if we observe an unequivocal object, it is often very difficult to make others perceive it and comprehend its character and the nature of the observation. Fictitious objects are in point of fact often seen more readily and apparently under more convincing aspects than real ones, but this applies usually to inexperienced observers.

In addition to the two reports of the recent shower of Andromedids mentioned in the last number of NATURE, there is a third from Austria (*Daily Chronicle*, November 25). It appears that the astronomers of the Vienna observatory, watching the sky "from the beginning of evening up to moonrise, saw sixty-seven shooting stars, mostly from Andromeda. A magnificent fireball was also observed shining in the constellation. Twelve photographs were taken." W. F. DENNING.

Bristol, December 8.

Birds Capturing Butterflies.

REFERRING to the letters on this subject in your papers of September 28 and November 16, I can certify to the fact of robins chasing and catching large white butterflies on the wing and swallowing them whole. In June we had ten robins coming freely to the hand for food, and thus had frequent opportunities of observing them daily. My gardener and his son have witnessed the same habit of the robins. HOWARD FOX.

Rosehill, Falmouth, December 7.

VALVE MOTIONS OF ENGINES.

ENGINEERS want a diagram which for any position of the main crank of a steam engine (the angle θ which it makes with the inner dead point being given) shows at once, with sufficient accuracy for practical purposes, the position of the piston in its stroke, and the distance of the valve from its mid position. This is a mathematical problem. Men who are cunning in geometrical constructions ought to help the engineers; but hitherto they have not done so. In the hope of enlisting their services I venture to put before the readers of NATURE the only easy construction with which I am acquainted. It has never before been published, except to his students, by the inventor, Mr. J. Harrison, of the Royal College of Science. Until I became acquainted with this method, I used a very laborious method of working, which necessitated the drawing of sine curves of different periods as described in my book on "Steam."

It will save trouble in expressing my meaning if I assume a uniform rotation of the crank. If we assume that the motions of piston and valve are simple-harmonic, a construction is very easy. When the valve is worked directly by an eccentric its motion is very nearly S.H., and in this case a construction, taking account of the shortness of the connecting rod, is easy.

But, as I have been trying to impress upon students for many years, when a valve is worked by any ordinary link motion or radial valve gear, the motion is not simple-harmonic; there is a small octave or kick of twice the fundamental frequency, and if this is taken into account, as well as the fundamental S.H. motion, it will be found that higher harmonics are of very little importance. Now in radial valve gears it is not at all difficult to write down the values of the terms a, α, b, β of the following expression from mere inspection of the gear. In link motions it is more difficult at present, but we are already seeing our way to easy rules. Here, then, is the problem which Mr. Harrison has solved:—

Given the ratio of length of connecting rod to that of the crank. Given that the distance of the valve to the right of its mid stroke (Fig. 1) is

$$y=c+a\sin(\theta+\alpha)+b\sin(2\theta+\beta),$$

b being small in comparison with a, show on a diagram the position of the piston and the value of y when θ has any value. Further, the laps XY and X'Y' (Fig. 2) being given, show on the diagram the amounts of opening of the ports to steam, these being obtained by subtracting the laps from y or $-y$.

With centre C (Fig. 3) and radius CA or CA' representing the crank, describe the crank circle ABA'B'. Draw BCB' at right angles to ACA'. With centre on CA produced, and radius equal to length of connecting rod, describe the arc BOB'. Make angle $\text{COC}_1=\beta-\alpha$ and $\text{OC}_1=2b$. We give the name "false centre" (relatively to both circles) to the point O.

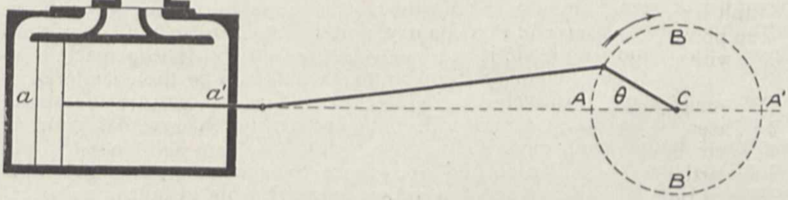

FIG. 1.—A is called the inner dead point. A' ,, outer ,, ,,
The motion from a to a' is called the *in* stroke. ,, ,, a' to a ,, *out* ,,

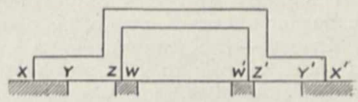

FIG. 2.—Valve shown in the middle of its stroke. X Y and X' Y' are the *laps* (sometimes called the *steam laps*). Z W and Z' W' are the inside laps (sometimes called the *exhaust laps*).

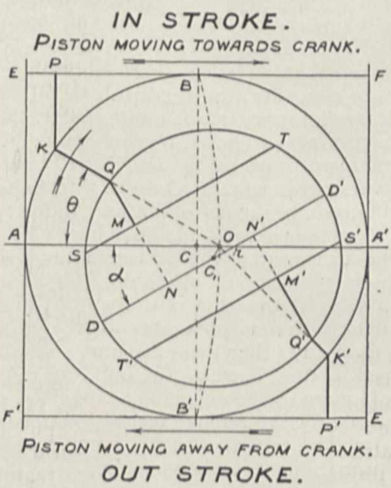

FIG. 3.—Mr. Harrison's diagram showing positions of piston and valve when crank makes an angle θ with inner dead point. The valve displacement to right of mid position (Fig. 2) being y, where $y=c+a\sin(\theta+\alpha)+b\sin(2\theta+\beta)$.

With centre C_1 and radius a, describe the circle DQD'Q'. Draw $\text{DC}_1\text{D}'$ making an angle with AA' equal to α. Draw ST parallel to DD' at a perpendicular distance from it equal to the lap XY of Fig. 2. Draw S'T' also parallel to D'D at a perpendicular distance from it equal to the lap X'Y' of Fig. 2.

Draw tangents at A, B, A', B'. In the *in* stroke of the piston, when the crank moves from A to B to A', let us show on EF the positions of the piston, and in the *out* stroke, when the crank moves from A' to B' to A, let us show on E'F' the positions of the piston.

For any value of θ: Make $\text{AOK}=\theta$, project K vertically to P; P shows the position of the piston, EP is its distance from the beginning of its stroke. OK cuts the valve circle in Q. The perpendicular distance QN of Q from $\text{DC}_1\text{D}'$ is y, and the part of it QM is the opening of the left-hand port to steam. Similarly, in the *out* stroke, when the crank has passed through the angle AOK' which is greater than 180°; project K' to P' to get the piston position in the out stroke. Let OK' cut the valve circle in Q'; then the perpendicular distance Q'N' is the distance of the valve to the left of its mid position (Fig. 2), and Q'M' is the opening of the right-hand port to steam.

It is easy to see how we get the openings of the ports to exhaust in exactly the same way. Lines joining O with S, T, S', T' show the angular positions of the crank when admission and cut off take place. In fact, we see that this diagram gives us the positions of the piston when admission, cut off, release and compression occur both in the *out* and *in* strokes. It gives us an easy way to study how changes in b and β enable us (even when the laps are equal) to balance, or even more than balance, the inequality of admission of steam on the two sides of the piston due to shortness of connecting rod.

It is easy to see how such a diagram may be modified for problems concerning cut off valves on the back of the main slide valve.

The same expedient of false centres may be used to show the velocity or acceleration of a slide.

In a modified diagram Mr. Harrison sometimes lets the two circles coincide, using two false centres.

The solution is a close approximation to the truth in all the usual cases, because b is always small in comparison with a.

JOHN PERRY.

INSECTS AS CARRIERS OF DISEASE.[1]

THE recent researches of bacteriologists into the *rôle* played by insects as carriers of infection, and the hunt after microbes to locate their natural habitat, is a necessary procedure before it becomes possible to enter on a scientific crusade against them. In those diseases which may be caused by infection carried by insects, it is a more hopeful task to deal with the insects which we can see, than to deal with the microbe which lurks unseen and unheeded. At the same time, it is an uncomfortable thought that insects which we have regarded as undesirable but harmless may be the cause of a serious illness.

The bacteriologist has now shown a fair-sized category of diseases to be caused by microbes, and having arrived so far the hygienist steps in and wants to know firstly, what is the habitat of these microbes outside the human or animal body if they have one, and secondly, by what means they are conveyed to the body from their resting-place outside or from one patient to another?

1 "On the *Rôle* of Insects, Arachnids and Myriapods, as carriers in the spread of Bacterial and Parasitic Diseases of Man and Animals. A critical and historical study." By Dr. G. H. F. Nuttall (from the *Johns Hopkins Hospital Reports*, vol. viii.).

That certain diseases may arise from the "bites" of insects has been surmised long before the microbial origin of disease was known, many theories were naturally based on insufficient evidence because the key to the riddle had not then been found. In some of the earliest records of epidemics any concurrent phenomena was thought to be the cause, thus the plague at Nimeguen, in Holland, in the seventeenth century, was said to be announced by swarms of insects and meteors.

All observations are of use, although in the light of present knowledge they may not bear the same interpretation as was originally put upon them; as a suggestion for investigation by experimental methods they may serve a purpose.

Dr. George H. F. Nuttall in this monograph has been at great pains to collect observations on the point from all sources, and has supplemented these with some experimental researches of his own.

Insects—using the term in its popular sense—may play a passive *rôle* in the propagation of disease. It is obvious that flies, for instance, after soiling their bodies in contaminated matter, may afterwards infect articles of food, especially milk; and no doubt many cases of typhoid fever are caused in this way. In India, where typhoid fever attacks so many of our troops, the refuse matter is placed outside the camp, and it has been suggested that articles of food in the camp might become infected by dust carried by the wind when it blows from the direction of the refuse matter; but it is more than likely that flies carried by the wind play a more important part, for they would seek out the food. The same may be said of cholera; in fact, an instance is given where milk was left out in the open in a jail in India at the time of a cholera epidemic, and it became infected with the cholera microbe by means of flies, whereas milk left out in another yard where there were no cholera cases and which was separated from the other yard by a high wall did not become infected.

In playing an active *rôle* insects may conceivably cause infection by "biting" after having "bitten" an individual suffering from an infectious disease or after feeding on contaminated substances, for instance, the body of an animal dead of anthrax. Experiments in this direction do not seem to have been very successful in the cases of bugs and fleas, which were the insects experimented with; but it was shown that anthrax and plague microbes do not survive more than a few days at most in the bodies of the insects. Even if the "bite" of an infected insect is harmless, it might be otherwise if the insect were crushed on the spot bitten, and the place scratched; such a procedure might be fraught with danger supposing the insect had recently been feeding on infected matter.

With respect to the tsetse-fly disease in domesticated animals, there is conclusive experimental proof that the fly carries the micro-organism or hæmatosine in this case from diseased to healthy animals.

The filariae, according to Manson, go through changes in the stomach of the mosquito, and finally make their way out into water in which the insects have died, and man becomes infected by drinking the water. In this case and in malaria the insect seems to act as an intermediary host to man. The mosquito—of which one species, the anopheles, seems to be mostly concerned—takes up the organism in the blood of the malarious subject, and, according to Manson, infects soil or water by dying in it; Ross and others, however, say it infects healthy persons by biting them after biting a malarious patient.

It is interesting to note that most of our previous notions as to the localities and time of year that malaria occurs, and the precautions adopted to prevent being attacked still hold good, *mutatis mutandis*, for the mosquito theory. C. B. S.

ETHNOGRAPHICAL MUSEUMS.

IN NATURE of September 14, attention was called to the rapid progress of ethnographical museums in Germany, and to the unsatisfactory state of ethnography in our own country. Since that time two things have happened which confirm the view then taken of the position of our national collections.

In the first place, one of the distinguished keepers of the Museum für Völkerkunde in Berlin has recently visited London, and has stated that the enlargement of the museum or its supercession by a completely new building will be seriously considered in the near future. When it is remembered that the Museum für Völkerkunde is already so enormously superior to anything which we have in this country, that it stands absolutely in a class by itself, it can easily be guessed that the projected improvements threaten to leave us in a position of inferiority positively humiliating. For even as matters now stand, the German collections are nearly ten times as good as our own.

The second occurrence to which we have alluded, is the issue of a report upon European anthropological museums by Mr. George A. Dorsey, of the Field Columbian Museum, who made a tour of the principal European cities in the autumn of last year. Extracts from his report have been published in the form of a short paper in the *American Anthropologist* for July, 1899, and it is therefore accessible to every one who feels any interest in the subject.

Mr. Dorsey begins by complaining that the collections illustrating the various branches of anthropology in Europe are all scattered about in different buildings. In London, if you wish to study man as an animal, you must go to the British Museum of Natural History in Cromwell Road, or to the Royal College of Surgeons; if you wish to study primitive art and industry, you must go to Bloomsbury. In Paris you must wander from the Jardin des Plantes to the Trocadéro, and so on in other cities. The great fields of anthropology are nowhere adequately represented in a single building, and the advantages of concentration are lost.

After this preliminary condemnation, Mr. Dorsey proceeds to discuss several museums in detail. He has a well-merited word of praise for the Pitt-Rivers collection in the University Museum at Oxford, where the development of different branches of human industry may be studied in a manner impossible anywhere else. Coming to Berlin, he thinks that the Museum für Völkerkunde contains the largest amount of ethnographical material to be found in any one museum in the world; and he is inclined to believe that it possesses a greater number of specimens than any other two museums combined. The one drawback is that, large as the building is, it has long proved inadequate to the enormous expansion of the collections, and is in consequence terribly overcrowded. As we have already seen, this is an inconvenience which will in all probability soon be remedied.

