Nature

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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THURSDAY, NOVEMBER 3, 1887.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873–76 *under the Command of Capt. G. S. Nares, R.N., F.R.S., and of the late Capt. F. T. Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, Kt., F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vols. XX. and XXI. (Published by Order of Her Majesty's Government, 1887.)

THE twentieth volume of the "Zoological Reports of the Voyage of H.M.S. *Challenger*" contains three memoirs, of which the first is "On the Monaxonida," by Stuart O. Ridley, M.A., and Arthur Dendy, B.Sc. The collection of this group of the Sponges was, in the first instance, intrusted to Mr. Ridley, who, to hasten the completion of the work, was afterwards joined by Mr. Dendy.

When about ten years ago Prof. Zittel gave the name Monactinellidæ to an order of Sponges, the position of this group became for the first time clearly defined. Prof. Sollas, some five years later, pointed out that Zittel's name implied a wrong idea, for that the characteristic spicules of the group were just as often "diactinal" as "monactinal," and suggested that, as both these forms were, however, "monaxonid,"—that is, having only one axis, which, in the case of the diactinal forms, passed through both the rays—the group should be called Monaxonidæ. As this group represents a division higher than that of a family, for which the termination "idæ" stands, all subsequent writers have adopted the name "Monaxonida." This group Sollas now regards as a tribe of the sub-class Demospongiæ, but the authors of this Report consider it with Zittel as one of the orders of the class.

The classifications of Gray, Bowerbank, Schmidt, or Carter, have now little but historic interest, while as for the more recent writers it would even seem as if each new series of novelties described necessitated a fresh shuffling of the orders, sub-orders, and families.

In the chapter on the anatomy and histology of the group the subject of the spicules is fully treated. It appears to us that no apology was needed for passing over the writings of Bowerbank on these forms; and when the authors too modestly refer us for further details as to the nature, &c., of siliceous spicules to, among other volumes, those of this author, we prefer, without meaning the slightest reflection on his great labours, to turn instead to the pages of the present Report.

The very difficult subject of a nomenclature for the spicules is treated at some length. Those of this order are divided into the two classes of "mega-" and "micro-" "sclera." In each of these there is a very numerous series of forms, all of which get separate names, founded on some prominent distinguishing character of the spicule. Let us hope that the majority of these names may find acceptance with writers on this group of Sponges, so that one difficulty in its study may be removed.

Passing over the descriptions of the spongin, the arrangement of the skeleton, and those of the ectosome and choanosome, we must briefly notice a very remarkable structure, which would appear to be quite unique, and which is found in a Sponge (*Cladorhiza tridentata*, sp. n.) from a depth of 1600 fathoms. The little Sponge in which this occurs is in shape somewhat like a miniature watch-stand. Embedded in the soft tissues, all around the upper margin of the concavity, a large number of small yellow globular bodies are found. Each globular body consists of a central, more deeply staining and granular portion, surrounded by and embedded in a matrix of faintly staining, perfectly hyaline ground substance. The granular appearance of the central mass is owing to very numerous embedded cells; these are irregular in shape and nucleated. Other peculiar cup-shaped bodies occur towards the periphery of the Sponge, embedded in the matrix. The authors think it probable that the cup-shaped bodies are aggregations of glandular cells similar to those met with in the ectosome of some other Sponges, and hint that the whole structure may be phosphorescent, and serve to attract minute organisms upon which the Sponge feeds. In regard to the canalsystem the authors' general conclusions are quite in accord with those of Vosmaer and Polejaeff. In the classification adopted the order is divided into two sub-orders, Halichondrina and Clavulina. The first of these is divided into four families: I. Homorrhaphidæ, II. Heterorrhaphidæ, III. Desmacidonidæ, and IV. Axinellidæ; the second into I. Suberitidæ, and II. Spirastrellidæ.

Over 200 species or well-marked varieties are described from the *Challenger's* dredgings, but all the new species were first diagnosed in the *Annals and Magazine of Natural History* during the course of last year (1886).

In reference to the geographical distribution, the authors remark that one cannot fail to notice the small number of stations at which these Sponges were found. Out of a total of 277 distinct stations, only 50 are represented as stations for these Monaxonids, and these are supplemented by 20 localities to which no station-number is attached; and these latter were not, it is to be assumed, deep-sea stations. We cannot agree with the suggestion that these forms were overlooked amongst the "rubbish" in sorting out the contents of the trawls and dredges; or with the idea that owing to their fragility they may have been destroyed. Doubtless the true explanation is that "the Monaxonida are not, on the whole, a predominant group in deep water."

While not a predominant group in deep water, still no less than 24 species were found at depths between 1000 and 2000 fathoms, while 46 occurred between depths of 200–1000 fathoms, and 140 species, or exactly double the previous number, were found at depths of from 0–200 fathoms.

The scarcity of Monaxonid Sponges at very great depths is somewhat compensated for by the unusual interest attaching to the species which do occur. Among other facts we find that, while the shallow-water forms are characteristically more or less shapeless in their external form or at the very most digitate or ramose, those from below the 1000-fathom depth have almost without exception beautifully symmetrical and definite shapes.

One of the most beautiful and extraordinary of the species described and figured is *Esperiopsis challengeri*, Ridley: it was taken in some quantity off the east of Celebes Island from a depth of 825 fathoms. From a slightly expanded attached base a slightly curved stem arises, which is composed of densely packed and firmly united stylote spicules: this stem is compressed laterally; numerous short simple branches arise from the concave edge at gradually increasing intervals, the longest of the internodes being at the top; the main stem and each of these branches terminate in fleshy sponge lamellæ, of which there may be six or seven in an apparently full-grown specimen. Each lamella presents the form of a deeply concave, transversely elongated cup: the oscula are confined to the convex surfaces of the lamellæ; the pores are found on the concave surfaces. This species is figured on Plate XVIII. Fifty-one plates accompany this Report.

The second Report in this volume is a supplement to Dr. L. von Graff's Report on the Myzostomida. It includes the description of seven new forms besides fourteen previously described species, all received from Dr. P. Herbert Carpenter; these were found by him while investigating the *Challenger* Crinoids. The author refers to the so-called cysts of *Antedon rosacea*, but declares that in no one case did he find therein any trace of a Myzostoma or any other encysted organism. On the contrary, both in the various pinnule deformities and in the arm swellings, he found a roundish brown foreign body, which was apparently the cause of the deformity. As to the nature or origin of this body nothing has been determined. Three plates of the new species and one of the cysts of *Antedon rosacea* accompany this Report.

The third Report is on *Cephalodiscus dodecalophus*, McInt., by Prof. W. C. McIntosh. This very remarkable new type of Polyzoon was dredged in the Strait of Magellan, and was, when first found, placed among the Compound Ascidians. The late Mr. Busk, Prof. Allman, and Prof. McIntosh, referred it to the Polyzoa. At first sight the flexible cœnœcium might easily be taken for a sea-weed, but it would seem to spread over the surface of the ground and not to grow erect. Of the numerous branches many anastomose; the general surface is spiny or fimbriated; the interior of the stem and branches contains an irregular series of wide canals. The Polypides are described as being perfectly free and at liberty to wander anywhere along the chambers, or even externally through the apertures. Each adult Polypide measures, from the extremity of the cephalic plumes to the tips of the pedicel, about 2 millimetres. Large buds in various stages of development arise from the Polypides. The twelve branchial plumes are very conspicuous. The author thinks that Cephalodiscus approaches Rhabdopleura. In an important appendix, by Mr. Sidney F. Harmer, the affinities of this form to Balanoglossus are ably pointed out, and he thinks that this genus (and perhaps Rhabdopleura also), must be removed from the Polyzoa and placed in Bateson's group of the Hemichordata. Seven plates and numerous woodcuts illustrate this Report.

Volume XXI. contains but one Report, that on the Hexactinellida, by Prof. F. E. Schulze, of the University of Berlin. This volume is issued in two parts, the first that of the text, comprising over 500 pages, and the second consisting of an atlas of 104 plates.

This is one of the most important of the fifty-three Reports hitherto published. This group of Sponges early attracted the special attention of the late Sir Wyville Thomson; and it was his intention to describe the Hexactinellids of the *Challenger* Expedition, but the work had scarcely been seriously commenced at the time of his death. It was fortunate that the services of Prof. Schulze were secured for the writing of this monograph, which is a most acceptable and welcome addition to our literature of this group.

In this Report, besides the collection made by the *Challenger*, the results of the previous cruises of the *Lightning*, *Porcupine*, *Knight Errant*, and *Triton* are also detailed, and the material has been further increased by a collection made at Japan by Dr. Döderlein.

The Hexactinellids are those forms of the Sponges in which the siliceous spicules belong to the triaxial type. Omitting the eighteenth century reference to a Sponge belonging to the genus Dactylocalyx, Dr. Gray was the first in the present century to describe some peculiar "glass rope-like" structures in the British Museum under the name of Hyalonema; though without recognizing until long afterwards their real affinities. This was in

1832, and in the following year Quoy and Gaimard figured and described their *Alcyonellum speciosum*. During the next twenty years only five more species were added to the list, the beautiful *Euplectella aspergillum*, Owen, being the most remarkable of these. The last twenty-five years have, however, witnessed an ever-advancing progress in our knowledge of these Sponges, thanks to the labours of Gray, Bowerbank, Wyville Thomson, Schmidt, Kent, Carter, Marshall, Sollas, and, above all, of Zittel, which labours have now culminated in the present Report.

It is scarcely to be wondered at that the beautiful glassy frame-work and the charmingly diversified spicules which form their "skeletons" have always attracted attention to these Sponges—an attraction that will be greatly intensified by the publication of this volume.

The Report opens with a general historical introduction, and then passes on to details of the forms and structures to be met with in the group: herein we find the nomenclature adopted for the spicules. This is followed by the description of the genera and species. It is pleasant to find in the synonymy and specific details that great pains have been taken to mention the work of all previous labourers in the field, and the author shows a due and kindly appreciation of what has been done by those who often had but little light to guide them on their way.

It is not easy to give any analysis of so elaborate a memoir, in which twenty new genera and sixty-five new species are described; while with scarcely an exception the numerous species already described are not only alluded to, but many fresh details are given about them. When it is recollected that but fourteen years ago only thirty species of this group of Sponges were known, the progress of our knowledge of them, it will be recognized, has been great.

These Sponges seem to be widely distributed in all the oceans; the largest number of forms—fifty-seven—being found in the Pacific Ocean; next comes the Atlantic Ocean, in which twenty-four species were found; while only sixteen were found in the South Indian Ocean; but it must not be forgotten that the South Indian Ocean has been very slightly investigated.

As to the bathymetrical distribution of the Hexactinellida, they would appear to be met with in depths of between 95 and 3000 fathoms, being more numerous between the depths of 100 and 900 fathoms, decreasing somewhat between those of 900 and 2500 fathoms, and again markedly diminishing between the depths of 2500 and 3000 fathoms, while below this depth no Hexactinellida Sponges have been found. Euplectellids seem to have a wide range, being met with at the moderate depth of 95 fathoms, and then being pretty evenly distributed down to a depth of 2750 fathoms. The four species of the new genus Holascus frequent great depths, varying from 1375 to 2650 fathoms. The maximum depth as yet known for any of these Sponges is that of 2900 fathoms, at which depth *Bathydorus fimbriatus* was found in the middle of the North Pacific Ocean.

It would be obviously impossible to give even a brief summary of the very remarkable new forms described in this splendid memoir of Prof. Schulze, and it is difficult to convey a correct notion of the beauty of the illustrations forming the large atlas of plates which accompanies the text. The diagnoses of the genera and the descriptions of the species are what one would expect from the well-known skill of the author.

We do not altogether agree with him when he writes that, "after a detailed investigation of a group of animals, it is incumbent on every naturalist who accepts the evolution theory to attempt the appreciation of his results in their relation to the phylogeny of the group." Looking at his array of facts, is it not possible for the thoughtful worker to bear in mind the incompleteness of the phylogenic record, and reverently to wait for more light? There may be nothing to object to in the stately genealogical tree of the Hexactinellida represented on p. 495, but is it not built up on but an incomplete and scanty framework?

One departure in this Report from the ordinary custom in the description of species we notice with regret—viz. that there is no synonymic list affixed to the species, neither are we referred, in connection with each form, to the place or places where it has been previously described. It seems scarcely necessary to point out the inconveniences attending such a style, or the great uncertainty it may on occasions give rise to. The volume opens at the description of *Rosella antarctica*, Carter. To find where it was first described by Mr. Carter we are obliged to refer to the synonymy affixed to the diagnosis of the genus; but here we get no certain information as to how many of the quotations given refer to this species; and this is of course much more confusing when we come to investigate a genus abounding with species, like, for example, Hyalonema. Indeed, by this method an author is very apt to overlook the fact that several writers may refer to the same species under quite different names, and a curious case of this nature, we suspect, occurs under Hyalonema. Dr. Gray, wrongly trusting to a Museum label, replaced the name *Hyalonema sieboldii*, which he had given to the first known species of this genus in 1835, by that of *H. mirabile*, under the impression that he had so named it in the "Synopsis of the Contents of the British Museum," 1832 (misprinted 1830), the year he had got the analysis of its glassy fibres from Mr. Pearsall. Depending on the accuracy of Dr. Gray, many authors referred to the species under this latter name; and further, for some time after the discovery of the Setubal species by Prof. Barboza du Bocage, this species, now known as *H. lusitanicum*, passed as the same species as *H. mirabile = H. sieboldii*. Even from the details given by Prof. Schulze, this seems clear; but in the description of Bocage's species (p. 225) no synonymic list is given, and not only does the before-mentioned fact not appear, but we find *H. lusitanicum* placed among those species "the upper end of which was not sufficiently preserved for deciding the question whether there is a sieve-plate or not." It is added that "neither on this specimen (the one figured in the Proc. Zool. Soc. Lond.) nor on others which Bocage afterwards obtained from the same locality could any portion of the sponge body be detected." But on p. 186 we find it stated that *H. lusitanicum* had been dredged from a depth of 480 fathoms south-west of Setubal, "bearing a sponge body with several oscular openings"; and again on the same page that among the Hyalonema found off the coast of Portugal by Barboza du Bocage and others, and named *H. mirabile*, there was one specimen with an oval cup-shaped body about 8 inches in length and 4 inches in breadth, with a sieve-net on the upper truncated surface of the sponge body, extending evenly over the oscular opening and over the layer of the "spiculate cruciform spicules" in the net beams. We may further add that there were to be found in the Museum at Lisbon nearly a dozen specimens of Hyalonema which were taken at Setubal. "Most of them were preserved in spirits of wine; they were certainly the very finest collection of this remarkable Sponge in Europe. The largest had a stem about 18 inches in height; there were no parasites of any kind on it, and it was furnished with a sponge mass some 8 inches in diameter, and nearly as much in height. A second specimen was very curious, for here two apparently distinct individuals had become matted together: the two glass ropes were interlaced, and the two sponge masses had grown together" (Proc. Dublin Nat. Hist. Soc., vol. v., 1869). It would have been most important to have had the opinion of such an authority as Prof. Schulze as to whether all these specimens from Setubal are referable to Bocage's species; and whether, as we venture to think, Marshall's *H. thomsoni* may not be only a well-marked variety thereof. It is possible that by thus calling attention to the subject we may yet learn more of the treasures of the Museum of Lisbon, and nothing in these remarks can in the very slightest degree detract from the merits and importance of this splendid contribution to our knowledge of the vitreous Sponges. E. P. W.

THE FERN-ALLIES.

Hand-book of the Fern-Allies: A Synopsis of the Genera and Species of the Natural Orders Equisetaceæ, Lycopodiaceæ, Selaginellaceæ, Rhizocarpeæ. By J. G. Baker, F.R.S., F.L.S., First-Assistant in the Herbarium of the Royal Gardens, Kew. (London: George Bell and Sons, York Street, Covent Garden, 1887.)

AS the author states in the preface, "The present Handbook is planned upon the same lines as Hooker and Baker's 'Synopsis Filicum,' and the two, taken in connection, cover the whole series of the Vascular Cryptogamia." The total number of species described in the "Hand-book" is 566, and as we may now place the number of known ferns at about 3000, the fern-allies may be taken to represent about one-seventh of the recent Vascular Cryptogams. The fern-allies include only eleven genera, and about four-fifths of the species belong to the two genera *Selaginella* (335 species) and *Lycopodium* (94 species). The eleven genera are placed by Mr. Baker in four "natural orders," while the Filices form a fifth: three of these, Filices, Equisetaceæ, and Lycopodiaceæ, being isosporous; and two, Selaginellaceæ and Rhizocarpeæ, being heterosporous. In this way the relationship of the Rhizocarpeæ to the ferns is quite lost sight of; the Selaginellas and Lycopods are separated more widely than is desirable, and no place is left for the fossil heterosporous Equisetinæ. The arrangement adopted by Mr. Baker is very good for herbarium work; but for classificatory purposes it ignores certain palæontological facts which we cannot at the present day afford to overlook. Mr. Baker, however, does not deal with the fossil types, and now that we have such a complete account of the recent forms, let us hope that before long we may have as complete a synopsis of the fossil forms; a work which would be of the greatest interest and importance.

In regard to the geographical distribution of the fern-allies it is interesting to notice that *Equisetum*, *Isoëtes*, and *Pilularia* predominate in the North Temperate Zone. *Lycopodium*, *Psilotum*, *Selaginella*, *Salvinia*, and *Marsilea* are eminently tropical; and *Phylloglossum* is peculiar to the South Temperate Zone. Like the ferns, the fern-allies are best developed in the Tropics; and in the Tropics we also find the greatest number of peculiar species. Thus, out of the 566 species, 484 are met with in the Tropics of the Old and New World; and no less than 402, or 83 per cent., of these are peculiar to the Tropics. As with the ferns so also with the fern-allies, tropical America is richest in species, including 237 species, of which 212 are peculiar. The Southern Temperate Zone yields only 83 species, of which 42, or 51 per cent., are peculiar, the fern-allies being thus much less numerous than the ferns in the southern flora. In the North Temperate Zone 150 species are met with, and of these 48, or 32 per cent., are peculiar. The North Temperate Zone is thus, like the South, deficient in fern-allies as compared with ferns, and this is apparently due to the small number of fern-allies as yet reported from temperate Asia. Only 6 species occur in the Frigid Zone, and, like the ferns, represent about 1 per cent. of the whole, none of the species being peculiar.

It is difficult to realize the amount of labour and research that must have been spent upon the production of this book; but anyone who has attempted to study the genus *Selaginella* will appreciate the masterly manner in which Mr. Baker has dealt with the 335 species of the genus, more than one-fourth of which he has himself described for the first time. Most of the species of Selaginellaceæ and Rhizocarpeæ have been described by Mr. Baker in his papers on the subject which have appeared from time to time, since 1883, in the *Journal of Botany*, but several new species are described in "Fern-Allies" for the first time, recent additions to the rich treasures of Kew. It is to be regretted that Mr. Baker does not more particularly refer to his papers in the *Journal of Botany*, and it is hard to understand why, in the descriptions of *Marsilea concinna* and *M. condensata*, he has omitted the references to the *Journal of Botany*, 1886, pp. 179 and 281 respectively. Then in transferring the matter from the *Journal of Botany* he has altogether dropped out the habitat of *Azolla nilotica*. There are also in the book not a few misprints, and a want of care is shown in numbering and lettering the sections of *Selaginella*. The index is also not quite up to the mark, as in *Marsilea*, with numerous synonyms omitted, and the misprints in *Pilularia* and *Psilotum*. As the index of the "Synopsis Filicum" was published separately as a catalogue of ferns, we may perhaps be permitted to express a hope that this index will not be so published until it is carefully revised. All that is wanting, however, is only a little more careful editing, and the few faults in no way detract from the sterling value of the work.

As the only modern synopsis of the group, it is a work that must be in the hands of every botanist who deals with the Vascular Cryptogams, and it will be a lasting monument to Mr. Baker's critical accuracy and great power of dealing with a difficult set of plants. W. R. MCNAB.