Of the ethnographical collections in London, our American critic has naturally something to say. After noticing that, from the ethnographical point of view, London, like Paris, is disappointing, he continues: "The large hall [gallery] devoted to this subject in the British Museum is not well adapted to the purpose for which it is used; it is rather inaccessible, poorly lighted, and does not admit of a ready scientific classification of the objects therein deposited. Naturally, this hall contains many of the rarest and most valuable objects that have ever been obtained by any museum in the world; but owing to the causes already mentioned, and to the crowding of the cases, it is practically impossible for the visitor in a short time to form any idea of the value of the collection. There are many rare and unique specimens, but the collection as a whole cannot be regarded as well illustrating the various fields of ethnography. . . . It is to be regretted that the capital of a nation which embraces in its domain so many and such diverse peoples should not possess a museum which shows the ethnic characteristics of some of these peoples in an adequate manner."

Mr. Dorsey has returned to his own country convinced that in the matter of the housing and exhibition of anthropological collections the United States have nothing to fear from comparison with Europe. He thinks that there is no building in Europe so admirably planned for museum purposes as the American Museum of Natural History at New York. Here ample space for future expansion has been allowed on a scale unequalled in Europe, and large, well-lighted and commodious quarters have been provided for storage and workrooms. He truly says that numerous workrooms with abundant light should be an essential feature of every museum. It is clear that in the United States the study of ethnology is being pursued with the same enthusiasm as in Germany, and that it has succeeded in a similar manner in securing a large measure of popular support. Viewed in the light of these facts, the conditions of things in Great Britain appears doubly deplorable.

NOTES.

THE complimentary dinner given to Major-General Sir John Donnelly on Tuesday, by his friends and former colleagues of the Department of Science and Art, is a testimony of the esteem in which he is held by all who have been associated with him in the work of the Department. Sir John Gorst presided, and in proposing the health of the guest of the evening, he pointed out that in 1859, when Sir John Donnelly was entrusted with the control of the science branch of the Department, the total number of science students under instruction was 395, and the payments made on account of their instruction amounted to 2000*l*. In 1897, the number of students in Departmental classes was 197,796, and the grants amounted to 169,000*l*. These figures form the best of evidence as to the growth of the work of the Department under Sir John Donnelly's administration. In addition to Sir John Gorst and Sir John Donnelly, among other speakers at the dinner were:—Captain Abney, Major-General Festing, Sir Norman Lockyer, Prof. Rücker, Sir George Gabriel Stokes, and Rear-Admiral Sir William Wharton.

DRS. STEVENS AND CHRISTOPHERS, of the Royal Society Malaria Commission, left Liverpool on December 9 for Sierra Leone, where they will continue their investigations on malaria. At Blantyre, in East Africa, where they were before, they gave more attention to investigating the relation of malaria to blackwater fever, which is very prevalent at that spot. Many persons deny the connection between the two, but it is a point that still requires to be settled. On the West Coast they will probably investigate the disease from the point of view of the mosquito theory.

PROF. GEORGES LEMOINE has been elected a member of the section of chemistry of the Paris Academy of Sciences, in succession to the late Prof. Friedel.

THE following are among the lectures to be delivered at the Royal Institution before next Easter:—Mr. C. Vernon Boys, six Christmas lectures (specially adapted for young people) on fluids in motion and at rest, experimentally illustrated; Prof. E. Ray Lankester, twelve lectures on the structure and classification of fishes; Dr. W. H. Rivers, three lectures on the senses of primitive man; Prof. H. H. Turner, three lectures on modern astronomy; Dr. Charles Waldstein, three lectures on recent excavations at Argive Heræum (in Greece); Lord Rayleigh, six lectures on polarised light. The Friday evening meetings will begin on January 19, when a discourse will be given by Lord Rayleigh, on flight; succeeding discourses will probably be given by the Hon. C. A. Parsons, Prof. J. Reynolds Green, Mr. H. Warington Smyth, Prof. J. H. Poynting, Major Ronald Ross, Prof. Frank Clowes, Sir Benjamin Stone, M.P., Prof. J. Arthur Thomson, Sir A. Noble, Prof. Dewar, and other gentlemen.

AN agricultural conference for the West Indies will be held at Barbados on January 6 and 8, 1900. His Excellency, Sir James Hay, K.C.M.G., the Governor of Barbados, has promised to meet the representatives at Bridgetown on Saturday morning, January 6, and offer them a welcome to the island. Immediately after, the President (Dr. D. Morris, C.M.G.) will deliver the opening address, and the business of the conference will begin. A characteristic of the conference will be the presence of representatives of the leading agricultural societies in the West Indies. By this means it is anticipated that the conference will act as an educative agent of great value, and by enlisting the co-operation of those practically engaged in agriculture, its deliberations will have wider scope, and the influence of the conference will be more widely recognised. The list of subjects to be dealt with covers practically every branch of West Indian agriculture.

ORNITHOLOGY has suffered a severe loss by the death of Arthur Cowell Stark, M.B., who was killed by a Boer shell at Ladysmith on November 18. Dr. Stark was an ardent naturalist, and specially conversant with South African ornithology, having devoted many years to the study of the birds of the Cape Colony and adjoining countries. At the time of his death he had just completed for the Press the first volume of a work on South African birds, which is to form a portion of Mr. W. L. Sclater's "Fauna of South Africa." Dr. Stark was in England during the past summer engaged in the preparation of his book, but returned to the Cape in September last, and proceeded to Natal in order to continue his collections in that colony. When war broke out he offered his services as a volunteer on the Medical Staff, and was sent up to Ladysmith by the last train that passed the Boer army. Standing at the door of the Royal Hotel in Ladysmith, on November 18, he was struck by an exploded shell, and died shortly afterwards. Dr. Stark was a graduate of the University of Edinburgh, and a well-known member of the British Ornithologists' Union.

A CONGRÈS international des sciences ethnographiques will be held in connection with the Paris Exposition, on August 26–September 1, 1900. There will be seven sections, dealing respectively with general ethnology, sociology, and ethics; ethnographical psychology; religious sciences; linguistics and palæography; sciences, arts, and industries; descriptive ethnography. The treasurer of the organising committee is M. Leclère, rue Lecourbe, 54, Paris, and the general secretary, M. Greverath, rue d'Athènes 3 bis, to which address foreign correspondence should be sent.

THE essay on the scientific work of Lord Kelvin, contributed by Prof. G. F. Fitzgerald to an elegant volume just published by Messrs. James MacLehose and Sons, Glasgow, is a masterpiece of appreciative writing. The volume contains a complete account of the celebrations on the occasion of Lord Kelvin's jubilee as professor of natural philosophy in the University of Glasgow; it is thus of particular interest to the many friends who took part in the ceremonies, and to the scientific bodies who sent delegates and messages of congratulation. Preceding this report is Prof. Fitzgerald's essay, in which the nature and significance of Lord Kelvin's contributions to science are described with such remarkable lucidity that every one interested in the progress of natural knowledge would do well to read it. A striking photogravure of Lord Kelvin, from a portrait taken in 1898, forms the frontispiece, and a portrait is given engraved from a photograph taken in 1846. The volume will doubtless be treasured by Lord Kelvin's many admirers, as a slight tribute of regard for the versatility of his genius.

THE *British Medical Journal* announces that Dr. Versin, whose name is well known for his researches on the plague, has been charged by the Government of Cochin China with a special mission to Java.

IT is reported in *Science* that the Russian Astronomical Society has finally given up its attempt to revise the Julian calendar. The reason assigned for its failure by the Society is "the impossibility of establishing an agreement between the dates of the religious festivals appearing in bcth calendars."

IN connection with the Institution of Electrical Engineers, a number of local centres are being established where papers will be read and discussed at the same time, or shortly after, their reading in London. In Cape Town these informal meetings have been held for some time past, and advance copies of the Institution's papers have been read at them. A meeting for the formation of a north-eastern centre was to be held yesterday at the Durham College of Science, and the Council have received a petition for the establishment of a similar organisation in Dublin.

WE regret to see the announcement of the death of Mr. N. E. Green, F.R.A.S. An artist by profession, Mr. Green was well known for his admirable astronomical drawings—especially those of Jupiter and Mars. On the occasion of the opposition of the latter planet in 1877 he went to Madeira, where he made a fine series of drawings, a selection from which was published in vol. xliv. of the *Memoirs* of the Royal Astronomical Society. A number of his drawings of Jupiter were reproduced in vol. xlix. of the same publication, and he left behind him a long series of unpublished lunar and planetary drawings. Mr. Green was President of the British Astronomical Association in 1897-98.

THE Institution of Electrical Engineers held their annual dinner on Wednesday, December 6, in the Hotel Cecil, Prof. Silvanus Thompson in the chair. Among the speakers was Lord Kelvin who proposed the toast of "Science." In the course of his remarks, he said:—When the electric telegraph came into practical existence in 1837, when ten years or so later the first submarine cables connected England and the Continent of Europe, and when another ten years or so saw the first Atlantic cable laid, electrical science in all the Universities of Europe was in a very backward state compared with the position in which it is now. A very great stimulus indeed was given to its study from its application to electric telegraphs, and especially to the great system of electric measurements which is so valuable now in pure science—a system which originated certainly not among practical engineers, but among University professors. Gauss and Weber gave from Germany the foundation of the system of electric measurements, the benefits of which are now enjoyed, and the first practical use of which was made in connection with submarine cables.

A PAPER on the manufacture of artificial silk or lustrocellulose was read by Mr. Joseph Cash at a meeting of the Society of Arts on December 6, and is printed in the *Journal* of the Society. A public company for the manufacture of this material by the Chardonnet process has been formed in England, and the factory will be capable when filled with machinery of producing 7000 lbs. of artificial silk per week. The first stage of manufacture is the nitration of cotton or wood pulp producing pyroxyline, discovered by Pelouze in 1838. The greatest care must be employed in conducting this operation, as it is the most important one in the whole process; mistakes sometimes even occur at the long-established factory at Besançon, in France. The process of nitration of cellulose is the displacement of a few molecules of hydrogen by nitric peroxide. There are several varieties of pyroxyline which are obtained by using different mixtures of acid. When the pyroxyline has been obtained, it is placed in a cylinder with a mixture of alcohol and ether; the cylinder is then slowly revolved for twelve hours, with the result that the pyroxyline is dissolved and collodion is produced. After filtration by forcing it through a sheet of cotton-wool between calico, under a pressure of fifteen atmospheres, the collodion is ready for use.

FOR the manufacture of artificial silk a pressure of forty to forty-five atmospheres is required to force the collodion from the reservoirs to the spinning machines, which are constructed with pipes running on each side. Into these pipes are screwed a number of taps with a glass capillary tube fixed on the end, called a silk-worm, through which the collodion is forced; immediately it comes into contact with the air it solidifies, enabling the operative to take hold of the thread or silk, as it can now be called, and convey it to the bobbin. From twelve to twenty-four of these threads are run together on to one bobbin, according to the size of silk required, as is the case with natural silk. After the silk has been dried it is very inflammable and quite unfit for use in textile goods; therefore, a process called denitration is next carried out, which reconverts the product into cellulose. One of the uses of the material is for mantles for the incandescent gas light, it being found that the salts of the rare metals can be mixed with the collodion with greater economy than with any other thread. Large works are in operation at Besançon, in France, producing 7000 lbs. weight per week; but the demand is so great that extensions of the works are being made in order to enable them next January to produce 2000 lbs. per day. The production at Sprietenbach is 600 lbs. daily. Other factories are about to be established in Belgium and Germany.

MENTION is made in *Science Abstracts* of a method of thawing water service pipes by means of electricity, successfully used in Canada. The frozen pipes are thawed by passing alternating currents through them. A pressure of twenty to fifty volts is used, obtained from a portable transformer connected with the street mains. A current of 200 to 300 amperes is passed through the frozen pipe until the water flows freely, which usually takes place in a few minutes.

IN 1894, Prof. van der Waals found a remarkable property of the molecular potential function occurring in his theory of capillarity, namely, that if a constant coefficient be left out of account the potential of a homogeneous sphere at an external point is the same function of the distance from the centre of the sphere as if the whole mass were concentrated at the centre. Dr. G. Bakker, writing in the *Proceedings* of the Roya Academy of Sciences of Amsterdam, now investigates the most general form of potential function possessing this property, and he obtains for the potential at distance r the form

$$\phi(r) = \frac{Ae^{-qr} + Be^{qr}}{r} + C.$$

For the potential function required in the theory of capillarity Dr. Bakker remarks that $B=0$. The author further investigates whether it is possible to obtain a potential differing in form from the Newtonian potential and satisfying the further condition that the potential is constant throughout the interior of a spherical shell. It is found that a solution exists, but as the expression for the potential function involves the radius of the shell, the result is in no way contradictory to Laplace's conclusion that the Newtonian potential is the only potential which is constant throughout the interior of a spherical shell, *irrespective of the size of its radius.*

WE have recently received the annual report for 1898–99 of the Bacteriologist of the Government of India. The report deals chiefly with experiments on Rinderpest carried on in the laboratory at Muktesar, a preliminary note of which appears. The methods of protective inoculation that are used in South Africa are not convenient for a country like India; Koch's method of using bile from an animal just killed, requiring the slaughter of mai ˙ ˙nimals, is contrary to the religious susceptiilities of the people. The disease, which has been in India for centuries, seems to be of an endemic character, and not liable to spread with the same alarming rapidity as it does in South Africa, so it does not seem all-important to produce a very lasting immunity to check the disease in any particular locality. Since the disease will probably have been going on for some time in a place before measures can be adopted, a rapidly immunising agent is desirable. The serum method seemed to be the most fitted to the purpose, and it is this that is being tried. It is a great loss that the laboratory at Muktesar, the only Government laboratory anything like properly equipped, has recently been burnt down, but we trust no time will be lost in rebuilding it; India at the present time can ill-afford to do without laboratories.