OUR BOOK SHELF.

The Sailor's Sky Interpreter. By S. R. Elson. (Calcutta: Thacker, Spink, and Co., 1879.)

THIS little book, which is written in verse, is a practical storm guide, dealing especially with the October cyclones in the Bay of Bengal. Many years of experience as pilot in the dangerous waters of the bay have made the author familiar with the phenomena of the weather in this part of the world. The details convey many a hint to students of Nature, and above all to navigators interested in the very violent storms which occur periodically at the change of the monsoons, and more especially about October at the close of the summer monsoon. The concluding stanza deals with the rules for avoiding the centre of a cyclone, and on this head the advice is both good and sound, and is at the same time put in a very concise form Sailors are very familiar with rhymes for the "Rules of the Road," but we can scarcely hope that the author's verse will be similarly mastered and remembered. Probably the author himself never contemplated such a use of his work; but yet there are couplets and triplets of Admiral FitzRoy's which have lived for a quarter of a century, and are still valuable aids. In the last volume of the "Indian Meteorological Memoirs" full credit is given to Mr. Elson for his valuable observations on the False Point cyclone, and especial mention is made of the high value of his observations bearing on the movement of the clouds. The author possesses just that local knowledge which in a recent issue of the "Fishery Barometer Manual" the Meteorological Office lamented the want of among its observers around our coasts for the further perfecting of our "Weather Forecasts;" and in the twenty stanzas which he has written he has pithily handed down his experiences for the benefit of his fellow-sailors.

Austral Africa. By John Mackenzie. Two Vols. (London: Sampson Low, 1887.)

THIS work, written by one who understands his subject thoroughly, ought to be cordially welcomed by all who have given any attention to the questions which have caused, during the last few years, so much trouble in South Africa. Mr. Mackenzie is convinced that these questions are not nearly so complicated and difficult as they are generally believed to be, and he has taken great pains to expound clearly and forcibly the policy which, in his opinion, would open up new markets for our commerce in South Africa, and secure the highest and best interests of the natives. The book is addressed rather to politicians than to persons interested in science, but students of the early forms of social institutions will find some statements worthy of their attention in Mr. Mackenzie's account of those native tribes with which he himself has come into contact. Archæologists will be interested, too, in what he has to say about the remarkable stone structures which are found over an extensive district to the east and north-east of Shoshong. These buildings, in the neighbourhood of which are the remains of ancient gold-mines, he compares with Persian towers of refuge and with the ancient round towers of Ireland and Britain.

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. No notice is taken of anonymous communications.*

Medical Education at Oxford.

THE problem, how far the older Universities should undertake special training for the professions, is fast finding its own solution. A degree is no longer any evidence that its possessor has been through any course of wide general culture preparatory to his technical education. Recent legislation, both at Oxford and Cambridge, has all tended in the direction of enabling the undergraduate to specialize at the earliest possible point in his career. Whether advisable or not, some such movement seemed inevitable if, in the midst of the daily increasing pressure of competition, the Universities were to retain any hold on the educational development of the country. Even Prof. Freeman's articles in the *Contemporary Review* are marked by a tone of querulous despair, rather than by any hope that the tide of innovation may be checked. For knowledge as a luxury or an ornament there is neither leisure nor inclination. Cambridge was the first to yield; but the multitudinous statutes which are every day promulgated at Oxford prove that the latter University is eagerly hurrying along the same path. New schools, new Boards of Faculties have been established; old restrictions have been removed Large sums of money have been expended on new buildings, in which new professors may give instruction in arts and sciences unheard of by the last generation. All this has been done in order that the student may proceed as speedily as possible to those special researches which are to arm him for the battle of life.

The ordinary curriculum at Oxford is now so modified and subdivided that a Bachelor of Arts may have no more extensive general education than that smattering of school-boy knowledge required for the examination called Responsions. It is hardly realized by those who are chiefly responsible for this movement how much the whole life of the University must be altered by so radical a change in its methods and its aims. The statute-book, indeed, is in such a state of chaos that there are few, even among the officials, who can unravel the intricacies of any one Faculty. In the department of medicine an attempt has recently been made, in a pamphlet issued by the Clarendon Press, to afford concise and accurate information to the hitherto bewildered undergraduate. By means of this publication it is possible to trace out the curriculum of an Oxford medical student and to contrast the present with the older system of education. Responsions, or some equivalent test, can be passed while the candidate is still at school, and at the same time he can take an extra subject which will exempt him from the First Public Examination. After reaching the University, only an elementary pass examination in divinity will stand between him and his scientific work He may then give himself up to preparation for one of the Honour Schools of natural science. For this he will have to pass various "preliminaries," for which there are schedules of alarming proportions. Physiology and chemistry are suggested as the most suitable schools, as by their means exemption is gained from portions of the First M.B. Whichever he may select, two years of the most severe application are necessary in order to gain a satisfactory position in the Class List. He will then, in his third or fourth year, be enabled to take his B.A. degree. The study of human anatomy will next absorb his energies. The amplest opportunities are now afforded to those who desire to take up this subject while residing at Oxford. The ideal candidate depicted in this pamphlet is supposed to spend but one academical year in this department. Extraordinary, indeed, must be the powers of the teacher who could impart, and of the pupil who could receive, a sufficiently deep impression of so important a science in so brief a time. After the first examination for the M.B., residence in Oxford would come to an end, and the student would migrate probably to London. With everything in his favour he might be able to obtain his degree in six or seven years from the date of his matriculation. There are other ways in which the course of study might be arranged, but the details are of small consequence. It matters little to the public whether the degree can be obtained in five years or seven. In either case the professional acquirements will be above the average. The eminence of the examiners and the reputation of the University will be a sufficient guarantee that tests are applied of sufficient stringency to exclude the ignorant and incompetent. It is well, however, that the real state of affairs should be fairly recognized and understood by those who have been accustomed to attribute some special virtues to a University degree. It is important also to consider whether in leaving the older methods and yielding, however reluctantly, to the pressure of the hour, a retrograde step has not been taken in the history of medical education. It is always a loss when something even distantly approaching to an ideal is degraded to the level of every-day life.

The older Oxford system, if antiquated and imperfect, had at least aims of a high and noble character—aims which could not fail to have an elevating effect on those by whom they were entertained. In former times to have taken a degree in arts, as a necessary preliminary to the beginning of a student's purely professional career, may not have meant, and, as a matter of fact, did not in the majority of cases mean, any very high standard of learning or culture. It did, however, carry with it some inestimable advantages which can never be attained under the existing system of specialization. It meant that a young man, while his mind was still plastic to all surrounding influences, was brought into contact with and joined in the same pursuits as fellow-students whose tastes would lead them to different pleasures, and whose circumstances would lead them to a variety of destinations. The physician or surgeon of the future became the companion of those who were afterwards to become clergymen, barristers, or schoolmasters. He read the same books, played the same games, belonged to the same clubs. In this way, however little actual knowledge he may have acquired, he gained an invaluable acquaintance with men's lives and habits. He formed friendships with men destined to follow very different careers. These associations could not fail to be of the greatest value to him in the pursuit of his special profession. I do not mean mere monetary advantage, but that derived from intercourse with men in other walks of life—that interchange of ideas so necessary to a healthy mind. Such a training must have been beneficial to all, but to the student of medicine it was an incalculable boon. Much of his success and much of the good he can hope to do depend on an intimate knowledge of mankind. Without that, no matter how highly trained he may be as a man of science, his acquirements will be of little avail, and his skill can never be used to the highest purpose.

How is the existing system likely to work in this direction? The student is advised and encouraged to enter at once on his special pursuits. He is to apply himself without delay to scientific study, associated with men like himself, plodding along the same track. If he aims at taking honours in natural science, he must curtail his exercise to the limits of a short "constitutional" and cut himself off from the common pleasures of the cricket-field and the river. His very social gatherings tend to consist more and more exclusively of men working in his own department. The Union and other such Clubs are given up for scientific Societies, where he thinks he can combine business with amusement. Such a life can hardly fail to narrow the most sympathetic mind, to hamper and confine the most commanding intellect; it is most unlikely to turn out a practitioner of the highest and most useful type. To live in a clique where priggishness is fostered by the worst kind of mutual admiration is hardly the ideal of University education. Fortunately the curriculum indicated in the pamphlet to which I have referred is not compulsory, and an intending medical student might not be altogether unwise if he decided to pass the first three years of his career in the ordinary pursuits of the University before turning his attention to more technical studies. Even the delay of a year or two would be more than counterbalanced to some by the benefits which such a course would undoubtedly confer.

Oxford. GEORGE I. WILSON.

Migration of Swallows along the Southern Coast.

THE following notes were made by me during a short stay at Lulworth, twelve miles east of Weymouth, from September 16 to 26. They may be of interest to some of your readers, as I have not been able to find the facts I observed recorded in any work on British birds.

When I arrived at Lulworth on the 16th, swallows and house-martins were about, but in no great numbers. On the 19th, in the course of a walk, I observed a few swallows apparently moving eastwards; and this caused me to spend the next morning on the top of a high and narrow ridge of down (Bindon Hill), running parallel with the sea—an admirable position for observation, as the movements of all birds were discernible from it at a long distance. The wind was east-north-east, and the air cold and very clear.

In half-an-hour it became clear to me that a general migration of swallows and martins was taking place along the coast in an easterly direction. The air would be thick with birds over my head for two or three minutes; then for a considerable interval hardly a bird would be visible. An ordinary glance at these dense parties was not enough to prove that they were travelling, or to show in which direction they were going; but by keeping the eye steadily upon them for some little time, and bringing the field-glass to bear on them when the eye failed, it became obvious that they were going east at a steady rate of speed, and apparently following the long spine of chalk down on which I stood, which extends from near Weymouth as far as Poole Harbour. The migration on this large scale lasted during the whole of that morning; in the afternoon the parties did not seem so large.

The next day (the 21st) a strong east wind was blowing, and the birds were not travelling high in air, but creeping steadily along the flanks of the down, and on the lower ground north and south of it. They were continually tacking, but every individual that I followed with my glass was moving swiftly towards the east. Those that were on the southern or seaward side of the down would come upon the sea at one point where the coast turns sharply northwards for a short distance: they did not attempt, however, to leave the land, but turned northwards with the coast, and pursued their way along the heights. On the 22nd and 23rd the same thing went on, but the numbers of the birds seemed to diminish, and they no longer went in parties that were plainly discernible. All this time there were a very few stationary swallows in one or two warm corners by the seaside.

From Dorset I went to Devonshire on the 26th. At Crediton and at Bideford (both warm and sheltered towns), I did not see a dozen swallows or martins in the course of a week; but I learnt that they had gathered for departure a few days before. I have since been informed that the gatherings had been noticed in Cornwall in the first week of the month. I infer that the migration I saw at Lulworth was that of the extreme West-of England birds, who were proceeding along the coast to the point at which they cross the Channel. I should be glad to know where that point is.

I had reason to believe that one or two other species were moving up regularly in the same direction. The well-known migration of the pied wagtail was apparently over; but the large number of gray wagtails in a district almost destitute of water was very striking, and, as far as I could see, these also were passing eastwards. But I hope to make further observations next year.

I may add that, on returning to my home in Oxfordshire in the first week of October, I found swallows and martins passing over my village in parties during the earlier hours of each day; but, owing to the want of a convenient elevated position for watching, it was much more difficult to follow their movements than it had been at Lulworth. W. WARDE FOWLER.

Swifts.

THOUGH I cannot add anything to the interesting and valuable evidence given by your correspondent, in your last issue, with regard to swifts remaining on the wing during the dark hours of a summer night, it reminds me of a most beautiful exhibition of their flight which I witnessed at Moscow this last summer. It was on August 2, as the last rays of the setting sun were lighting up the domes and cupolas of that wonderful city, which we gazed upon from the heights of the Kremlin for the first time, that we noticed hundreds of these birds wheeling round their summits or darting hither and thither in every direction. At the same time the matchless Russian bells were pealing forth from every bell-tower in honour of the Empress's birthday, which was to be celebrated on the morrow, and it was surely difficult to believe that the swifts were not revelling in the music like ourselves, especially as I cannot remember ever seeing them again in such numbers, though our visit to Moscow was prolonged for ten days, and we frequently visited the Kremlin at the same hour. E. BROWN.

Further Barton, Cirencester, October 29.

Hughes's Induction Balance.

THE points noted by Mr. Cook on page 605 (vol. xxxvi.), are merely the well-known facts that a magnetic body has most effect when presented to the coils end-ways, *i.e.* with its greatest dimension along their axis, whereas a substance which acts mainly by conduction has most effect when presented flat-ways, or parallel to their face. Any possible effect due to diamagnetism is far too small to be thus easily noticed. OLIVER J. LODGE.

The Ffynnon Beuno and Cae Gwyn Caves.

I THINK it would be well for geologists and anthropologists to allow the age of the deposits and stone instruments found at these caves to remain an open question for the present. At present I have had no opportunity of seeing any papers on the subject, and I know of no opinions other than the one expressed by Dr. Hicks, NATURE, vol. xxxvi. p. 599. I am however fairly well acquainted with the glacial deposits of North Wales and with Palæolithic implements, and I have seen the caves and the tools found at and in them. My quite unbiased opinion is and will so remain,—unless I get very convincing proof to the contrary,—that the drift at the caves has been without doubt relaid; and is no more a true glacial deposit than the valley gravels of the Thames. As for the tools—one in the British Museum (South Kensington), and one in Denbighshire—they belong to the *very latest* of Palæolithic times, and might be passed for Neolithic; the Denbighshire example seen by me is a knife-flake with fine secondary chipping up one edge.

Dunstable. WORTHINGTON G. SMITH.

SYNTHESIS OF GLUCOSE.

ANOTHER important acquisition to our store of knowledge has recently been made. Glucose, commonly called grape-sugar, has been artificially prepared by Drs. Emil Fischer and Julius Tafel in the chemical laboratory of the University of Würzburg. This happy achievement, which is announced in the number of the *Berichte* just received, is one which has long been looked forward to, and which cannot fail to give deep satisfaction in chemical circles all over the world. As is generally the case in syntheses of this description, not only has the sugar itself been actually prepared, but, what is at least quite as important, considerable light has been thrown upon that much-discussed question—the constitution of sugars. A most remarkable, and yet only to be expected, attribute of this artificial sugar is that it is found to be entirely incapable of rotating a beam of polarized light. As is well known, there are several naturally-occurring varieties of glucose, all of which may be expressed by the same empirical constitution $C_6H_{12}O_6$, and all possessing the power of rotating the plane of polarization: dextrose, or grape-sugar, the best-known of these varieties, as its name implies deviates the plane of polarization to the right, as do several other less important varieties; while lævulose, or fruit-sugar, rotates the plane to the left. But in artificially preparing a glucose of the composition $C_6H_{12}O_6$ there is just as much tendency for one kind to be formed as another, and the probability is that both dextro and lævo are simultaneously formed, and thus neutralize each other, producing a totally inactive mixture. It may be that, as in the case of racemic acid, the two kinds are formed side by side and neutralize each other in the solution; or it may even be that, as is the case with truly inactive tartaric acid, there is a true neutralization within the molecule itself; which of these hypotheses is correct is a question for further work to decide.

The substance employed as the base of operations was acroleïn, $CH_2{=}CH{-}CHO$, the aldehyde derived by oxidation of allyl alcohol. The acroleïn was first converted to its dibromide, $CH_2Br \cdot CHBr \cdot CHO$, which was then treated with cold baryta water, whereupon the bromine was removed by the barium leaving the artificial sugar in solution. The real difficulty was found to be in the isolation of the sugar, but this was eventually overcome by the use of phenyl hydrazine, $C_6H_5 \cdot NH \cdot NH_2$, which forms a hydrazine compound of the formula $C_{18}H_{22}N_4O_4$ with the new sugar, very similar to the compounds formed by phenyl hydrazine with ordinary dextrose and lævulose. This phenyl hydrazine compound was then found to yield by reduction a base $C_6H_{13}NO_5$, which, on treatment with nitrous acid, parted with its nitrogen and left a syrupy substance, possessing all the properties of sugars, and distinguished only from ordinary grape-sugar by its optical inactivity.

The actual operations were performed briefly as follows:—

Seventy-five grammes of pure crystallized barium hydrate were dissolved in a little over a litre of water, and 50 grammes of previously redistilled acroleïn dibromide added drop by drop, the flask being continuously agitated, surrounded by ice-cold water, for about an hour. In a similar manner eight successive quantities were treated until in all about 400 grammes of acroleïn dibromide had been converted into sugar. These eight separate portions were then mixed, slightly acidified with sulphuric acid, and the barium precipitated with a solution of sodium sulphate. After removal of all the barium by filtration the solution was neutralized with soda and evaporated down to 1½ litres. On cooling, a solution of 50 grammes of the hydrochloride of phenyl hydrazine and 50 grammes of crystallized sodium acetate in 100 cubic centimetres of water were added; after standing twelve hours a reddish-brown resin separated out and was removed by filtration. 150 grammes more of phenyl hydrazine hydrochloride and the same quantity of sodium acetate were then added, and the solution warmed upon a water-bath; after again standing some time the solution became turbid, and in course of four hours a dark-coloured precipitate, partly crystalline and partly resinous, separated out. After washing and drying, and subsequent agitation with ether and trituration with alcohol to remove organic impurities, and extraction of the inorganic salts by hot water, the phenyl hydrazine compound was finally isolated.

Analysis of the recrystallized compound indicates that its composition is $C_{18}H_{22}N_4O_4$, and its properties are very similar to those of the phenyl hydrazine compound of ordinary grape-sugar, the melting-points of the two bodies being identical, 205° C. It is almost insoluble in water, ether, and benzene, and only with difficulty soluble in hot alcohol; it is more soluble in glacial acetic acid, but the solution soon becomes dark red. It crystallizes from hot alcohol in pretty little prism aggregates, while the ordinary grape-sugar compound crystallizes in spherical aggregates of fine needles. It is further distinguished from the latter compound inasmuch as a layer 20 cubic centimetres thick, is without action upon a beam of polarized light.

When reduced by means of zinc dust and acetic acid, a base was produced analogous to the one formed by the reduction of the corresponding phenyl hydrazine compound of grape-sugar. This base was difficult to isolate, owing to the non-crystallizable nature of its acetate; the fact was fortunately discovered, however, that its oxalate was crystalline, and readily obtained pure. Hence its analysis has been effected, and the numbers found point to the composition $(C_6H_{13}NO_5)_2 \cdot C_2H_2O_4$. This base reduces Fehling's solution strongly on warming, and with phenyl hydrazine regenerates the parent compound; but, once again, is optically inactive.

Finally, by the action of nitrous acid, nitrogen at once began to be evolved, and when the evolution ceased the liquid was neutralized with soda, evaporated *in vacuo*, and the residue extracted with alcohol. On evaporation of the alcohol the sugar was left as a bright brown syrup, free from nitrogen and ash, of sweet taste, and capable of instantly reducing Fehling's solution.

Up to the present time two hypotheses as to the constitution of sugars have pretty evenly balanced each other. According to one, sugars are considered, in virtue of their power of reducing ammoniacal silver solutions, as aldehydes containing also alcohol groups; on these lines grape-sugar would be formulated, $CH_2OH{-}(CHOH)_4{-}CHO$. But it has since been shown that the property of reducing ammoniacal silver solutions is not confined to aldehydes, for the series of bodies known as ketone alcohols also possess it; hence grape-sugar may also be written $CH_2OH{-}(CHOH)_3{-}CO{-}$

CH_2OH. Both theories account for most of the hitherto known reactions of the glucoses, hence the matter has remained an open question. Drs. Fischer and Tafel, however, consider that their synthesis from acroleïn, which is itself an aldehyde, points to the probability of the former hypothesis being the correct one. The action of baryta water upon the dibromide evidently causes a simple exchange of bromine for hydroxyl, and the first product of the reaction is almost as certainly glycerine aldehyde, $CH_2OH-CHOH-CHO$. This latter substance, however, appears to polymerize at once under the influence of the baryta water into sugar, two molecules of glycerine aldehyde uniting to form a molecule of glucose.