WHETHER ants can hear is a question which has for some time been engaging the attention of Mr. Weld, of the Iowa University, who has published an account of some of his experiments, and the conclusions he draws from the same, in *Science* of November 24. He states that for many years it has been the accepted opinion amongst naturalists that these insects are not endowed with an acoustic sense, at least within the range of sounds perceptible to the human ear. This opinion is based upon the failure of experiments to show that even the loudest and shrillest noises produce the slightest effects on ants subjected to their influence. This, however, is not the result of Mr. Weld's experiments upon several American species of these insects. In one case an ant confined in a test-tube was brought near a milled disc rotating in the air. At each sound from this apparatus the ant showed unmistakable signs of agitation, quickly moving its head and antennæ. Again, when shrill sounds were produced close to a colony protected under glass, the ants instantly showed by their rapid movements signs of excitement and alarm. This leads the experimenter to conclude that at least some (and possibly only American) species of ants are capable of perceiving vibrations, conducted through the air or other media, which are audible as sound to the human ear. He is, however, careful to add that this does not necessarily demonstrate that they hear in the strict sense of the word, but merely that they are capable of perceiving ordinary sound vibrations.

IN the course of an article on the late Mr. P. H. Gosse, published in the March number of the *Journal of the Jamaica Institute*, Mr. Duerden has some interesting observations on recent changes in the fauna of that island. He first of all states that in spite of its being less abundant around country residences, the Indian mungoose appears to be as common as ever in the island, over 1400 head having been trapped on two estates in eight weeks. His next subject is ticks, which have become a terrible plague in certain districts. Although they always existed, originally there appears to have been but one species in the island, but many others have been introduced on foreign cattle and sheep. A few years ago a virulent disease broke out in the cattle, which was at first diagnosed as being allied to the well-known "Texas fever." Subsequently the characteristic symptons of that disease were found to be absent, as were the well-known parasitic organisms by which it is accompanied; but there still seems no doubt that the bovine epidemic is in some way connected with the presence of myriads of introduced ticks.

IN a second communication to the same journal, Mr. Duerden gives the results of the attempts to improve the sea-fisheries of Jamaica. Unfortunately these attempts have not met with the success that was hoped for. The two chief reasons for the failure—and they are amply sufficient—are, firstly, the amount of coral on the sea-bottom, which renders trawling impracticable; and, secondly, a general scarcity of fish, especially those of the valuable flat-fish group (*Pleuronectidae*) On one place where trawling is practicable, it was considered a remarkable feat that a dozen small soles were taken in a day. There are no shoals of fish corresponding to those of the herring, mackerel, and cod of other seas; so that the whole outlook is gloomy in the extreme.

THE *American Naturalist* for November contains the fifth instalment of Messrs. Cowstock and Needham's important contributions to the study of the structure of the wings of insects, for the details of which we must refer our readers to the memoir itself.

MESSRS. FRIEDLÄNDER AND SON, Berlin, have just issued a catalogue (No. 439) containing classified lists of books and papers on crystallography.

MESSRS. DAWBARN AND WARD have published the third edition of Dr. P. H. Emerson's "Naturalistic Photography." The first part is concerned with the æsthetic side of photography, but in the second part technique and practice are treated, and from it both amateur and professional photographers may derive sound philosophy and serviceable hints.

IN the part just received (1899, 1te Hälfte) of the *Sitzungsberichte* of the Niederrheinische Gesellschaft für Natur und Heilkunde zu Bonn, the most important papers are by Dr. Max Koernicke on the spiral thickening bands in the conducting tubes of plants; and by Prof. W. Voigt on artificial regeneration in Planaria.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. F. G. Stenning; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mr. R. Caton Woodville; two Hobbys (*Falco subbuteo*), captured in the Indian Ocean, presented by Mr. J. H. Ingram; a Fieldfare (*Turdus pilaris*), British, presented by Mr. Herbert Goodchild; a Delaland's Gecko (*Tarentola delalandii*) from Teneriffe, presented by Mr. J. Chappell; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, a Bee-eater (*Merops apiaster*), a Partridge (*Perdix cinerea*), European; two Brown's Parrakeets (*Platycercus browni*) from North Australia, a —— Tortoise (*Testudo nigrita*) from the Galapagos Islands, three Blanding's Terrapins (*Emys blandingi*) from North America, deposited; a Yellow-footed Squirrel (*Sciurus ludovicianus*) from Texas, a Tufted Duck (*Fuligula cristata*), European; two Common Scoters (*Œdemia nigra*), British, purchased.

OUR ASTRONOMICAL COLUMN.

ORBIT OF FIFTH SATELLITE OF JUPITER.—Prof. E. E. Barnard has had the fifth satellite of Jupiter under close observation for some considerable time during the oppositions of 1898 and 1899. Although the increasing southerly declination and the bad season in which the oppositions now occur make the satellite a difficult object, good measures have been secured on several dates. Tisserand having drawn attention to the fact that the measures previously given provided evidence of the eccentricity of the satellite's orbit (*Comptes rendus*, vol. cxix., October 8, 1894), Prof. Barnard decided to observe it as continuously as possible, to settle this question. Tisserand's results indicated that the line of apsides of the satellite's orbit should also have a motion of + 882° a year, or + 2°·42 daily, giving a complete revolution in five months. From the Lick measures he computed the semi-major axis of the orbit to be 47″·906, the eccentricity 0·0073, and longitude of Perijove for 1892, November 1, = −4°. Prof. Barnard's more recent measures enable him to revise these values, and his results are contained in the *Astronomical Journal*, No. 472. On calculating the position of the satellite from Tisserand's value of the motion, a considerable error is found, and the daily motion of the apse line is probably more nearly +2°·465 or 900° yearly, giving a complete revolution of the orbit in 4·9 months.

An interesting question that may also be settled by continued observation of the satellite is the distribution of matter at the equator of Jupiter itself, as the motion of the perijove of the satellite does not agree with that deduced from the actual polar compression of the planet.

During the whole of the measures half the field of view was covered with a piece of smoked mica, through which the bright limb of the planet was observed, and the distances measured from the limb afterwards reduced to the centre by previous measures of the planet's diameter with the same instrument. The increased number of elongations measured gives a much more correct value of the period. The value now given is

11h. 57m. 22·647s.,

which Prof. Barnard considers correct to one-hundredth part of a second.

PARTIAL ECLIPSE OF THE MOON, DECEMBER 16.—There will be a partial eclipse of the moon, visible at Greenwich, during the early morning of Sunday next, in respect to which the following particulars apply :—

First contact with penumbra = 10h. 33·7m. ; with shadow = 11h. 44·6m.

Second contact with penumbra = 16h. 18·1m. ; with shadow = 15h. 17·2m.

Magnitude of eclipse (moon's diameter = 1) = 0·995.

First contact with shadow occurs at a point 66° from the north point towards the east, measured along the moon's limb.

Last contact with shadow at a point 59° from north point towards the west.

The eclipse is visible in Western Asia, throughout Europe and Africa, and in Eastern America.

OCCULTATION OF NEPTUNE, DECEMBER 16.—There will be another occultation of Neptune during the early morning of Sunday, while the moon is still in the penumbra of the earth's shadow after the partial eclipse. The following are the particulars for observers near London :—

	Sidereal time.	Mean time.	Angle from North Point.	Angle from Vertex.
	h. m.	h. m.	°	°
Disappearance...	9 18	15 36	158	118
Reappearance ...	9 53	16 11	222	180

Greenwich Mean Time of conjunction in R.A.... } 1899 December 16d. 14h. 53m. 15s.

Limits of latitude, 90° N. to 30° N.

Neptune passes the meridian of Greenwich at 13h. 40m., so that it will be well situated for observation of the occultation.

MERIDIAN OF UNIVERSAL TIME.—In the *Revue Scientifique*, Ser. 4, vol. 12, p. 526, M. C. Tondini di Quarenghi summarises most of the evidence in favour of and against the adoption of the meridian of Greenwich as the initial meridian for universal time. The chief objection is cited as a physical one, viz., the extreme uncertainty of the meteorological conditions, rendering celestial observations impossible on a large proportion of the days and nights throughout the year. The advantages of the site at Jerusalem suggested by the Italian Government are the superior observing conditions and the possibility of the district being declared neutral ground, thus ensuring the permanence of the station irrespective of political changes. A further advantage would be the possibility of establishing other subsidiary stations at intervals along the meridian.

THE DEVELOPMENT OF GANGLION-CELLS AND NERVES.[1]

THE results of this memoir largely are in keeping with certain revolutionary changes in embryological doctrine, with which the names of Klaatsch, Miss Julia Platt, Goronowitsch and others are identified. According to their views certain vertebrate structures, which have hitherto been genetically referred wholly or in part to the mesoderm, such as scales, certain cartilages, and even bones, are in fact directly or indirectly products of the outer layer of the embryo, the ectoderm or epiblast. This is only a brief and very general statement of the tendency of their lines of research, and it may be added that as to the details there exist important differences between the different observers. It will not be needful to review all their conclusions here. Our concern is solely with the aspect of the question presented to us by Dr. Goronowitsch in his memoir.

Researches on the development of nerves and ganglia date back to Remak, whose conclusions as to their mesoblastic origin from the protovertebræ or mesoblastic somites were commonly held as recently as twenty-five years ago. About then date the researches of Balfour and Marshall, who maintained that these structures arose as outgrowths of the central nervous system, and that therefore they were epiblastic in origin.

Later on their conclusions were somewhat modified by Beard, in the discovery that the posterior root-ganglia, both cranial and spinal, did not develop as actual outgrowths from the central organ, but that their foundations were to be traced to the deeper portions of the epiblast outside the limits of the future brain and spinal cord. It was also demonstrated that the cranial ganglia received additions from special regions of sensory epiblast, since termed by Kupffer "placodes," on the level of the notochord and above the gill-clefts. Thus, for the sensory portion of each cranial ganglion, two sources of origin could be identified, and the parts so derived were termed neural and lateral respectively. A few years ago Kupffer added a third source, and described an "epibranchial" ganglionic foundation as arising from it. Kupffer's results were obtained in the lamprey, unquestionably one of the most difficult forms among vertebrate animals for the study of organogeny. His results have never been confirmed by any other observer, either in the lamprey or in any other vertebrate.

Whilst it is certain that his epibranchial ganglia have no existence in Elasmobranch fishes, it is also in embryos of these easily demonstrated how Kupffer fell into the error of supposing their presence. In fine, had his researches been carried to sufficiently early "stages" or phases he would have seen that his lateral and epibranchial ganglia merge into one, the foundation of a lateral ganglion.

Since Kupffer's researches were fully published in 1894–5, embryological investigation of the development of cranial and spinal nerves and ganglia has been put somewhat in the shade by brilliant researches into their comparative anatomy at the hands of Allis, Dixon, Ewart, Fürbringer, Haller, Strong and F. J. Cole. Pages and pages might be filled in review of these, along with a critical digest of numerous other papers, embryological and morphological, issued since 1885. Controversies have been waged as to the morphological nature of certain nerves and ganglia, as to their mode or modes of development, and as to the way—apparently a simple problem, but by no means such—in which nerve-fibres arise.

The work under review is only in a minor degree a contribution to a knowledge of the morphological nature of nerves, *i.e.* in so far as it relates to the olfactory and auditory nerves. On the other hand, it emphatically claims to furnish decisive replies to the two latter questions, as to the mode or modes of development of ganglia and of nerve-fibres. If the conclusions drawn by Goronowitsch from his researches can be upheld, it would seem to follow that the investigations of the past twenty-five years—except those of Sedgwick—have been largely in vain.

According to Dr. Goronowitsch, what Balfour and Marshall regarded as outgrowths of the central nervous system, and termed "the neural ridges," have nothing to do with the development of the cranial ganglia. The existence of these "ridges" of cells he does not dispute, but he maintains that the component cells become resolved into the surrounding meso-

[1] Untersuchungen über die erste Anlage der Kranialnerven bei *Salmo fario*." By N. Goronowitsch. Nouveaux Mémoires de la Société impériale des Naturalistes de Moscou, T. xvi. L. 1, pp. 1-55, 3 plates.

blast. The cranial ganglia take their entire origin from Froriep's "Kiemenspaltenorganen." These structures were first discovered by Froriep, and independently by Beard, who identified them as the foundations of the lateral sense organs, and termed them, because of their genetic relations to the gill-clefts, the "branchial sense-organs." Moreover, as previously stated, these patches of sensory epithelium, the "placodes" of Kupffer, were shown to be the sources of ganglionic elements, forming the lateral ganglia. Goronowitsch has now, therefore, endeavoured to limit the cranial ganglia in their origin to these lateral sources alone.

Peculiar, though not confined to himself, are the views maintained by Dr. Goronowitsch as to the mode of attachment of the ganglion with the central organ, and as to the formation of nerve-fibre in general.

In the solutions offered of these problems—which, of course, are really one and the same, to wit, that of the development of nerve—he places himself entirely on the side of A. Sedgwick.

The latter zoologist has maintained, without thus far illustrating his thesis by figures, that nerve-fibres arise *in situ* in the mesodermic reticulum, connecting together the various portions of the developing embryo and filling all the spaces between skin and central nervous system.

The logical conclusion attaching to this view is that nerve is mesodermal in origin. This conclusion Goronowitsch does not hesitate to draw. In his own words in literal translation he says (*inter alia* on p. 40) "the nerve-forming tissue of the complex nerve-trunk is furnished by axial mesoderm."

Incidentally he, like Sedgwick, rejects the doctrines of His, Golgi and their followers, that nerve-fibres arise as processes of ganglion-cells. Naturally! The two views are mutually exclusive. If nerve-fibres arise in a reticulum of mesoderm or mesenchyme, they cannot also be processes of ganglion-cells.