In consideration of the fact of its derivation from acroleïn, the name acrose has been applied to the sugar which has been, with so much skill and steady determination, synthetically formed and isolated; and there can be no doubt that this name will stand as a memento of the progress made in organic chemistry during the year 1887.

A. E. TUTTON.

MODERN VIEWS OF ELECTRICITY.[1]

PART II.—CURRENT ELECTRICITY (*continued*).

IV.

Electrical Inertia.

RETURNING now to the general case of conduction, without regard to the special manner of it, we must notice that, if a current of electricity is anything of the nature of a material flow, there would probably be a certain amount of inertia connected with it, so that to start a current with a finite force would take a little time; and the stoppage of a current would also have either to be gradual or else violent. It is well known that if water is stagnant in a pipe it cannot be quite suddenly set in motion; and again, if it be in motion, it can only be suddenly stopped by the exercise of very considerable force, which jars and sometimes bursts the pipe. This impetus of running water is utilized in the water-ram. It must naturally occur, therefore, to ask whether any analogous phenomena are experienced with electricity; and the answer is, they certainly are. A current does not start instantaneously: it takes a certain time—often very short—to rise to its full strength; and when started it tends to persist, so that if its circuit be suddenly broken, it refuses to stop quite suddenly, and bursts through the introduced insulating partition with violence and heat. It is this ram or impetus of the electric current which causes the spark seen on breaking a circuit; and the more sudden the breakage the more violent is the spark apt to be.

The two effects—the delay at making circuit, and the momentum at breaking circuit—used to be called "extra-current" effects, but they are now more commonly spoken of as manifestations of "self-induction."

We shall understand them better directly; meanwhile they appear to be direct consequences of the inertia of electricity; and certainly if electricity *were* a fluid possessing inertia it would behave to a superficial observer just in this way.

But if an electric current really possessed inertia, as a stream of water does, it would exhibit itself not only by these effects but also mechanically. A conducting coil delicately suspended might experience a rotary kick every time a current was started or stopped in it; and if a steady current were maintained in such a coil it should behave like a top or gyrostat, and resist any force tending to deflect its plane.

Clerk Maxwell has carefully looked for this latter form of momentum effect, and found none. One may say, in fact, that nothing like momentum has yet been observed in an electric current by any *mechanical* mode of examination. A coil or whirl of electricity does not behave in the least like a top.

Does this prove that a current has no momentum? By no means necessarily so. It might be taken as suggesting that an electric current consists really of two equal flows in contrary directions, so that mechanically they neutralize one another completely, while electrically—*i.e.* in the phenomena of self-induction or extra-current—they add their effects. Or it may mean merely that the momentum is too minute to be so observed. Or, again, the whole thing—the appearance of inertia in some experiments and the absence of it in others—may have to be explained in some altogether less simple manner, to which we will proceed to lead up.

Condition of the Medium near a Circuit.

So far we have considered the flow of electricity as a phenomenon occurring solely inside conductors; just as the flow of water is a phenomenon occurring solely inside pipes. But a number of remarkable facts are known which completely negative this view of the matter. Something is no doubt passing along conductors when a current flows, but the disturbance is not *confined* to the conductor; on the contrary, it spreads more or less through all surrounding space.

The facts which prove this have necessarily no hydraulic analogue but must be treated *suorum generum*, and they are as follows:—

(1) A compass needle anywhere near an electric current is permanently deflected so long as the current lasts.

(2) Two electric currents attract or repel one another, according as they are in the same or opposite directions.

(3) A circuit in which a current is flowing tends to enlarge itself so as to inclose the greatest possible area.

(4) A circuit conveying a current in a magnetic field tends either to enlarge or to shrink or to turn half round according to the aspect it presents to the field.

(5) Conductors in the neighbourhood of an electric circuit experience momentary electric disturbances every time the current is started or stopped or varied in strength.

(6) The same thing happens even with a steady current if the distance between it and a conductor is made to vary.

(7) The effects of self-induction, or extra-currents, can be almost abolished by twisting the covered wire conveying the current closely on itself, or even by laying the direct and return wire side by side; whereas they may be intensified by making the circuit inclose a large area, more by coiling it up tightly into close coil, and still more by putting a piece of iron inside the coil so formed.

Nothing like any of these effects is observable with currents of water; and they prove that the phenomena of the current, so far from being confined to the wire, spread out into space and affect bodies at a considerable distance.

Nearly all this class of phenomena were discovered by Ampère and by Faraday, and were called by the latter "current-induction." According to his view the dielectric medium round a conducting circuit is strained, and subject to stresses, just as is the same medium round an electrically charged body. The one is called an electrostatic strain, the other an electro-magnetic or electro-kinetic strain.

But whereas electrostatic phenomena occur *solely* in the medium—conductors being mere breaks in it, interrupters of its continuity, at whose surface charge-effects occur but whose substance is completely screened from disturbance—that is not the case with electro-kinetic phenomena. It would be just as erroneous to conceive electro-kinetic phenomena as occurring solely in the insulating medium as it would be to think of them as occurring solely in the conducting wires. The fact is, they occur in

[1] Continued from vol. xxxvi. p. 585.

both—not only at the surface of the wires like electrostatic effects, but all through their substance. This is proved by the fact that conductivity increases in simple proportion with sectional area; it is also proved by every part of a conductor getting hot; and it is further proved in the case of liquids by their decomposition.

But the equally manifest facts of current attraction and current induction prove that the effect of the current is felt throughout the surrounding medium as well, and that its intensity depends on the nature of that medium; we are thus wholly prevented from ascribing the phenomenon of self-induction or extra-current to simple and straightforward inertia of electricity in a wire like that of water in a pipe.

We are thus brought face to face with another suggestion to account for these effects, viz. this: Since the molecules of a dielectric are inseparably connected with electricity, and move with it, it is possible that electricity itself has no inertia at all, but that the inertia of the atoms of the displaced dielectric confer upon it the appearance of inertia. Certainly they do sometimes confer upon it this appearance, as we see in the oscillatory discharge of a Leyden jar. For a displaced thing to overshoot its mean position and oscillate till it has expended all its energy, is a proceeding eminently characteristic of inertia; and so, perhaps, the phenomena of self-induction are similarly, though not so simply, explicable.

Further consideration of this difficult part of the subject is however best postponed to Part III.

Energy of the Current.

I have now called attention to the fact that the whole region surrounding a circuit is a field of force in which many of the most important properties of the current (the magnetic, to wit) manifest themselves. But directly we begin thus to attend to the whole space, and not only to the wires and battery, a very curious question arises. Are we to regard the current in a conductor as propelled by some sort of end-thrust, like water or air driven through a pipe by a piston or a fan, or are we to think of it as propelled by side forces, a sort of lateral drag, like water driven along a trough by a blast of air or by the vanes of paddle-wheels dipping into it? Or, again, referring to the cord models, Figs. 5, 6, and 13, were we right in picturing the driving force of the battery as located and applied where shown in the diagrams, or ought we to have schemed some method for communicating the power of the battery by means of belts or other mechanism to a great number of points of the circuit?

Prof. Poynting has shown that, on the principles developed by Maxwell, the latter of these alternatives, though apparently the more complicated, is the true one; and he has calculated the actual paths by which the energy is transmitted from the battery to the various points of a circuit, for certain cases.

We must learn, then, to distinguish between the flow of *electricity* and the flow of electric *energy*: they do not occur along the same paths. Hydraulic analogies, at least hydraulic analogies of a simple kind, break down here. When hydraulic power or steam power is conveyed along pipes, the fluid and its energy travel together. Work is done at one end of the tube in forcing in more water, and this is propagated along the tube and reappears at the distant end as the work of the piston. But in electricity it is not so. Electric energy is not to be regarded as pumped in at one end of a conducting wire, and as exuding in equal quantities at the other. The *electricity* does indeed travel thus—whatever the travel of electricity may ultimately be found to mean—but the energy does not. The battery emits its energy, not to the wire direct, but to the surrounding medium; this is disturbed and strained, and propagates the strain on from point to point till it reaches the wire and is dissipated. This, Prof. Poynting would say, is the function of the wire: it is to dissipate the energy crowding into it from the medium, which else would take up a static state of strain and cease to transmit any more. It is by the continuous dissipation of the medium's energy into heat that continuous propagation is rendered possible.

The energy of a dynamo does not therefore travel to a distant motor through the wires, but through the air. The energy of an Atlantic cable battery does not travel to America through the wire strands, but through the insulating sheath. This is a singular and apparently paradoxical view, yet it appears to be well founded.

Think of a tram-car drawn by an underground rope, like those in the streets of Chicago or Hampstead Hill. A contact piece of iron protrudes from the bottom of the car and grips the moving rope, which is thus enabled to propel the car. How does the energy of the distant stationary engine reach the car? *Viâ* the rope and the iron connector, undoubtedly. They both have to be strong, and are liable to be broken by the transmitted stress.

Next, think of an electric tram-car driven by means of a current taken up from an underground conductor, like that of Mr. Holroyd Smith at Manchester, or at the late Inventions Exhibition. A contact piece of wire rope protrudes from the bottom of the car and drags a little truck along the conductor, which is thus enabled to supply electricity to the electro-magnetic motor geared to the wheels. How does the energy of the distant dynamo reach the car in this case? *Not viâ* the wire connector; not even *viâ* the underground conductor. It travels from the distant dynamo through the general insulating medium between cable and earth, some little enters the conductor and is dissipated, but the great bulk flows on and converges upon the motor in the car, which is thus propelled. All the energy of the conducting wire is dissipated and lost as heat: it is the energy of the insulating medium which is really transmitted and utilized.

Phenomena peculiar to a Starting, or Stopping, or Varying Current.

There is a remarkable fact concerning electric currents of varying strength, which has been lately brought into prominence by the experimental skill of Prof. Hughes, viz. that a current does not start or stop equally and simultaneously at all points in the section of a conductor, but starts at the outside first. This fact is naturally more noticeable with thick wires than with thin, and it is especially marked in *iron* wires, for reasons which in Part III. will become apparent; but the general cause of it in ordinary copper wires can very easily be perceived in the light of the views of Prof. Poynting just mentioned.