Whatever is to be said for the full acceptance of the process-theory of His and Golgi, and whatever the ultimate fate of the germ-layer theory, no fact in vertebrate embryology stands on a firmer basis than the origin of all nervous structures from the outer layer, the ectoderm or skin, and to fall back upon the mesoderm or its reticulum as the source of nerve appears to us a retrograde step to the embryological standpoint of thirty years ago.

While readily and willingly acknowledging Goronowitsch's industry and zeal in working out this memoir, evidenced by the detailed and laborious description, the carefully drawn and beautifully lithographed plates, his main thesis must remain in abeyance until proof further and more convincing, that this is so for representative members of each of the great vertebrate classes, can be brought forward.

THE UTILITY OF KNOWLEDGE-MAKING AS A MEANS OF LIBERAL TRAINING.[1]

THE subject on which I wish to address a few remarks to you to-day, by way of opening the fortieth session of our College, is the utility of knowledge-making as a means of liberal training.

That the main work of the highest of educational institutions should consist of original research, and that ability to make additions to knowledge should form the chief test of qualification for the highest academic distinction, may be said to have received world-wide recognition; but the value of research work in institutions or departments of a lower grade has not been similarly recognised, and the tests for lower academic degrees and certificates do not, in general, at least formally, include a research test. I wish to bring to your notice some considerations which go to show that the work of all educational institutions, from the highest to the lowest, should be, to a considerable extent, at least, of the nature of original research—understanding by that term, however, the effort to make additions to our own knowledge, not necessarily to the knowledge of the race.

In this sense we have all been engaged more or less in original research from our earliest years; and we probably attained greater success in infancy than in youth or in later life. The young child is completely cut off from all external sources of information; and it could acquire no knowledge beyond a remembrance of confused sensations, if it did not possess the power of "putting that and that together" and finding things out for itself. By applying this power, however, the child succeeds in bringing a large measure of order out of the chaos of sensations which it experiences. The method which it uses is the scientific or knowledge-making method. It finds out the usage of a word, for example, by putting together various instances of its use, constructing a theory as to the meaning of the word, testing the theory by subsequent observation, and modifying the theory as experience widens—in fact, by subjecting its experience to imagination, induction and deduction, and thus, as the logicians would say, generalising such experience. How exactly the process is carried out, even the New Psychology has not yet told us. But it certainly gets carried out somehow; and the result is a series of brilliant, though possibly to some extent sub-conscious, discoveries. The evolutionist would tell us, perhaps, in his learned phraseology, that this phenomenon is a case of the ontogenetic recapitulation of phylogeny, by which he would mean that the young animal in learning its mother-tongue passes in a few months or years through an epitome of the course of development for which the race required as many æons. Even so, the phenomenon does not lose its suggestiveness from our present point of view.

Whether it be because, when the mother-tongue has been acquired, the period of octogenetic recapitulation is complete, and the child brought thereby up to date, or because it is then brought into communication with encyclopædic friends, I cannot say; but certainly once the child is able to question its mysterious neighbours and to understand their answers, its power of applying the scientific method rapidly diminishes, becoming weakened apparently because of the readiness with which information may now be obtained by simple appeal to authority. But though weakened the power is not wholly lost; for it exhibits itself, more or less, in the study both of language and of natural phenomena, during the period of tutelage between early childhood and incipient manhood, and it comes into greater or smaller activity when the young man goes forth to engage in the work of life. And what his degree of success is to be in such work as his hand may find to do will depend, in no small measure, upon his power of putting that and that together and making knowledge for himself from his own experience.

The value of experience in the direction of the work of life does not need to be established by argument. It has become proverbial. But the connection of its value as a directing agency with the making of knowledge may need a few words of exposition. That the mental process which enables us to learn by experience in later life is a knowledge-making process—the same as that used by the child in acquiring its mother-tongue, though perhaps more consciously performed—becomes obvious if we consider any particular kind of work in which men engage. The merchant, to take a single case, in order that he may be able to foresee what kinds and qualities of the many articles in which he deals it will be desirable for him to have in stock, must watch the purchases of his customers, and make mental note of their satisfaction or discontent. The transactions are too numerous to be carried in the memory or to admit of written memoranda. If he is to make progress in judging as to what his stock should include, he must put related experiences together, weld the lessons he learns from them into general rules, and make these rules more and more accurate as time goes on. And the same is true of many other questions which he must settle for himself. Unless, in fact, he can generalise his mercantile experience, as a child generalises its linguistic experience, he must continue to buy and sell with no greater intelligence than he did at the outset of his business career.

"Till old experience do attain
To something like prophetic strain,"

as Milton puts it, he can have no complete success.

A similar statement may be made with respect to the physician, the farmer, the investigator, the housewife, the artisan, the politician, the clerk,—with respect, in fact, to all classes of workers, whatever the form of work in which they may be engaged. It may be made also, not only in regard to their main work, but in so far as they may in addition be engaged in athletic, literary, artistic, political, social, religious, or any other effort, and whether that effort take the form of work or play. In short, it is applicable to a greater or smaller extent to at least the great bulk of the various forms of activity of which the lives of most of us are made up. The subject-matter of experience, the material with which we must deal, is different in different cases; but there is one condition

[1] Inaugural address delivered at the opening of the fortieth session of Dalhousie College, Halifax, Nova Scotia, on September 13, by Prof. J. G. Macgregor.

of success which is common to them all,—the possession of the power of foreseeing; and there is one method of acquiring foresight,—the making of knowledge for ourselves from our own experience.

If this be so, it is obvious that this power of knowledge-making should be raised to as high a pitch of efficiency as possible before we enter upon the active work of life. Its growth, like that of all intellectual faculties, is slow; and the facility of its initial cultivation diminishes with advancing years. It is hazardous, therefore, to postpone its cultivation until we are face to face with the problems of life, or even until we enter upon the special study of the main work of life in the technical or professional school. It should be cultivated, and cultivated with especial care, during the whole period of tutelage, whether it be spent at the school only or in part in a department of liberal training of the college. And in order that it may be cultivated, it must be kept in continual exercise.

I do not know that provision for the exercise of this faculty has ever been generally made, with full consciousness, in either school or college; but it can readily be shown that it was given far more exercise in the educational institutions of two or three generations ago, than it is in general in those of the present day.

The curriculum of the old schools, which is also that of the old-fashioned conservative school of our time, consisted largely of classics and mathematical science (including natural philosophy), its backbone being the study of classics; and while the study of mathematics, though an admirable discipline, is for the most part deductive in character, and thus gives only a limited exercise to the power under consideration, the study of language, and especially the study of Latin and Greek, gives it very abundant exercise. Even if the study of a language is carried out with the aid of a grammar and a lexicon, *i.e.* with frequent appeal to authority, it involves continual putting together of instances of the usage of words and phrases which have come to our notice, formation of hypotheses as to their usage, and repeated modification of such hypotheses, after they have been brought to the touchstone of experience. The lexicon, especially the lexicon of the old school, would give little more than a clue in many cases to the English equivalents of say, Latin words, the exact equivalents, whether words or phrases, being determinable only by a study of the context and a fruitful drawing upon experience. And when we think how large is the number of words and phrases and constructions, of the usage of which the student of a language is gradually forming more and more accurate conceptions, we see at once how abundant is the exercise which this study provides of the putting of that and that together. The material on which the knowledge-making power is thus exercised, is of course of one kind, and therefore in general of a kind quite different from the material on which it must be exercised in after life. The exercise afforded is thus one-sided and by no means complete. But it is nevertheless exercise of the same intellectual power which we must later on apply to the more varied and complex material which life will afford.

While the study of the classics gave the student under the old régime considerable experience in the making of knowledge, the curriculum as a whole gave him both the key to his own literature and the literatures of Greece and Rome, and an introduction to the principles of the systems of knowledge which existed at the time. His stock of information we should now consider small; but it bore a great ratio to the whole body of available information. And it should be noted that such knowledge as the student had acquired, had been acquired in a leisurely, thoughtful way, and largely by his own effort, and would thus have become a permanent possession.

The men of the schools, therefore, in those days, had acquired, besides facility of access to the great storehouses of human wisdom, two things of direct importance for success in the work of life—an outfit of knowledge and the power of adding to it from their own experience. They were consequently men of power, and were recognised as such. And as it was the knowledge they possessed that was the only readily recognisable part of their outfit, their knowledge came naturally to be regarded as the secret of their power.

It appears to be Bacon to whom the credit belongs, of having coined the aphorism: "Knowledge is power." If so, to Bacon also must attach the opprobrium of having perpetuated a false and vicious generalisation. However important knowledge may be, it is not *the* essential condition of power. It is only one of the conditions. A second, perhaps the first, is the ability to make knowledge, which *may* be developed in the acquisition of knowledge, but also may not. No knowledge, no power: would have been sound doctrine; Knowledge *is* power: was false doctrine.

And while the possession of knowledge is essential to power, it is not the possession of an outfit of knowledge at the beginning of active life that is essential, but the possession of such outfit when it is wanted. In the old days the world's whole stock of knowledge was so comparatively small, that it was possible in the period of tutelage to get an outfit of its principles at least. At the present day the world's stock is so large, that the school and college can no longer furnish a corresponding outfit. Yet the men of the present day are at little disadvantage on that account. For as the volume of knowledge has increased, its accessibility has increased also. And thus, provided the student of to-day has been trained to acquire knowledge, has been taught, in fact, the most important of the three R's, the art of reading, with all that the art of reading involves, he can readily provide himself at any time with such information as he may require. Thus, nowadays, it is not so much knowledge that is even one of the conditions of success, as a well developed power of acquiring knowledge.

It was largely on the basis of Bacon's false generalisation that the fight was waged in later years between classics and the rapidly growing sciences. The advocates of the introduction of science into the curriculum of the school and college, based their demand mainly on the importance for success in life and for general culture, of a knowledge of the laws of natural phenomena. And their opponents, though relying largely on the excellence of the results achieved under the old system, met the utilitarian arguments of men of science by urging various minor utilities involved in the study of Latin and Greek. Neither party seems to have realised, at least fully, the more profound utility which might be involved in both kinds of study.

The introduction of science into the curriculum under this mistaken conviction could not but have unfortunate results. Its primary effect on the study of classics was to diminish the time devoted to it. But there was a more serious secondary effect; for, since knowledge was power, and as much knowledge of Latin and Greek must therefore be acquired, if possible, as before, the student had to be subjected to a forcing process. Helps of all kinds consequently developed a vigorous, nay a rank, growth—elaborate grammars full of detailed information, lexicons giving all the shades of meaning that words might have, annotated texts removing all difficulties from the student's path, even translations, fitly described in college slang as *cribs* and *ponies*. Power of translating was acquired by the aid of such educationally illegitimate helps; but it was acquired to a smaller extent than formerly, by the student's generalising his own experience and to a greater extent by the use of information derived from authority. The study of the classics consequently, first because of the diminution of time, and secondly because the time was no longer so well employed, came to provide a doubly diminished exercise of the knowledge-making power. The command of the classical languages, too, which was thus acquired, became for these reasons a less permanent possession; and the study of them no longer served to open up to the student, to the extent to which it had previously, the great literatures of the past.

Nor did the science study itself atone for the deterioration which its introduction involved in the study of classics. I need hardly point out that the method which is used in the making of knowledge in any branch of science, is the same as the method we must apply in making knowledge from the experience of everyday life. Indeed, it gets the name of the scientific method, because, though it had been used by men in all ages in the learning of languages and in learning by experience of all kinds, it was first brought to the notice of logicians by the rapid development of science, which resulted from its systematic application to the study of natural phenomena. Any single science, therefore, may be studied as any language may, so as to afford practice in knowledge-making. Language study has the advantage of affording a larger number of simple problems on the material of which the student has the widest experience. A science has the advantage of presenting problems with a greater range of difficulty on a material which is in general more complex. A group of sciences has the further advantage over even a group of languages, of affording a greater variety of subject-matter for the exercise of the knowledge-making power, and consequently giving the student practice in learning from experience under such different conditions as to fit him more completely for using his experience under the conditions of actual life.

The combination of linguistic and scientific study, therefore, if both had been conducted by knowledge making methods, might have been expected to produce better results in the cultivation of the knowledge-making power, than the study of either singly. But under the domination of the conviction that knowledge is power, science could not be studied in this way. The main object for which it had been introduced into the curriculum was the provision of an outfit of useful information, and the study must be carried on, so as to provide as large an outfit as possible. The obvious means of furnishing this outfit was the synoptic text-book, an epitome of the latest results in any branch of science; and all that the student had to do, in order to possess himself of it, was to get up the book. Clearly with this as his method he could not learn to use his own experience, but must become

"Deep versed in books and shallow in himself."

It is true, that when, after a time, the new science study was found to have become a mere getting up of books, the cry of "Back to nature!" was raised. As Wordsworth put it:

"Come forth into the light of things,
Let Nature be your teacher."

As a result, experimental demonstrations were tried; but they were found insufficient. And now laboratory work has been introduced into school and college, and students are made, themselves, to carry out many scientific processes. They are taught to use the balance, to verify Boyle's law, to measure electric currents, to prepare gases, to analyse solutions, to dissect frogs to classify insects, to use the microscope, to hunt out the names of plants. But they are always shown how to do the things required of them. And thus, from our present point of view, this mode of coming into the light of things can be of little avail. For while it makes the student's conceptions more vivid and the knowledge acquired more accurate and less transitory, and while it affords subsidiary training, *e.g.* of the hand and the eye, it gives but little additional opportunity of acquiring power in the making of knowledge. Even such additional opportunity as was at first afforded, when the student had no book to follow and was thrown to a certain extent upon his own resources, has now been withdrawn. For it was soon perceived that a greater amount of ground could be covered if he spent no time in working things out for himself. And so the text-book of laboratory work was devised, telling him exactly what to do and exactly how to do it. "Back to nature!" has thus meant: Back to books! And it could not have been otherwise. For under the conviction that it is knowledge that is power, practice in the putting of that and that together must appear to involve a waste of precious time.

There is another influence which has tended to strip the study of science of the high educational value which it might possess, viz., the influence of the written examination. Men of knowledge under the old régime having been found to be men of power, it became desirable that they should be certified by competent bodies. The degree and the diploma thus came into prominence; and the tests applied to candidates for them, when the candidates became numerous, took generally the form of written examinations. Now it is quite possible to test in this way the possession of command over a language, of deductive power in such subjects as mathematics or philosophy, and of information on any subject. But it is impossible to test by examinations of this kind, directly, the possession of the knowledge-making power. The making of knowledge, even in its humbler forms, is a creative process. It occurs only when the flash of imagination lights up the storehouses of experience and reveals the relations of its accumulated observations. And as the wind bloweth where it listeth, so imagination does not become luminous at command. Put even such men as Faraday or Darwin into the examination hall and tell them to spend an hour in exhibiting on paper their ability to find things out for themselves, and they must almost inevitably fail. It would, in fact, be no more absurd to ask a poet to exhibit true poetic inspiration, at a given date, than to ask a knowledge-maker to make knowledge.

If, therefore, the possession of knowledge-making power is to be tested at all by written examinations, it must be tested indirectly. And in some cases it can. The exercise of this power in the study of a language, besides strengthening the power itself, produces a command of the language which is not otherwise attainable. And consequently it is possible to test the acquisition of this power in linguistic study, indirectly, by a skilful testing of the candidate's command of the language. Its exercise in science study, however, produces in addition to increase of the power itself, nothing but a stock of information, which is much more readily obtainable from books. The acquisition of the knowledge-making power in science study cannot therefore be even indirectly tested by the written examination.

Now written examinations, when used either as the only tests, or as the chief tests, for a degree or a certificate, must tend to encourage the acquisition of what they are capable of testing and to discourage the acquisition of what they cannot test. For candidates soon find out what kind of work will pay, and they naturally confine themselves to it. Hence if such examinations are used as tests for degrees, while they may encourage the cultivation of the knowledge making power in linguistic study, they must discourage and repress it in the study of science.

And if this is the effect of written examinations generally, the effect is of course intensified when they are conducted by a central examining body. For the central examiner, who sets a paper for, say, the schools of a district, can obviously find out even less about the knowledge-making power of candidates than the examiner who can adapt his paper to the work done in a particular school. Centralised examining has serious evil effects of its own. But apart from such effects, which it would be foreign to my subject to discuss now, it must exert a specially strong influence in repressing the cultivation of the knowledge-making power, and in transforming the student into Pope's

"bookful blockhead, ignorantly read,
With loads of learned lumber in his head."

A third difficulty with which the sound teaching of science has met, arises from the complex character of its subject-matter. To compare different usages of words, for example, one has but to turn over the leaves of a book; to compare instances of the occurrence of natural phenomena, the phenomena must be watched for or reproduced under varying conditions. Knowledge-making, therefore, especially in its early stages, finds more difficult problems in science than in language; and the young investigator meets with greater hindrances to progress. The early investigators felt this difficulty, and banded themselves together in societies in order to enjoy the suggestions and criticism of their fellows. The science student of course needs the helping hand still more; and the teacher must be able to give the requisite aid in a judicious way. He must be a knowledge maker himself, must have sufficient experience in the subject he is teaching, and must be largely endowed with tact and common sense. Unfortunately the old curriculum furnished men with practically no experience of science, the new curriculum furnished men with little knowledge-making power, and no curriculum could furnish the tact and common sense. The available teachers have thus in general been incompetent. And in the making of scientific knowledge, a pupil under an incompetent teacher must stick fast.

Competent teachers in classics, on the other hand, have always been more readily obtainable. And—what is of more importance—in the making of linguistic knowledge, a pupil under an incompetent teacher does not stick fast. He has the experience of his childhood to help him, is capable of exercising the knowledge-making power, without the teacher's aid, on the familiar material which language affords, and in his effort to make progress, cannot help exercising it to a greater or smaller extent. Let me draw special attention to this point; for the fact that in the study of language, exercise of the knowledge-making power is not only possible, but in a large measure inevitable, even under an incompetent teacher, gives to language study a great advantage over science study, as a means of discipline in all educational institutions, but especially in those of lower grade, in which, owing to their large number, the difficulty of securing competent teachers is especially great.

The conclusions we have now reached may be summarised thus:—(1) Few of the subjects of the old curriculum could be studied without exercise of the knowledge-making power;—

many of the subjects of the new curriculum can. (2) The demand for useful information did not affect the old curriculum;—it seriously diminished the exercise of the knowledge-making power in the new. (3) Written examinations might stimulate such exercise in the old curriculum;—they could not but repress it in the new. (4) Competent teachers could readily be secured for the old curriculum;—they have not generally been available for the new. (5) Incompetent teachers could not largely exclude practice in knowledge-making under the old curriculum;—they could not fail to exclude it largely under the new. Obviously, therefore, the more intensely modern the curriculum has become, *i.e.* the more linguistic study has been excluded and science study introduced, the less efficient in general must the curriculum have become, so far as practice in knowledge-making is concerned.

If the above discussion is sound, any system such as our modern system, from which the method of investigation is largely excluded, must be distinctly inferior, as a means of preparing young people for the work of life, to a system such as the one which has become old-fashioned, in which it is given abundant exercise. It is difficult, however, to establish an inferiority in a case of this kind from experience. For in any trial that may be made of the two systems there must always be extraneous circumstances on which the burden of any observed inferiority may be laid. On the present occasion I cannot take time even to summarise such evidence as goes to show that the inferiority which is to be expected has been found to be actual. I must content myself with a mere reference to the result of what is perhaps the most decisive of all the trials which have been made, viz., that made in Prussia as to the relative educational efficiency of the Gymnasium, with its largely classical course, and the Realschule, with its largely scientific course. Both institutions had been conducted with characteristic German thoroughness with respect to the training of teachers and the provision of equipment, and the written examination system had been applied in a non-centralised form. Except in so far as tradition and the wider privileges of Gymnasium graduates may have led the more promising men to enter the Gymnasium, the two institutions seem to have worked under equally favourable conditions. Yet when in 1880, after a trial of more than ten years, the question of continuing to admit graduates of the Realschule to certain courses of the University of Berlin came up for discussion, even the scientific professors testified that for the work of their departments, mainly scientific research, the men nurtured in the Gymnasium had been found better qualified than those who had come up from the Realschule. The effect of tradition and privilege may have had much to do with this result; and the means of instruction in science twenty years ago were of course not so elaborate as they are now. But it is significant, that in the light of the present discussion, it was to be expected that for success even in scientific research, *i.e.* the making of new knowledge of natural phenomena, power of knowledge-making, though cultivated on linguistic study only, would be of greater importance than the stock of scientific knowledge which it is the aim of the modern curriculum to afford.

Our own experience in Nova Scotia is less definite. We have not had the two systems running side by side, and can only compare the present state of things with the past; and the comparison is complicated by the fact that the present state of things is in many respects in advance of the past. But there is no doubt that the country is full of a deep and growing discontent, which, though it finds vent at times in ill-grounded criticism, rests in the main on a solid basis. The farmer, to take a single example, finds that the boys he sends to the High School rarely return to the farm. He blames the school, with its Latin and its multiplicity of sciences, and demands the provision of something more practical, such as the teaching of agriculture. There are probably many reasons why the farmer's boy does not return to the farm; but there can be little doubt, if my position is sound, not merely that he is not fitted, but that he is actually unfitted, by his High School course, for the farmer's work. The farmer must, above all things, be able to learn quickly and accurately from his own experience. His boy, after passing through an intensely modern curriculum, under the pressure of a centralised examining system, and under the guidance of teachers in whom, for the most part, the colleges have failed to develop the investigating spirit and power, must almost inevitably be less able to make knowledge for himself out of his own experience, than he would have been, had he remained on the farm; while even that part of his large stock of acquired knowledge which bears upon agriculture must consist in general of inaccurate and ill-digested epitomes of sciences, in which he has little, if any, genuine interest. The farmer's discontent is therefore probably justified; but he is wrong in the details of his criticism. With the teachers who are at present available, Latin is the subject from which his boy will acquire, more than from any other, the essential power of putting that and that together. Although it is true that the usual synoptic study of the whole circle of the sciences will make his boy neither a farmer nor anything else, it is also true that a more informal study, a knowledge-making as distinguished from a mere information-supplying study, of bodies and the changes they undergo, and of plants and animals, rocks and soils, would cultivate in him the power of using his experience, give him, not much perhaps, but certainly some real knowledge bearing on agriculture, give him the scientific experience requisite for the reading of agricultural books, and give him a living interest in all the operations of the farm. Fruitful teaching in agriculture, however, is impossible. The teacher could teach it only if he were a somewhat experienced farmer himself; and even if he were, he could not teach it adequately to beings with such limited experience as boys.

Nor is the farmer the only exponent of discontent. The feeling of dissatisfaction is general. And if my position is sound it might be expected to be general. For if our school discipline fails to cultivate in our youth the power of learning by experience, it fails to give them what is at least one great essential of success, not in farming merely, but in whatever form of work they may be called upon to undertake.

There is one other educational experience, perhaps specially characteristic of our time, to which I should like to refer, viz., the frequency of the success of the self-made man. His success is usually attributed to innate ability, organising power, push, knowledge of men, and what not. To my mind it is largely due to a well developed power of learning by experience; and he owes that in great measure to the school of practical life in which he has had his training. This school provides an entirely different curriculum from the one we have been considering. It furnishes its pupils with no outfit of information whatever; but compels them to hunt out for themselves such information as they may require. And instead of devising cunning ways of stopping the putting of that and that together, it compels its pupils, by sending them early into active life, to cultivate that power for themselves. Many of them of course go down; for no helping hand is extended to them, and the method is rough. But many manage to obtain the knowledge they require, learn how to put the that and that of their experience together, and graduate, often, as we should say, with high honours, in one or other of the departments of active work. They may not have been brought into contact with much that makes for sweetness and light, and may thus be deficient in literary and general culture; but for all forms of activity that demand the generalising of experience, their rough school has given them a training which is, in some respects at least, admirable. Can we wonder then that the practical man, who rightly regards ability to tackle the main work of life as the most important component of a complete culture, and who sees daily the comparative helplessness of the products of the modern curriculum, decides to send his son as early as possible to the school of practical life?

If, notwithstanding the imperfect manner in which I have presented the value of the knowledge-making power, you are convinced of its great importance, you cannot fail to be interested in the question: How are we to secure its cultivation in the school and college?

We may dismiss at once the proposal suggested by what has been said as to the efficiency of the old-fashioned school, that we should return to the classical curriculum, or, at any rate, to language, as the chief means of educational discipline. Such harking back, even looked at from our present point of view only, would be bad policy, for two reasons, (1) because a combination of language and science study, if both are properly carried out, affords a far better training in knowledge-making than either singly, and (2) because, though an outfit of knowledge of science, adequate for use in the work of life, is no longer capable of being provided beforehand as part of a course of liberal training, the acquisition of power of acquiring knowledge demands considerable scientific experience. A curriculum of which science is an important component, therefore, should be retained, provided the science as well as the language be studied by knowledge-making methods.

Nor need we stop to consider the assertion, made by eminent educational authorities, that in the school at least, such methods cannot be employed in science, or that they have been tried and have failed. Both assertions are sufficiently met by the fact that under favourable conditions, they have been tried and have succeeded.[1] But it must be admitted that knowledge-making methods could not be introduced generally with success, under the prevalent conditions of the present day. For so long as a large body of varied information is an essential condition of academic distinction, so long as the written examination is used as the main test of proficiency, and so long as teachers themselves have not had the investigating spirit developed in them, the school cannot cultivate the knowledge-making power in any large measure.

Reform, to be radical, therefore, must begin with the universities, and with the leading universities. They only can make the conditions for degrees what they please, and they only can hold the examiner completely in check. The smaller universities and colleges must, in the interests of their students, follow more or less the lead of their bigger sisters; and though Councils of Public Instruction and other bodies which govern schools may be largely free to modify their curricula and to regulate their examinations, they cannot secure the services of teachers who are imbued with the investigating spirit, until that spirit has become embodied in the universities.

But while radical reform may not be possible at present, partial reform can be carried out even by a college such as ours, by its steering a middle course between encouraging the use of knowledge-making methods and supplying the information demanded by the larger universities, and by thus cultivating the power and the spirit of investigation to as great an extent as may be possible under present conditions. And the reform thus inaugurated may be extended to the schools of its district, through the teachers supplied by the college, if the governing body of the schools is willing to co-operate. . . . . .

It is true that as the early investigators in science made progress without the complex and therefore costly appliances which the investigator of to-day in general requires, so students can get an astonishingly large amount of practice in knowledge-making with very simple materials, and that consequently a knowledge-making equipment involves much smaller expenditure than that which is required by the up-to-date course. Nevertheless, even for practice in the making of knowledge which was made by others long ago, not to speak of the making of knowledge of a later date, or of new knowlege, our equipment is entirely inadequate.

There is still another aspect in which we are deficient, viz., in the working facilities afforded to professors. That the professor of a scientific subject may cultivate the knowledge-making power in his students, he must be a knowledge-maker himself; and to do so in full measure he must be enabled to prosecute original research under favourable conditions. His work may be humble, and its value may be comparatively small; but provided its value is real, it will help him to kindle in his students the enthusiasm which springs from the conviction that the subject they are studying is a growing subject, and that it is possible for them to assist in its growth. It is not therefore in the interest of the professors, but in the interest of their students, that I hold it to be the duty of the college to give professors both the time and the necessary outfit for research. Giving them the requisite time means the provision of competent assistants. Giving them the requisite outfit means the provision, not necessarily by any means of completely equipped laboratories, but of books and other working appliances sufficient for at least a few lines of research.