For, remember that a current in a wire is not pushed along by a force applied at its end, so as to be driven over obstacles by its own momentum combined with a *vis a tergo*; but it is urged along at every point of its course by a force just sufficient to make it overcome the resistance there, and no more, the force being applied to it through the medium of the dielectric in which the wire is immersed. A lateral force it is which propels the electricity; and it naturally acts first on the outer layers of the wire or rod, only acting on the interior portions through the medium of the outside.

To illustrate this matter further, rotate a common tumbler of liquid steadily for some time and watch the liquid; dusting powder perhaps over it to make it more visible. You will see first the outer layer begin to participate in the motion, and then the next, and then the next, and so on, until at length the whole is in rotation. Stop the tumbler, and the liquid also begins gradually to stop by a converse process.

If the liquid sticks together pretty well, like treacle, the motion spreads very rapidly: this corresponds to a poor conductor. If the liquid be very mobile, the propagation of motion inward is slow: this corresponds to a very good conductor. If the liquid were perfectly non-viscous, it would correspond to a perfect conductor, and no motion would ever be communicated to it deeper than its extreme outer skin.

Think now of a long endless tube full of water, say the hollow circumference of a wheel, and spin it: the liquid is soon set in rotation, especially if the tube be narrow or the liquid viscous; but it is set in motion by a lateral not an end force, and its outer layers start first.

Just so is it with a current starting in a metal wire. If the wire be fine, or its substance badly conducting, it all starts nearly together; but if it be made pretty thick, and of well conducting substance, its outer layers may start appreciably sooner than the interior. And if it were infinitely conducting, no more than the outer skin would ever start at all.

In actual practice the time taken for all the electricity in an ordinary wire to get into motion is excessively short—something like the thousandth of a second—so that the only way to notice the effect is to start and reverse the current many times in succession.

If the hollow-rimmed wheel above spoken of were made to oscillate rapidly, it is easy to see that only the outer layers of water in it would be moved to and fro; the innermost water would remain stationary; and accordingly it would appear as if the tube contained much less water than it really does. The virtual bore of the pipe would, in fact, for many purposes be diminished. So is it also with electricity; the sectional area of a wire to a rapidly alternating current is virtually lessened so far as its conducting power is concerned; and accordingly its apparent resistance is slightly higher for alternating than for steady currents. The effect is however too small to notice in practice except with thick wires and very rapid alternations.

By splitting up the conductor into a bundle of insulated wires, thus affording the dielectric access to a considerable surface of conductor, the force is applied much more thoroughly, and so the effect spoken of is greatly lessened. The same thing is achieved by rolling out the conducting-rod into a flat thin bar. Making the conductor hollow instead of solid offers no particular advantage, because no energy travels *viâ* the hollow space, it still arrives only from the outside; *unless*, indeed, the return part of the circuit is taken along the axis of the hollow like a telegraph cable. In this last arrangement all the energy travels *viâ* the dielectric between the two conductors, and none travels outside at all. It will be perceived therefore that, as in static electricity, the term "outside" must be used with circumspection: it really means that side of a conductor which faces the opposite conductor across a certain thickness of dielectric.

We learn from all this that, whereas in the case of steady currents the sectional area and material of a conductor are all that need be attended to, the case is different when one has to deal with rapidly alternating currents, such as occur in a telephone, or, again, such as are apt to occur in a Leyden-jar discharge (see Part I., p. 560), or in lightning.

In all these cases it is well to make the conductor expose considerable surface to the propelling medium—the dielectric—else will great portions of it be useless.

Hence, a lightning-conductor should not be a round rod, but a flat strip, or a strand of wires, with the strands as well separated as convenient: and though I have not yet mentioned the special effect of iron, I may as well say here that iron is about 90,000 times worse than copper for the purpose of a lightning-conductor in respect of the phenomenon just described, seven times as bad on account of its inferior conducting power, and about twice as good as copper because of its higher melting-point and specific heat.

The Question of Electrical Momentum again.

We are now able to return to the important question whether an electric current has any momentum or not, as it would have if it were a flow of material liquid. Referring to Part I. (p. 533), a hint will be found that the laws of flow of a current in conductors—the shape of the stream-lines, in fact—are such as indicate no inertia, or else no friction. Now Ohm's law shows that at any rate *friction* is not absent from a current flowing through a metal; hence it would appear at first sight as if *inertia* must be absent.

The stream-lines bear upon the question in the following kind of way. If an obstacle is interposed in the path of a current of water, the motion of the water is unsymmetrical before and behind the obstacle. The

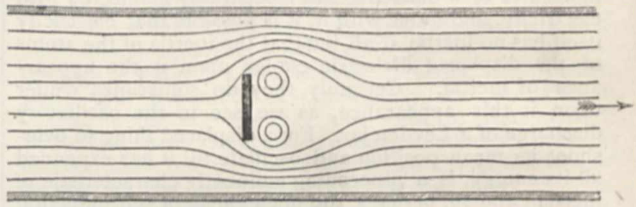

FIG. 14.—Stream-lines of water flowing through a pipe with an obstruction in it.

stream-lines spread out as the water reaches the obstacle, and then curl round it, leaving a space full of eddies in its wake (Fig. 14).

But if one puts an obstacle in the path of an electric current—say by cutting a slit in a conducting strip of tinfoil—the stream-lines on either side of it are quite symmetrical, thus—

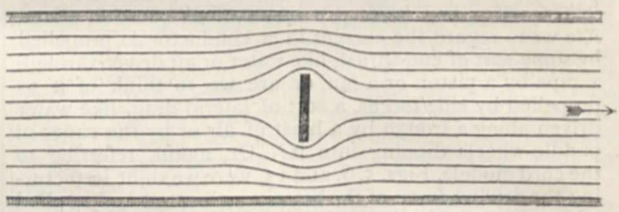

FIG 15.—Electrical stream-lines past an obstacle.

And this is exactly what would be true for water also, if only it were devoid either of friction or of inertia, or of both.

Is not this fact conclusive, then? Does it not prove the absence of momentum in electricity?

Plainly the answer must depend on whether there is any other possible mode of accounting for this kind of flow. And there is.

For suppose that water, instead of being urged by something not located at or near the obstacle—instead of being left to its own impetus to curl round or shoot past as it pleases—suppose it were propelled by a force acting at every point of its journey, a force just able to drive it at any point against the friction existing at that point and no more; then the flow of water would take place according to the electrical stream-lines shown in Fig. 15.

An illustration of such a case is ready to hand. Take a spade-shaped piece of copper wire or sheet, heat it a little, and fix it in quiescent smoky air; looking along it through a magnifier in a strong light you will see the warmed air streaming past the metal according to the stream-lines of Fig. 15; and this just because the moving force has its location at the metal surface, and not in some region below it. (See Lord Rayleigh, NATURE, vol. xxviii. p. 139). One cannot indeed say that it is propelled at every point of its course, but it is propelled at the critical points where the special friction occurs, and this comes to sufficiently the same thing.

We learn, therefore, that stream-lines like Fig. 15 prove one of three things, not one of two; and the three things are: (1) that the fluid has no friction; or (2) that it has no inertia; or (3) that it is propelled at every point of its course.

If any one of these is true of electricity, there is no need to assume either of the others in order to explain the actual manner of its flow. Now we have just seen that, according to Prof. Poynting's interpretation of Maxwell's theory, the third of the above is true—electricity is propelled at every point of its course; consequently, as said in Part I. (p. 533), the question of its inertia so far remains completely open.

Voltaic Battery.

Leaving this singular mode of regarding the subject for the present, to return to it perhaps after Part III., let us proceed to ask how it comes about that a common battery or a thermopile is able to produce a current.

If we allow ourselves to assume the existence of an unexplained chemical attraction between the atoms of different substances, an explanation of the action of an ordinary battery cell is easy. You have first the liquid containing, let us say, hydrogen and oxygen atoms, free or potentially free—that is, either actually dissociated or so frequently interchanging at random from molecule to molecule that the direction of their motion may be guided by a feeble directive force. Each of these atoms in the free state possesses a charge of electricity—the hydrogen all a certain amount of positive electricity, the oxygen twice that amount of negative. Into this liquid you then plunge a couple of metals which attract these atoms differently: for instance, zinc and copper, which both attract oxygen, but zinc more than copper; or, better, zinc and platinum, the latter of which hardly attracts it at all; or, better still, zinc and peroxide of lead, one of which attracts oxygen, the other hydrogen.

Immediately, the free oxygen atoms begin moving up to the zinc, the free hydrogen atoms to the other plate.

When one speaks of the plates attracting the atoms, it is not necessary to think of their exerting a force on all those in the liquid, distant and near: all that is necessary is to assume a force acting on those which come within what is called "molecular range" of its surface—a distance extremely minute, and believed to be about the ten-millionth part of a millimetre. If the zinc plate removes and combines with all the oxygen atoms which come within this range, they will be speedily replaced by others from the next more distant layer by diffusion, and these again by others, and so on. And thus there will be a gradual procession of oxygen atoms all through the liquid towards the zinc, the rate of the procession being regulated by the force acting, and by the rate of diffusion possible in the particular liquid used. All the atoms which reach the zinc neutralize a certain portion of its electricity by means of the positive charge they carry, and thus very soon it would become positively electrified enough to neutralize its attractive power on the similarly charged oxygen atoms, and everything would stop. But if a channel for the escape of its electricity be provided by leading a wire from it to the copper plate, the circuit is completed, the electricity streams back by the wire, and the procession goes steadily on. The electricity thus imparted to the copper, or platinum, neutralizes any repulsion it exerted on the negatively charged hydrogen atoms, and makes them in a similar way begin a procession towards it, deliver up their charges to it, combine with each other, and escape as gas.

Without going into all the niceties possible, this mode of thinking of the matter at least calls attention to some of the more salient features of a battery.

If, instead of two different plates, plates of the *same* metal be immersed, they will need to be oppositely electrified by some means before they are able to cause the two opposite processions, and so maintain a current in the liquid. This plainly corresponds to a voltameter.