At first sight the considerable expenditure which would be required for this purpose, will appear to most of you to be expenditure on luxury; and possibly the benefit which a college derives from the fact that its professors are known as original investigators, although undoubtedly great, may be of the nature of a luxury. But when we reflect on the importance of training all our young people to use their experience, and consequently of stimulating our college students, many of whom are to be the teachers of our youth, to acquire the knowledge-making power in the highest possible degree, it becomes apparent that research facilities for our professors are not a mere luxury, but are necessary for the performance of thoroughly successful educational work.

I have referred so far only to what liberal training requires. In addition, it is desirable, especially from the point of view o. the provision of teachers of higher grade, that those of our students who have shown great promise of power in the making of knowledge, should, without leaving their own country, have ready access to the requisite facilities for research in any department in which they may wish to carry on special study. In other words, Canada ought to have at least one university thoroughly equipped for investigation in all the main departments of knowledge—and I say one, because, however desirable such equipment would be in all, with our local art schools and agricultural schools and other technical schools undeveloped, the country cannot probably afford more than one. And this is desirable, not in order that Canada may take her place worthily among other nations by contributing her share to the growth of knowledge, and not because of the material progress that might result from the advance of science, but mainly because the fruitful investigating work that would be conducted at a fully equipped university, would tend to foster the spirit of investigation in all the colleges, and through the teachers they supply, in all the schools, and would thus tend to make even those who never enter a college better knowledge-makers, and therefore more successful men, in whatever department of work they might be engaged.

It is for this reason that the young people of Canada are to be congratulated, even more than the institution immediately concerned, on the great strides which McGill University has recently been enabled to make towards complete equipment; and for the same reason, I may express the hope, in which I know you will all join, that she may soon acquire as thorough an outfit in all departments as she has already acquired in some. If but one of our universities is to receive complete equipment at present, it is fitting that the one having its seat in our commercial metropolis should be selected for the trust. And if McGill University, regarding herself as the trustee of a rich endowment, held for the benefit of the whole Dominion, is able to rise to the level of her opportunity, her influence will, at no distant date, be felt for good in the life work of every Canadian.

The friends of our smaller colleges must therefore rejoice in the rapid enrichment of their more fortunate sister. Nevertheless its first effect upon them has naturally been one of depression. It is obviously impossible for them to do for the colleges in which they are interested, what McGill's benefactors are doing for her. And, although in a country of such magnificent distances as Canada, it is obviously desirable that our young men should have colleges, or at least a college, provided for them in their own section of the Dominion, in order that as many of them as possible may enjoy the advantage of the higher forms of education, and also that their own section may retain their services for its own development, those who have hitherto supported the smaller colleges naturally ask: Is it worth while for us to make any further effort? Indeed, are we justified in encouraging our young people to attend the smaller colleges when a university so much more fully equipped is open to them?

Such questions receive their answer from the present discussion. Liberal training does not demand, as the provision of encyclopædic knowledge does, that students should be supplied with all the books and all the latest contrivances in all departments of knowledge, or even in any department. It demands only, so far as subjects requiring costly equipment are concerned, that they should have access to such equipment in the chief departments as will enable them to have sufficient and sufficiently varied exercise of the knowledge-making power. Complete equipment is requisite only in an institution which aims at furnishing opportunity for original research on all lines, in fact, at the making of specialists rather than the making of men. Only a small part of such an equipment is necessary for, or can be used in, even the most thorough liberal training.

It follows that the small college with incomplete equipment can furnish quite as sound and thorough liberal training as the completely equipped university, provided it is not too small to supply the important training which college life affords, and provided its equipment, though comparatively small, is adequate; and consequently, that if both these conditions are fulfilled, it is completely justified in inviting students to trust their training to its care.

[1] See Armstrong: "The Heuristic Method of Teaching: Special Reports on Educational Subjects," vol. ii. (London: Education Department, 1898.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—A statute will be promulgated early next term with the intention of instituting degrees of Doctor of Letters and Doctor of Science. The present statutes provide for the degree of Bachelor of Letters and Bachelor of Science, for which a course of special study or research, and a residence of two years, are required. Several of these research degrees have been granted during the last four years. It is now proposed that the Doctorate should be instituted, for which a candidate shall submit published papers or books containing an original contribution to the advancement of learning or science. A candidate for the degree of Doctor of Science must either be a Bachelor of Science of twenty-six terms standing, or a Master of Arts of thirty-nine terms standing.

The B.Sc. degree has been granted to Mr. H. N. Dickson, of New College; his dissertation consisted of a chemical and physical examination of the surface waters of the North Atlantic collected during 1896 and 1897, and contained 4000 estimations of the salinity.

The lecture list announced for next term contains those to be delivered under the newly instituted School of Geography.

Dr. John Scott Haldane has been reappointed lecturer in physiology for a period of three years.

The newly instituted John Locke scholarship in mental philosophy has not been awarded.

The following alternative subjects are recommended for the Johnson Memorial Prize in 1903: (1) periodic orbits; (2) meteors; (3) an investigation of the image of a star in a telescope as affected by the physical properties of light.

Dr. J. A H. Murray, editor of the "New English Dictionary," has been appointed Romanes lecturer for 1900.

The annual grant of 300*l*. to the chemistry department of the University Museum has been renewed for five years, and the sum of 170*l*. is to be spent on cases for the Pitt-Rivers Museum.

CAMBRIDGE.—Prof. Marshall Ward has been elected a member of the General Board of Studies.

Mr. Timothy Holmes and Prof. W. Burnside, F R.S., have been elected Honorary Fellows of Pembroke College.

A Shuttleworth Scholarship in Botany and Comparative Anatomy will be awarded at Caius College in March next. The value is 55*l*. a year for three years, and candidates must be medical students of the university of not less than eight terms' standing. Application is to be made to the senior tutor before March 1.

MR. R. T. GLAZEBROOK'S successor as principal of University College, Liverpool, is Mr. A. W. W. Dale, Fellow and Tutor of Trinity Hall, Cambridge.

SIR WILLIAM C. MACDONALD, of Montreal, has founded a Chair of Geology for McGill University in that city, as a memorial of the late Sir William Dawson. According to the terms of the gift, the income of the endowment will be paid to Lady Dawson during her lifetime, and on her death will become available for the maintenance of the new Chair.

AT University College, London, a course of eight lectures dealing with the methods of spectroscopy especially in connection with the photography of the spectrum will be given on Friday evenings, at 5.30, by Mr. E. C. C. Baly, commencing on January 19, 1900. Among the subjects to be treated and illustrated by experiments are:—The history of the determination of the modern standards of wave lengths; the comparison of spectra and determination of wave lengths visually and photographically with prism apparatus; the determination of wave lengths with the grating; and methods of producing emission and absorption spectra.

A COPY of the special report on the new department of agricultural chemistry of the University College of Wales, Aberystwyth, recently submitted to the Court of Governors, has been received. The work of this promising department of the College is carried on in premises specially designed for the purpose. This accounts for the convenient arrangements for access and inter-communication shown upon the plan which accompanies the report. The rooms and the laboratory fittings give evidence that much care has been taken to design arrangements which will conserve the energies of the staff, and give facilities for good practical work by the students.

ON Thursday last, upon the occasion of the distribution of prizes and certificates to the successful students of the Goldsmiths' Company's Technical and Recreative Institute, New Cross, Mr Asquith made a few remarks on the work of polytechnic institutes in London. He pointed out that in the metropolitan area, north and south of the Thames, there are no less than eleven institutions of this kind, with four or five subsidiary branches, upon which a capital expenditure of no less than 500,000*l*., at the least, has been made, with an annual expense to those who promoted them of something like 130,000*l*., and with an attendance of no less than 50,000 students. The Goldsmiths' Institute is not only one of the most flourishing among London polytechnic institutions, but in some respects it is unique. Unlike every other institution of the kind in London, it does not receive grants of money either from the Technical Board of the London County Council or from the Central Parochial Foundation of the City of London. The whole cost, except the comparatively insignificant sum received from the students' fees, is defrayed out of the funds of the Goldsmiths' Company.

THE *Times* reports that the executive committee of the Agricultural Education Committee has recently passed a series of resolutions including the following:—(1) That, in view of the importance of concentrating the control of agricultural and rural education in the hands of one Government department, it is expedient that all the educational work of the Board of Agriculture should be transferred to the new Board of Education; (2) that the staff of the new Board should include an adequate number of inspectors, well acquainted with the needs of the agricultural classes and the conditions of country life; (3) that the Board's inspectors should be instructed to see that the curricula of rural schools are differentiated from those of urban schools. With regard to training, the committee think that provision should at once be made at certain of the teachers' training colleges for giving those students who desire it practical as well as theoretical instruction in subjects bearing on agriculture and horticulture; and that a special rural teachers' certificate should be awarded to those teachers who have gone through a full course of instruction, practical and scientific, in agricultural subjects. As to higher agricultural instruction, it is suggested that the Board of Education should encourage those county authorities, who have not yet done so, to provide, or to contribute to, school and experimental farms, and should inspect and report annually on such farms; that no more certificates for proficiency in the "principles of agriculture" should be granted to persons who have not completed an adequate course of practical instruction; and that the courses for Schools of Science situate in country districts should be differentiated from those of urban schools of science by substituting instruction in agricultural science and experimental agriculture for that in other subjects. Another resolution suggests that, with a view to interest agricultural societies in the work of agricultural education, they should be supplied with leaflets, reports, &c., to distribute among their members, who should be invited to visit agricultural schools and experimental plots in their neighbourhood, and to discuss them at their meetings.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, December 8.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair.—Prof. S. P. Thompson read a paper on obliquely crossed cylindrical lenses. Any two cylindrical lenses crossed obliquely are optically equivalent to two other cylindrical lenses crossed rectangularly, and hence to a sphero-cylindrical lens. Owing to the difficulty of manufacturing cylindrical lenses with the axes of the opposite faces in different directions, it becomes of importance to the optician to be able to calculate the constants of the equivalent but more easily ground sphero-cylindrical lens. To a first approximation a surface of radius of curvature "r" will impress upon a plane wave a curvature of $\frac{\mu - 1}{r}$ where "μ" is the refractive index of the material. If we suppose an equiconvex cylindrical lens cut by two planes at right angles, the line of intersection of the planes passing normally through the centre of the lens, then the sections of the lens will in general be portions of ellipses. It is possible, therefore, to write down in terms of the angle which one of these planes makes with the axis, the convergivity which would be impressed by the lens upon plane waves travelling in these planes. The effect of a second lens crossing the first obliquely can also be written down with respect to the same two planes. The joint effect of the two lenses can then be resolved along any two lines at right angles. Differentiating the expressions for these effects and equating to zero, we get the directions of maximum and minimum cylindricity. These directions are at right angles, and represent two lenses crossed rectangularly, which are the optical equivalent of the original pair considered. The sphero-cylindrical lens is then easily obtained. From the mathematical expressions Prof. Thompson has deduced a graphical solution of the problem. The author exhibited a convenient combination of two cylindrical lenses for giving varying degrees of cylindricity. Let two lenses be ground, each being a mixed equi-cylinder consisting of a concave and convex ground at right angles to one another on the opposite faces of the glass. Two such mixed cylinders, if rotated with equal motion in opposite directions, will give a varying cylindricity of fixed direction in space. With the axes of positive cylindricity coincident they give the maximum; but when each is rotated 45°, their resultant is zero. When rotated beyond 45°, the resultant axis of cylindricity is negative in the fixed direction in which it was formerly positive.—Mr. T. H. Blakesley read a paper on exact formulæ for lenses. In this paper the author makes use of the definition of focal length with respect to magnifying power, which he has described in the *Proceedings* of the Physical Society for November 1897. By this method the focal length of a lens combination is simply a line and not the distance between two definite points. Following the methods of his previous paper, Mr. Blakesley showed how it was possible to determine accurately the constants of lens combinations, and pointed out practical applications to the racking of telescopes for camera work, the determination of refractive indices of liquids, &c.—Prof. W. E. Dalby exhibited a friction dynamometer. The torque to be measured produces a twist in a spiral spring, and the object is to determine the amount of this twist. Side by side upon the shaft are two pulleys, one keyed to the shaft and the other fastened to the end of the spring. The lead of one pulley upon the other, therefore, measures the twist. Two other pulleys are mounted upon a slide, and are joined up to the first ones by means of a continuous band similar to a Weston's differential pulley block. When the shaft is at rest, the two pulleys on the slide are touching; but any motion of the shaft produces a twist in the spring, and therefore a lead of one of the shaft pulleys on the other. This produces a separation of the slide pulleys, which is proportional to the lead, and therefore to the torque, and so from a knowledge of the constants of the dynamometer and its number of revolutions per second the power transmitted is at once determined.—Prof. S. P. Thompson read a note on an organic compound of great double refraction. This substance is crystallised naphthaline, and it is 60 per cent. more doubly refracting than Iceland spar. It is exceedingly brittle, and therefore difficult to work into prisms. Any worked surface must be at once covered with glass to prevent sublimation.—The Society then adjourned until January 26, 1900.