Taking advantage of the known fact that the atoms are charged, Helmholtz avoids the necessity for postulating any chemical (non-electrical) force between zinc and oxygen, by imagining that all substances have a specific attraction for electricity itself, and that zinc exceeds copper and the other common metals in this respect.

He would thus think of the zinc attracting, not the oxygen itself, but its electric charge; and so would liken a battery cell still more completely to a voltameter. The polarization or opposition force acting at the hydrogen-evolving plate he would account for by the attraction of hydrogen for negative electricity, and the consequent repugnance of the hydrogen atoms to part with their charges.

Thermo-electric Pile.

A thermopile may be thought of in the following way, but in trying to understand the nature of these actions at present one must admit that some speculation and vagueness exist.

We have seen that when electricity is propelled through or among the molecules of a metal it experiences a certain resistance or opposition force which is exactly proportional to the speed of its motion. In other words, there is a connexion between matter and electricity in many respects analogous to fluid friction but varying accurately as the first power of the relative velocity. Hence, if an atom of matter be vibrating about a fixed point, it will tend to drive electricity to and fro with it; but if it be only one of a multitude, all quivering in different phases, they will none of them achieve any propulsion. This may be considered the state of an ordinary warm solid. But if from any cause a set of atoms could be made to move faster in one direction than in the reverse direction—to move forwards quickly and backwards slowly—then such an unsymmetrically moving set *will* exert a propulsive tendency and tend to drive a current of electricity forwards, simply because the force exerted is proportional to the velocity, and so is greater on the forward journey than on the return.

Wherever conduction of heat is going on along a substance the atoms are in this condition. They are driven forward infinitesimally quicker, by the more rapidly moving atoms at the hot end, than they are driven back by the less rapidly moving atoms in front. And hence such a slope of temperature exerts a propulsive tendency: there is an electromotive force in a substance unequally heated.

This fact was discovered theoretically and verified experimentally by Sir William Thomson.

But not only is there such a force at a junction of a hot and cold substance, there is also a force at the junction of two substances of different kinds, even though the temperature be uniform. It is not quite so easy to explain how it now comes about that the atoms at this kind of junction are moving faster one way than the other; nevertheless, such a thing is not unlikely, considering the state of constraint and accommodation which must necessarily exist at the boundary surface of two different media. However it be caused, there is certainly an E.M.F. at such a junction.

Thus, then, in a simple circuit of two metals, with their junctions at different temperatures, there are altogether four electromotive forces—one in each metal, from hot to cold or *vice versâ*, and one at each junction; and the current which flows round such a circuit is propelled by the resultant of these four.

But the contact force at a junction is by no means confined to metals. It occurs between insulators also, and it is to it that the striking effects produced by all frictional electric machines are due.

By thus noticing that the connexion between matter and electricity, known as resistance and defined by Ohm's law, is competent to produce contact electromotive forces, we may perceive how it comes to pass that in good conductors such forces are so weak, while in insulators they are so strong. Electricity slips through the fingers of a metal as it were, and the driving force it can exert is very feeble; while an insulator gets a good grip and thrusts it along with violence.

The metals differ in their gripping power, and, roughly speaking, the best conductor makes the worst thermo-electric substance. A bad conductor, like antimony, or, still better, galena, or selenium, or tellurium, makes a far more effective thermo-electric element than a well-conducting metal. Not that specific resistance is all that has to be considered in the matter; there is also a specific relation between each metal and the two kinds of electricity. Thus, iron is a metal whose atoms have a better grip of positive than of negative electricity, and so a positive current gets propelled in iron from hot to cold. Copper, on the other hand, acts similarly on negative electricity, and it is a negative current which is driven from hot to cold in copper. And all the metals can be classed with one or other of these two, except perhaps lead, which appears to grip both equally, and so to exert no differential effect upon either.

Passage of Electricity through a Gas.

There remains to be said something about the way in which electricity can be conveyed by *gases*.

The first thing to notice is that there is no true conduction through either gases or vapours; in other words, a substance in this condition seems to behave as a perfect insulator—perhaps the only perfect insulator there is. Not even mercury vapour is found to conduct in the least. This shows that mere bombardment of molecules, such as is known to go on in gases, is not sufficient either to remove or to impart any electric charge.

The commonest way in which electricity makes its way through a gas, setting aside the mere mechanical conveyance by solid carrier, is that of disruptive discharge. Let us try and look into the manner of this a little more closely, if possible.

First of all, since locomotion is possible to the molecules of a gas the same as of any other fluid, it is natural to ask why electrolysis does not go on as in a liquid. Now, for electrolysis in a liquid two conditions seemed necessary: first, that the atoms or radicles in a molecule should be oppositely charged with electricity; second, that they should be in such a condition (whether by dissociation or otherwise) that interchanges of atoms from molecule to molecule, or, in some other way, a procession of atoms, could be directed in a given direction by a very feeble or infinitesimal force.

Since a gas does *not* act as an electrolyte, one of these conditions, or perhaps both, must fail. Either the atoms of a gas-molecule are not charged, which is a plausible hypothesis for elementary gases, or else the atoms belonging to a gas-molecule remain individually belonging to it, and are not readily passed on from one to another.

When one says that a gas does not act as a common electrolyte, the experimental grounds of the statement are that a finite electrostatic stress certainly is possible in its interior—a stress of very considerable amount; and when this stress does overstep the mark and cause the electrode to yield, the yielding is evidently not a quiet and steady glide or procession, but a violent breaking down and collapse, due to insufficient tenacity of something. One may therefore picture the molecules of a gas, between two opposite electrodes or discharge terminals maintained at some great difference of potential, as arranged in a set of parallel chains from one to the other, and strained nearly up to the verge of being torn asunder. In making this picture one need not suppose any fixture of individual molecules: there may be a wind blowing between the plates; but all molecules as they come into the field must experience the stress, and be relieved as they pass out.

If the applied slope of potential overstep a certain limit, fixed by observation at something like 33,000 volts per linear centimetre for common air, the molecules give way, the atoms with their charges rush across to the plates, and discharge has occurred. The number of atoms thus torn free and made able to convey a charge by locomotion is so great that there has never been found any difficulty in conveying any amount of electricity by their means. In other words, *during* discharge the gas becomes a conductor, and, being a conductor by reason of locomotion of atoms, it may be called an electrolytic conductor.

But whether the charge then possessed by each carrier atom intrinsically belonged to it all the time, or whether it was conferred upon the components of the molecules during the strain and the disruption, is a point not yet decided.

What is called "the dielectric strength" of a gas—that is, the strain it can bear without suffering disruption and becoming for the instant a conductor—depends partly on the nature of the gas, and very largely on its pressure. Roughly, one may say that a gas at high pressure is very strong, a gas, at low pressure very weak. An ordinary electrolyte might be called a dielectric of zero strength.

One reason why pressure affects the dielectric tenacity of a gas readily occurs to one: it is certainly not the only one, but it can hardly help being at least partially a *vera causa*; and that is, the fact that in a rare gas there are fewer molecules between the plates to share the strain between them.

Thus if 40,000 volts per centimetre break down ordinary air, 40 volts per centimetre ought to be enough to effect discharge through air at a pressure of about $\frac{3}{4}$ millimetre of mercury; and at a pressure of 50 atmospheres 2,000,000 volts per centimetre should be needed.[1]

A Current regarded as a Moving Charge.

To review the ground we have covered so far. We first tried to get some conception of the nature of electrostatic charge, and the function of a dielectric medium in static electricity. We next proceeded to see how far the phenomena of current electricity could be explained by reference to electrostatics. For a current, being merely electricity in locomotion, need consist of nothing but a charged body borne rapidly along.

Charge a sphere with either positive or negative electricity, and throw it in some direction: this constitutes a positive or a negative current in that direction. There is nothing necessarily more occult than that. And a continuous current between two bodies may be kept up by having a lot of pith balls, or dust particles, oscillating from one to the other, and so carrying positive electricity one way, and negative the other way. But such carriers, as they pass each other with their opposite charges, would be very apt to cling together and combine. They might be torn asunder again electrically, or they might be knocked asunder by collision with others. Unless they were one or other, the current would shortly have to cease, and nothing but a polarized medium would result.

Instead of pith balls, picture charged atoms as so acting, and we have a rough image of what is going on in an electrolyte on the one hand, and a dielectric on the other. The behaviour of metals and solid conductors is more obscure. Locomotive carriage is not to be thought of in them; but, inasmuch as no new phenomenon appears in their case, it is natural to try and

[1] It is true that tension per unit area, or energy per unit volume, is proportional to the *square* of the potential-slope, and I attach no special importance to the simple proportion assumed in the text. There is a great deal more to be said on these subjects, but this is scarcely the proper place to say it.

picture the process as one not wholly dissimilar; and this is what in one place we tried to do; with, however, but poor success.

I have said that an electric current need be nothing more occult than is a charged sphere moving rapidly; and a good deal has been made out concerning currents by minutely discussing all that happens in such a case. But, even so, the problem is far from being a simple one. One has to consider not only the obviously moving charge, but also the opposite induced charge tied to it by lines of force (or tubes of induction, as they are sometimes called), and we have this whole complicated system in motion. And the effect of this motion is to set up a new phenomenon in the medium altogether—a spinning kind of motion that would not naturally have been expected; whereby two similarly charged spheres in motion repel one another less than when stationary, and may even begin to attract, if moving fast enough; whereby also a relation arises between electricity and magnetism, and the moving charged body deflects a compass needle. Of which more in the next Part. OLIVER J. LODGE.

(To be continued.)

THE TWEEDDALE COLLECTION.

THE great collection of birds formed by the late Marquess of Tweeddale has now safely arrived in London, and has been deposited in the Natural History Museum at South Kensington. It is sufficient to say that it equals in extent the valuable donation of American birds presented by Mr. Osbert Salvin and Mr. F. Du Cane Godman, numbering about 27,000 specimens; and though inferior in number of individual skins to the great Hume collection, which reached the phenomenal number of 63,000 specimens, it is not inferior in interest to either of these wonderful collections. Mr. Hume thoroughly worked the territory of the British Asian Empire from Scinde to Assam and Manipur, from Khatmandu to Ceylon, and from Tenasserim to Singapore; but to the eastward of these countries the work had been continued by other naturalists, and the results of their labours are largely represented in the Tweeddale collection, which now forms part of the British Museum.