Zoological Society, November 28.—Dr. Henry Woodward, F.R.S., Vice-President, in the chair.—Mr. Lydekker exhibited (on behalf of Messrs. Rowland Ward, Ltd.) and remarked on a headless skin of a kob-like antelope from Lake Mweru, which he proposed to call *Cobus smithemani*, after its discoverer, Mr. F. Smitheman. He likewise exhibited the skull and horns of another kob, belonging to Sir E. G. Loder, for which the name *C. vardoni loderi* was suggested.—Mr. Oldfield Thomas exhibited the skull of a baboon recently obtained at Aden by Messrs. Percival and Dodson. It appeared to represent a new species allied to *Papio hamadryas*, but distinguished by its small size, the row of upper cheek-teeth being only 41·5 mm. in length. It was proposed to be named *Papio arabicus*.—Mr. W. Saville-Kent exhibited, with the aid of the lantern, a series of slides demonstrating the utility of trichromatic photography as applied to the correct colour-registration of biological subjects. Photographic transparencies representing various species of plants and animals were included in the series.—Mr. J. S. Budgett gave a general account, illustrated with lantern-slides, of his recent expedition to the Gambia Colony and Protectorate, undertaken primarily for the study of the habits of *Polypterus*. Some living and spirit specimens of this fish were exhibited, and remarks were made upon it, as also upon *Protopterus*, of which examples were likewise obtained. Special reference was made to the antelopes met with during a trip up the Gambia River to the end of its navigable waters, and specimens of the heads of those obtained were laid on the table. A collection of Gambian birds was also exhibited.—A communication was read from Mr. L. A. Borradaile, in which it was shown that both genera (*Coenobita* and *Birgus*) of the Pagurine land-crabs (*Coenobitidae*) are hatched in the *Zoaea*-stage.—Dr. W. G. Ridewood read a paper on the relations of the efferent branchial blood-vessels to the *circulus cephalicus* in the Teleostean fishes, based upon an examination of specimens of sixty-one species. He demonstrated the great variation that is met with in the arrangement of the efferent vessels, and discussed the possibility of utilising the characters as a means of arriving at a natural classification of the group.—Mr. G. A. Boulenger, F.R.S., read a paper on the reptiles, batrachians and fishes collected by the late Mr. John Whitehead in the interior of Hainan. The collection contained specimens of fifteen species, embracing four species of reptiles, six of batrachians, and five of fishes. Of these, two species of reptiles, three of batrachians, and three of fishes were described as new.—A communication was read from Dr. A. G. Butler on a collection of butterflies made by Mr. Richard Crawshay in British East Africa. Sixty-eight species were enumerated and remarked upon, of which four were described as new.—A second communication from Dr. Butler contained a list of a small collection of butterflies made by Captain Hobart, of the Grenadier Guards, in the Nandi District of the Uganda Protectorate. Of the seventeen species represented in the collection, one (*Cymothoe hobarti*) was described as new.—A communication was read from Mr. J. Y. Johnson, containing a note on the habit and mode of growth of the corals belonging to the genus *Pleurocorallium*.—Mr. W. E. de Winton made some supplementary remarks to those published in the *Proceedings* for 1898 (p. 900), on the moulting of the King Penguin (*Aptenodytes pennanti*) now living in the Society's Gardens.

Entomological Society, November 15.—Mr. G. H. Verrall, President, in the chair.—The President announced the death of Dr. C. G. Thomson, one of the honorary fellows of the Society.—Mr. J. J. Walker exhibited four examples of a species of Curculionidæ—*Cleonus sulcirostris*, taken on red sandy soil at Barr's Hill, near Oxford. These examples, he pointed out, were of a reddish tint, harmonising with the colour of the soil on which they were found, and in marked contrast to that of normal grey specimens, some of which, taken at Deal and Reading, he showed for comparison.—The President exhibited specimens of *Chersodromia hirta*, which were found under sea-weed at Brora in August 1899.—Mr G. W. Kirkaldy exhibited two species of Hemiptera of economic interest, one a Pyrrhochorid—*Dysdercus cingulatus* (Fabr.), sent by Mr. E. E. Green from Ceylon, where it was found appearing in abundance on the cotton plants, the other a Psyllid—*Aleyrodicus dugesii* Cockl., forwarded by M. A Dugès, who stated that it is attacking the white mulberries in Mexico.—Mr. J. H. Leech contributed part iii. of his paper on Lepidoptera Heterocera from Northern China, Japan, and Corea.

CAMBRIDGE.

Philosophical Society, November 13.—Mr. Larmor, President, in the chair.—Intumescences on *Hibiscus vitifolius*, by Miss E. Dale. *Hibiscus vitifolius* is a plant which is common in the hotter parts of Asia, Africa and Australia. It is usually very hairy, but the hairiness is subject to considerable variation, and the hairs are of several different kinds. On plants grown in greenhouses there are formed abnormal outgrowths of the epidermal and the subepidermal tissue of the stems and leaves. These emergences, especially on the leaves, usually bear stomata at their apices, and those on the stem are characterised by the formation of a cork-cambium at the base of each, which cuts off the older outgrowths. No traces of fungi or mites have been found, but experiments show that these outgrowths are not formed on plants in the open, where transpiration is more freely promoted. Seedlings and cuttings from such plants devoid of outgrowths, when placed in a greenhouse, develop outgrowths, while seedlings from plants provided with them, and which themselves have developed them, lose them if transferred to the open. It seems therefore probable that growth under glass may promote the production of some actively osmotic body in the young cells, and that the over-turgescence is expressed in the abnormal protrusions. Hence the application of the name "Intumescences."—Note on the name *Balanoglossus*, by Dr. Harmer. It was suggested that the species which belong to *Balanoglossus* as restricted by Spengel should be placed in a new genus *Balanocephalus*, whose type-species would be *B. kupfferi*. *Balanoglossus* should be dropped as a generic name, but may conveniently be retained as a semi-popular designation in cases where it is not desired to restrict a statement to any particular genus of the Enteropneusta.—The skeleton of *Astrosclera* compared with that of the Pharetronid sponges, by J. J. Lister. The structure of *Astrosclera willeyana*, the representative of a new family of sponges, obtained by Dr. Willey in the Loyalty Islands, was described, and attention was drawn to the resemblance between its skeleton and that of some members of the *Pharetrones*, a group of sponges which are found as fossils in formations ranging from the Carboniferous to the Cretaceous period. It was pointed out that the resemblance between the skeletal elements formed within the living protoplasm of *Astrosclera* and the bodies formed by purely physical processes in the St. Cassian fossils may have a bearing on the problem of the mode of origin of sponge spicules.—Note on hypotheses as to the origin of the paired limbs of Vertebrates, by J. Graham Kerr. In a paper on hypotheses as to the origin of the paired limbs of Vertebrates, which was taken as read, Mr. J. Graham Kerr referred first to the two hypotheses which were predominant at the present time as explaining the origin of the paired limbs—that which derives them from portions of a once continuous lateral finfold, and that which derives them from the septa between adjacent gill-clefts. The first portion of the paper consisted of a brief statement of these two views together with the fundamental facts upon which they rest, followed by a critical examination of them in the light of modern research. The author came to the conclusion that both views must be looked upon rather as suggestive hypotheses than as scientific theories of the facts as at present known to us. He therefore ventured to bring forward a third view, confessedly a mere hypothesis, which seemed to him to have received very inadequate attention—that the paired limbs are homodynamous with the somatic or true external gills.—Observations upon Polypterus and Protopterus, by J. S. Budgett. Two distinct species of Polypterus occur in the Gambia, *Polypterus lapradii* and *Polypterus senegalus*; the latter was observed in captivity and also in the wild state. The pectoral fins are distinctly organs of propulsion and not as in Teleosts almost exclusively balancers. Polypteros uses its bilobed air bladder as a lung, and can survive an exposure to a damp atmosphere of twenty-four hours. The spiracle is used to emit the excess of air in the pharynx but not for the passage of water. Both species migrate from the river to the flooded meadows in June and July and, spawning in August and September, return to the river in October and November.

EDINBURGH.

Royal Society, December 4.—Lord Kelvin in the chair. As usual at the first meeting of the session, the President gave a brief sketch of the work accomplished last session. Lord Kelvin then proceeded to discuss two physical problems, namely, the problem of the spinning top, and the question as to the manner in which ether is affected by the motion through it of attracting and repelling points. Many mathematicians of the highest order had attacked the problem of the rotation of a rigid body of which one point is fixed; but the peculiarity of the spinning top was that no point was fixed until it settled into the so-called "sleeping" condition. Mr. Archibald Smith, in a paper published in the first volume of the *Cambridge Math. Journ.* (1837), seems to have been the first to have correctly considered the question, Why does a spinning top rise to the sleeping state and then fall away again? And no later mathematician seems to have taken up this question at all. Lord Kelvin had recently worked out a simple case in which the centre of gravity was constrained to move in a vertical line. The minimum angular velocity, for which the upright "sleeping" motion was stable, depended in a simple way upon the curvature of the assumed hemispherical apex on which the top spun. The second problem was a fresh attempt to reconcile the apparently opposite properties of ether which render it so mobile to mass motions through it and yet so sensitive to rapid molecular vibrations. Briefly stated, the idea was to have an intermediate link between the molecule and ether in the form of a "doublet feeler." This doublet consisted of repelling and attracting points, which produced appropriate strains in the ether when themselves set in vibration by the vibrating molecule. The idea, however, gave no clue as to the nature of electricity and magnetism.—In a paper on the rectal gland of the Elasmobranchs, Dr. J. Crawford gave an account of an investigation into the structure and function of this appendage in the dog-fish and skate. The evidence was in favour of its being an excretory organ of the nature of a kidney.—An obituary notice of Dr. Charles Hayes Higgins, prepared by Dr. Sydney Marsden, was read.—Dr. Noel Paton gave an account of further investigations of the life history of the salmon in fresh water. This second instalment dealt chiefly with the fish taken in the months February, March and April, and the general conclusions agreed with those already drawn, the chief result being that the migration of the salmon is regulated wholly by the question of nutrition. The comparative scarcity of male fish caught prevented any certain conclusions being drawn in regard to them. From a comparative study of the pigments Miss Newbiggin had collected strong evidence in favour of Sir John Murray's view that the colour of the salmon was derived from the pigments in the Crustacea, which supplied directly or indirectly the chief food for these fish.—Dr. Thomas Muir communicated a paper on the eliminant of a set of general ternary quadrics, Part ii.

Mathematical Society, December 8.—Mr. R. F. Muirhead, President, in the chair. The following papers were read:—On the evaluation of a certain determinant, by Prof. Crawford.—A special case of the dissection of any two triangles into mutually similar pairs of triangles, by Mr. Alex. D. Russell.—Elementary proof of the potential theorems regarding uniform spherical shells, by Dr. Peddie.

PARIS.

Academy of Sciences, December 4.—M. van Tieghem in the chair. Justification of Fermat's principle on the economy of time in the transmission of a luminous movement through a heterogeneous transparent isotropic medium, by M. J. Boussinesq. Researches on the phenomena of phosphorescence produced by the radiation of radium, by M. Henri Becquerel. The rays given off by some milligrams of barium chloride containing radium were allowed to fall upon various substances, such as calcium and strontium sulphides, rubies, diamond, calc spar, fluorite, and hexagonal blende, in a Becquerel phosphoroscope. When placed first in the dark, and then brought up to within a few millimetres of the radiating substance, all those minerals which became luminous under the influence of the X-rays, also became luminous under the radium rays; but ruby and calc spar, which only become phosphorescent under luminous rays, remained dark. There are, however, differences between the X-rays and these new radiations. Thus a specimen of diamond which was brilliantly luminous under the action of radium did not become luminous when exposed to the radiation from a focus tube, and similar differences were noted for other substances. The whole of the facts observed show that there is really a continuous giving out of energy by radio-active bodies.—On the metallic compound radicals: mercury derivatives, by M. Berthélot. Measurements of the heat of combustion and formation of mercury-methyl, mercury-ethyl, and mercury-phenyl.—Lactic acid, by MM. Berthélot and Delépine. A thermochemical study of lactic acid, and lactones derived from it.—On the explosion of potassium chlorate, by M. Berthélot. If potassium chlorate is introduced suddenly into a vessel which has been previously heated to a temperature much above that at which decomposition commences, an explosion takes place, as with picric acid under similar conditions, although under a slow heating potassium chlorate shows no explosive properties. The explosion produced is clear and sharp, although a little prolonged, resembling a slow powder. These facts give a probable explanation of the recent explosion of chlorate at St. Helens.—On the normal existence of arsenic in animals, and its localisation in certain organs, by M. Armand Gautier. From a consideration of the use of arsenical compounds as a specific in certain diseases, especially in anæmia and Basedow's disease, the author came to the conclusion that the activity of arsenic in such diseases must be to its forming a constituent part of some organs, more particularly the thyroid gland. A search for arsenic showed that it is present as a normal constituent of the thyroid gland in weighable amounts in herbivora, carnivora, and in man. It is also present in smaller quantities in some other organs. In the normal state, there would appear to be about 1 milligram of arsenic in 127 grams of thyroid gland. Further research showed that if the gland is slowly digested at 38° in presence of acidulated pepsine solution, the peptone formed contained no arsenic, the whole being concentrated in the residue of cellular nuclei.—Research and estimation of minimal quantities of arsenic in the organs, by M. Armand Gautier. The tissues are warmed with pure nitric acid (containing about one per cent. of sulphuric acid) until the whole is liquefied, then strong sulphuric acid is added and heat again applied, the oxidation being completed by the addition of nitric acid in small quantities. The liquid is diluted largely with water, sulphurous acid added, and hydrogen sulphide passed for some hours. After purification, the arsenic sulphide is oxidised and poured into a Marsh's apparatus.—M. Georges Lemoine was elected a Member in the Section of Chemistry in the place of the late M. Friedel.—Particulars of a destructive earthquake in the Moluccas on September 30, by the French Consul at Batavia.—Remarks by M. Lœwy on the "Annales de l'Observatoire de Toulouse."—Observations of the Leonids and Biélids made at Athens, November 1899, by M. D. Éginitis.—On some properties of certain systems of circles and spheres, by M. C. Guichard.—On the theory of groups, by M. R. Baire.—On differential equations of the second order with fixed critical points, by M. Paul Painlevé.—Generalisation of a formula of Gauss, by M. E. Busche.—On the transformation of Abelian functions, by M. G. Humbert.—Influence of the X-rays upon the electrical resistance of selenium, by M. Perreau. The X-rays were found to reduce the resistance of selenium in a similar manner to light rays, the reduction caused by the Chabaud tube used being nearly the same as that caused by diffused daylight, or a gas flame at 1·5 metres.—On the proof of the fluorescence of aluminium and magnesium in water and in alcohol under the action of the currents from an induction coil, by M. Thomas Tommasina.—Dissociation of potassium and ammonium iodomercurates by water, by M. Maurice Francois. The decomposition of $(NH_4)I.HgI_2.H_2O$ and of $KI.HgI_2.5H_2O$ is a limited one, and is reversible. When the state of equilibrium is attained, the amount of alkaline iodide present in the liquid is constant for a given temperature.—On the heats of partial neutralisation of carbonyl-ferrocyanic acid compared with those of ferrocyanic acid, by M. J. A. Muller. Carbonyl-ferrocyanic and ferrocyanic acids are of the same order of strength.—On some new combinations of benzene with phosphoric anhydride, by M. H. Giran.—Preparation of tetrachloro- and tetrabromo-orthoquinones starting from the corresponding tetrahaloid derivatives of guiacol and veratrol, by M. H. Cousin. The tetrachloro-derivatives of guiacol and veratrol are first hydrolysed by nitric acid, and the resulting pyrocatechols oxidised to the corresponding quinones.—On a case of hysterical hemiplegia cured by hypnotic suggestion and studied by chronophotography, by M. G. Marinesco.—Biological observations on *Peripatus capensis*, by M. E. L. Bouvier.—On the hybrid fertilisation of the albumen, by M. Hugo de Vries.—The Cretaceous minerals of Aquitaine, by M. Ph. Glangeaud.—On the history of the Jiu valley, in the Central Carpathians, by M. E. de Martonne.—On the vestiges of an ancient vitrified stronghold in the upper valley of the Dore (Puy-de-Dôme), by M. J. Uselade.

NEW SOUTH WALES.

Royal Society, September 6.—The President, W. M. Hamlet, in the chair.—"Sailing birds are dependent on wave-power," by L. Hargrave. The author points out that sailing birds passed most of their time over the face or rising side of waves, and that by so doing they abstracted power from the moving water as the progress of the wave raised the air above it at a velocity proportional to its speed and slope. He used Prof. S. P. Langley's results to show that the uplift of a moderate swell was amply sufficient to support a plane and keep it moving at about thirty-five miles per hour in a calm.—"Some applications and developments of the prismoidal formula," by G. H. Knibbs. Starting with a demonstration that the prismoidal formula was rigorously applicable to solids with parallel plane ends, whose mantles were ruled surfaces, the paper showed how the volumes of series of longitudinally contiguous solids, with plane ends, and skew or warped—ruled quadric—surfaces on the other sides, could most conveniently be calculated. The determination of the volumes of solids whose longitudinal axes were plane-curves, or curves of double curvature, was also considered, and it was shown that the prismoidal formula was also rigorously applicable to circularly warped solids, the centre of gravity in such changing its position linearly with the distance along the curved longitudinal axis. When the change of the centre of gravity of a right section is a non-linear function of the distance along the curved axis, or when the radius of curvature is not constant, the prismoidal formula is not rigorously applicable. The paper closed with suggestions as to the application of the formulæ.—Among the exhibits were twenty-four mounted photographs, including a series of photographs of aboriginals representing two types, male and female, a few illustrative of camp life and corroborrees, and a special series illustrating some of the details of an aboriginal Bora ceremony. The photographs were taken and exhibited by Mr. Chas. H. Kerry, and afterwards presented to the Society.

Royal Society, October 4.—Prof. T. W. E. David, Vice-President, in the chair.—Current Papers, No. 4, by H. C. Russell, C.M.G., F.R.S. This paper began by calling attention to the fact that during the years 1896 and 1897 the prevalent winds over Australia and the Indian Ocean were north-west, and that as a result, comparatively few current papers were received, because the wind forced the bottles carrying current papers towards the south, and in this way prevented them from resting in the Australian Bight, the great dumping ground for bottles. It was also shown that during the past year north-west winds had been few and light, while southerly winds had been frequent, and, as a consequence, current papers had been frequently received. On many days they came in pairs, and on one day three current papers had been seen, which is the maximum for one day, and during the past year 105 had been received. Referring to the drift of the disabled steamer *Perthshire*, it was shown that the direction the steamer took was just that which the author had found to be the course of bottle-papers, and that although the *Perthshire* was driven by many winds, it would appear that the final result did not produce any deviation from the drift-line of that part of the Tasman Sea. Reference was made to the unusual number of breaks in propeller shafts, and to the greater speed of current papers and the great number of violent storms, which the author thought all pointed to unusual energy in the sea and atmosphere, which may have caused the unusual strains on propeller shafts.—Note on the occurrence of Glaciated Pebbles in the Permo-Carboniferous Coal-field near Lochinvar, New South Wales, by Prof. T. W. E. David. These glaciated pebbles occur on a geological horizon over 1000 feet below the level of the Greta Coal-seams, whereas the horizons, where Mr. W. G. Woolnough and Mr. R. D. Oldham discovered their glacial pebbles, are from 1500 to about 2000 feet above the level of the Greta Coal-seams. These glacial beds at Lochinvar are at the very base of the Permo-Carboniferous System, and in general appearance closely resemble the Bacchus Marsh Glacial beds of Victoria, a locality where there is evidence of ice action on a grand scale over a wide area. These last belong probably to about the same geological age as the beds near Lochinvar. The height of the glacial beds at Lochinvar is about 200 feet above the sea, and the thickness of the beds probably not less than 200 feet. The pebbles were probably transported by floating ice. Those at Lochinvar were carried to their present resting place before the Greta Coal-seams were formed, and those at Branxton some time subsequent to the formation of the Greta Coal, in either case at times when this part of the Hunter Coal-field was submerged under the sea, as marine shells of Permo-Carboniferous age occur immediately above the glacial beds.

AMSTERDAM.

Royal Academy of Sciences, October 28.—Prof. Stokvis in the chair.—Prof. Martin reported on behalf of Prof. Behrens and himself on a treatise by Mr. Fritz Noetling, entitled "The miocene of Burma." The conclusion of this report was adopted, viz. to insert this treatise in the *Transactions* of the Academy.—Mr. H. E. de Bruyn read a paper on the relation between the mean sea level and the height of half tide. The author proved that various causes, such as (1) the height of the flood tide, (2) the average sea level, (3) the time of year, (4) the presence of drift ice, influence the difference between the above two averages, and he determined the amount of this influence in the case of the sea level at Delfzyl.—Prof. Bakhuis Roozeboom presented Dr. H. J. Hissink's dissertation, entitled "On mixed crystals of sodium nitrate with potassium nitrate and of sodium nitrate with silver nitrate," and made a communication on the subject. He also read a paper on the nature of inactive carvoxime.—Prof. Behrens read a paper on Isomorphous compounds of gold and mercury. The following communications were presented for insertion in the *Proceedings*: by Prof. Kamerlingh Onnes, on behalf of Dr. E. van Everdingen, jun., a paper on the Hall effect and the increase of magnetic resistance in bismuth at very low temperatures; by Prof. Van der Waals, a paper of Dr. G. Bakker, entitled "Observations on Van der Waals' molecular potential function"; by Dr. J. P. Van der Stok, a paper on tidal constants in the Lampong and Sabargbay; by Prof. Jan de Vries, a paper by Prof. L. Gegenbauer of Vienna, entitled "Neue Sätze über die Wurzeln der Functionen $C_n^\nu(x)$.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (Mathematico-physical Section), Part 2, contains the following memoirs contributed to the Society:—

March 11.—Eduard Riecke: Free electricity on the surface of Crookes' tubes.

May 6.—H. T. Simon: The law of action of the Wehnelt interruptor; and on rapid spark-discharges.

May 13.—O. Wallach: Researches (vii.) from the University Chemical Laboratory. (1) On substituted cyanamides and thiocarbamides. (2) On phenyl- and tolyl-butyric acid. (3) Conversion of pentacyclic into azotised hexacyclic compounds. (4) On mixed diazoamido-compounds.—H Liebmann: Proof of two theorems on the determination of "ovaloids" by the measure of curvature or the mean curvature for all normal directions.

June 24.—J. Orth: Researches from the Göttingen Pathological Institute.

July 22.—Eduard Riecke: On the pressure within certain radiometers.—A Schönflies: On the distribution of stationary and non-stationary points in certain functions of a real variable.—E. Wiechert: Seismometric observations in the Göttingen Geophysical Institute.

August 13.—O Wallach: Researches (viii.) from the University Chemical Laboratory. (1) On the oxidation of pinene. (2) On compounds of the fenchone-series. (3) Condensation products from hydro-rubeane, aldehydes and secondary bases.

August 28.—C. Hartlaub: Preliminary communication on the genera *Margelopsis* and *Nemopsis*.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 14.

ROYAL SOCIETY, at 4.30.—The Piscian Stars: Sir Norman Lockyer, K.C.B., F.R.S. On the Origin of certain Unknown Lines in the Spectra of Stars of the β Crucis Type, and on the Spectrum of Silicon: Joseph Lunt.—A Note on the Electrical Resistivity of Electrolytic Nickel: Prof. J. A. Fleming, F.R.S.—Investigations on Platinum Thermometry at Kew Observatory: Dr. C. Chree, F.R.S.—Observations on the Morphology of the Blastomycetes found in Carcinomata: Dr. K. W. Monsarrat.

SOCIETY OF ARTS, at 4.30.—Round about the Andamans and Nicobars: Colonel R. C. Temple.

MATHEMATICAL SOCIETY, at 8.—Sums of Greatest Integers: G. B. Mathews, F.R.S.—Note on Circular Cubics: A. B. Basset, F.R.S.—Formulæ involving Central Differences; and their Application to the Calculation and Extension of Mathematical Tables: W. F. Sheppard.—On the Expression of Spherical Harmonics as Fractional Differential Coefficients: J. Rose-Innes.—The Genesis of the Double Gamma Functions: E. W. Barnes.—The Theorem of Residuation, being a General Treatment of the Intersections of Plane Curves at Multiple Points: Dr. F. S. Macaulay.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion on Mr. Crompton's and Mr. John Holloway's Papers.—Electrical Time Service: F. Hope-Jones.

FRIDAY, DECEMBER 15.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Precautions against Plague and Cholera at the Quarantine Station at El Tor: Dr. Armand Ruffer.—The Behaviour of Plague at Oporto: Dr. Arthur Shadwell.—The Control of Plague in India by the Medical Inspection of Railway Passengers: Dr. Spencer Low.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On Sludge: Blamey Stevens.

MONDAY, DECEMBER 18.

ROYAL STATISTICAL SOCIETY, at 5.30—Some Notes on Makeham's Formula for the Force of Mortality: H. P. Calderon.

TUESDAY, DECEMBER 19.

ZOOLOGICAL SOCIETY, at 8.30.—General Remarks on the Mammal-fauna of South Africa: W. L. Sclater.—Contributions to the Osteology of Birds. Part IV. Pygopodes: W. P. Pycraft.—On the Myology of the Edentata, Part II.: B. C. A. Windle and F. G. Parsons.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Combined Refuse-destructors and Power-plants: C. Newton Russell.—*Papers to be read, time permitting*: The Purification of Water after its Use in Manufactories: Reginald A. Tatton.—Experiments on the Purification of Waste-Water from Factories: W. O. E. Meade-King.

ROYAL STATISTICAL SOCIETY, at 5.—Some Statistics relating to Working-Class Progress since 1860: G. H. Wood.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Negatives for Three-colour Work: Captain W. de W. Abney, C.B., F.R.S.

WEDNESDAY, DECEMBER 20.

SOCIETY OF ARTS, at 8.—Bi-Manual Training by Blackboard Drawing: H. Bloomfield Bare.

GEOLOGICAL SOCIETY at 8.—On some Effects of Earth-Movements in the Carboniferous Volcanic Rocks of the Isle of Man: G. W. Lamplugh.—The Zonal Classification of the Wenlock Shales of the Welsh Borderland: Miss G. L. Elles.—On an Intrusion of Diabase into Permo-Carboniferous Rocks at Frederick Henry Bay (Tasmania): T. Stephens.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Climatic Conditions necessary for the Propagation and Spread of Plague: Baldwin Latham.—Note on a Remarkable Dust Haze experienced at Teneriffe, Canary Islands, February, 1898: Dr. Robert H. Scott, F.R.S.

ROYAL MICROSCOPICAL SOCIETY, at 8.—A Review of Photo-micrography, and its Different Methods: Edmund J. Spitta.

THURSDAY, DECEMBER 21.

LINNEAN SOCIETY, at 8.—The Air-bladder and its Connection with the Auditory Organ in the Notopteridæ: Prof. Thos. W. Bridge.—On some New and Interesting Foraminifera from the Funafuti Atol, Ellice Islands: F. Chapman.

CHEMICAL SOCIETY, at 8.—The Condensation of Glycollic Aldehyde and Formation of α and β Acrose: H. Jackson.—On Brasilin and Hæmatoxylin, Part III. A. W. Gilbody and W. H. Perkin, jun.—The Action of Alcoholic Potash on Monobromoglutaric Ester: N. E. Bowtell and W. H. Perkin, jun.—(1) Mercurous Iodide; (2) On the Interaction of Mercurous Nitrite and Ethyl Iodide: Dr. P. C. Rây.

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