On the death of the late Marquess, his entire collection and library were bequeathed by him to his nephew, Capt. R. G. Wardlaw Ramsay, of Whitehill, a naturalist of high promise and performance; and in the moment of satisfaction at receiving his magnificent donation one cannot help feeling great regret that the many cares and duties incident upon his succession to the family estates at Whitehill have temporarily deprived him of the leisure necessary for the working out of the great collection left to him by his uncle. The facilities for ornithological study, however, at the Natural History Museum, are now rapidly becoming so perfect that one may reasonably hope that he will, in common with all ornithologists, be able to work in that institution with the same comfort as in his own museum in Scotland. If in future years the student of birds finds that at South Kensington the work he loves can be done more expeditiously and with command of a larger series of specimens than in any other Museum in the world, his gratitude will be largely due to the four naturalists we have mentioned—Mr. Allan Hume, Messrs. O. Salvin and F. D. Godman, and Capt. Wardlaw Ramsay—for the unexampled generosity which has led them to present to the British nation the wonderful collections which will make our Ornithological Museum famous for all time.

Many naturalists who read this article will remember how, twelve years ago, the entire collection of bird-skins in the British Museum was contained in a few book-cases in a dingy cellar at Bloomsbury, where all the skins were kept in wooden boxes—a barbarous method, which was not only clumsy, but actually harmful to the specimens themselves. The development of the collection since that era is one which any English naturalist may consider with pride. Not only is the invaluable series of skins in the British Museum now well cared for and properly housed, but the *raison d'être* of the large collections in private hands has been removed. It is admitted on all sides that had the facilities of study in the old days been such as they now are in the Natural History Museum, there would have been no need for ornithologists to devote their private means to the formation of the collections which have, however, now become the foundation of the greatest Ornithological Museum in the whole world.

The three great collections which have enriched the British Museum during the last two years have each been, in their way, of supreme importance for zoological science. The Hume collection was a perfect marvel in the way of complete series of specimens. Not only are the various plumages of the Indian birds exemplified in a manner hitherto unheard of, but even the geographical ranges of most of the species are illustrated in a perfect way by the series of specimens contained in the collection. The Salvin-Godman donation consisted of American birds, and added hundreds of species to the British Museum which were desiderata to that collection. Though not so rich in series of various plumages as the Hume collection, the number of gaps in the quota of American birds which their donation filled was simply enormous, and from being one of the most backward in regard to its neotropical collection of birds, the British Museum is now one of the foremost as regards the value of its American series.

The Tweeddale collection "takes up the running," so to speak, where Mr. Hume left off, and it must not be supposed that the donation now made by Capt. Wardlaw Ramsay is merely the collection of skins left to him by his uncle. To imagine this would be but a poor appreciation of the energy which has led him during the last few years to develop and greatly increase the collection by the addition of a large number of birds obtained during his military career in the East, and by hundreds of other valuable specimens acquired since his uncle's death. Thus the skins from the Kurrum Valley in Afghanistan, and from the Karen Hills in Burmah, obtained by Capt. Ramsay himself, are supplementary additions of the highest value to the Hume collection, inasmuch as Mr. Hume never had correspondents in these parts, and the specimens from the Andamans and Nicobars are also of great importance; but of course the interest of the Tweeddale collection centres round the expedition to the Philippine Archipelago made by Mr. Alfred Everett for the late Marquess. Mr. Everett visited several islands on which no zoologist had previously trod, and as a natural result he discovered some beautiful new species of birds which are still unrepresented in any other collection but that of Capt. Ramsay. Altogether Mr. Everett furnished material for twelve important memoirs by the Marquess of Tweeddale, and the number of Philippine types now presented to the British Museum adds immensely to the wealth of the donation. Lord Tweeddale was also greatly interested in an obscure family of birds—the Drongos, or Crow-shrikes (*Dicruridæ*)—and possessed a wonderful collection of these birds, although it may be stated that there is scarcely a family of Oriental birds which is not strongly and completely represented in the collection.

Ornithologists will understand the nature of this noble gift of Capt. Ramsay when they learn that in addition to the collection of birds he has also presented the whole of the splendid Tweeddale library (nearly 3000 volumes) to the British Museum, to be placed in the Bird-Room, alongside of the collection of skins, for the benefit of students of ornithology. The Tweeddale library is one of the best in the world, containing many rare volumes which we have not seen elsewhere, and this donation alone is worth several thousands of pounds. With a series of bird-skins now numbering nearly a quarter of a million, and with the best ornithological library in the world, it will be strange if the work done at the British Museum in future be not rendered an easy and an enjoyable task, though it must be remembered that the very magnitude of the collection contributes to the difficulty of its exact study. The writer may be excused an expression of deep gratitude to the ornithologists who have enriched the collection under his charge, so that from a series of (at the most) 40,000 skins, the number of bird-skins has been raised in fifteen years to more than 200,000, and he merely adds a hope that he may see the British Museum become the repository of all the work of English ornithologists, not only from this country, but from all parts of the Empire.

This article has dealt merely with the three great donations which have been received during the last two years, and has not recorded the many other collections, of almost equal importance, which have been acquired by the Trustees of the British Museum since 1872, the results of the life-work of such naturalists as Sclater, Wallace, Gould, and others of whom the country is proud, the acquisition of whose collections also is a source of the greatest encouragement to the writer.

R. BOWDLER SHARPE.

THE STORM OF OCTOBER 30.

THE gale which swept over the southern part of England on the morning of Sunday the 30th was both sudden and severe. On the previous day the weather was exceptionally fine over the country generally, and in many places it was a truly "pet" day. The Meteorological Office, in their morning report referring to the barometric rise which was going on in the south and west, remarked that "some improvement in the weather is therefore likely in the south." In the afternoon of Saturday, however, there were signs of approaching bad weather, and by six o'clock a disturbance was shown to be situated off Scilly, the barometer reading 29·4 inches. The Meteorological Office considered the situation sufficiently menacing for the issue of storm signals, and the south cone was hoisted in the south and south-west districts. During the night the storm passed in an east-north-east direction over the southern counties of England, travelling at the rate of about thirty miles an hour. The centre passed almost directly over London at about five o'clock in the morning, when the wind changed suddenly about 180°, the barometer at the time registering 28·86 inches, and in the next two hours the mercury rose 0·4 of an inch. At Greenwich Observatory the anemometer recorded 17·2 lbs on the square foot at 7·5 a.m., which is equivalent to an hourly velocity of about sixty miles. By 8 a.m. the centre of the disturbance had passed to the eastward of our islands and was situated a short distance off Yarmouth. The storm afterwards travelled in a north-easterly direction, maintaining somewhat its former rate of movement, and on Monday morning the central area was in the neighbourhood of Stockholm. The gale was rather severe on our southern coasts, but its principal violence was felt in the English Channel and on the French and Danish coasts. The Paris *Bulletin* shows that at many of the stations the wind reached the full force of a hurricane, and the sea was terrific. The amount of rain which fell during the storm was unusually heavy, 1·59 inches being registered at Scilly, and upwards of an inch at other stations in the south of England and also in the north of France. As is commonly the case with these quick-travelling and rapidly-developing storms, the disturbance was a "secondary" to a larger disturbance which was passing from off the Atlantic to the northward of our islands.

ROBERT HUNT, F.R.S.

MR. ROBERT HUNT, whose death we have already briefly announced, was born at Devonport, then called Plymouth Dock, on September 6, 1807. His father was a naval officer who perished, with all the crew, in H.M.S. *Moucheron*, in the Grecian Archipelago. Robert Hunt, left to his mother's care, was destined for the medical profession; and, having been placed with a surgeon in London, he attended the anatomical lectures of Joshua Brooks; but his studies were interrupted by failing health, and his medical training was never completed. In 1840, Mr. Hunt became secretary to the Royal Cornwall Polytechnic Society at Falmouth. His earliest contributions to science were in connection with photography—a subject to which he applied himself with assiduity immediately on the announcement of Daguerre's discovery in 1839. Mr. Hunt's investigations led to the discovery of several new processes, which were either described in the *Philosophical Magazine* or announced to the British Association. His experimental researches on the chemical activity of the highly refrangible rays of the solar spectrum, his work with the actinograph, and his study of the influence of light upon the germination of seeds and the growth of plants, formed the subject of numerous papers between 1840 and 1854. Mr. Hunt's "Researches on Light" appeared in 1844. His "Manual of Photography," which was the first general work on the subject published in this country, passed through six editions.

While Mr. Hunt was in Cornwall he undertook some interesting inquiries, conjointly with the late Mr. Robert Were Fox, into the electrical phenomena of mineral veins; and he also entered upon an examination of the air in some of the Cornish mines. In 1845 he came to London, at the invitation of Sir H. T. De la Beche, to succeed Mr. Thomas Jordan, as Keeper of Mining Records at the Museum of Economic Geology, then recently established in Craig's Court. On the establishment of the Government School of Mines in 1851, he was appointed Lecturer on Mechanical Science, and opened his course with an address on the importance of cultivating habits of observation. After holding this position for two sessions he resigned it to the late Prof. Willis, and undertook for a short time the duties of Lecturer on Physics. In 1854 Mr. Hunt was elected a Fellow of the Royal Society.

For the last thirty years Mr. Hunt's energies have been mainly directed to the collection and collation of statistical information relating to British mining and metallurgy. From 1853 until the abolition of the Keepership of Mining Records he published regularly the annual volumes of "Mineral Statistics," containing a vast mass of voluntary returns obtained by his personal influence. As a member of the Royal Coal Commission of 1866, he undertook the statistical part of the inquiry, and published detailed information on the coal resources of the country.

The technical education of the metal-mining population of the West of England was a subject that Mr. Hunt always had at heart. He was an earnest advocate for the establishment of local mining schools, and should be regarded practically as the founder of the Miners' Association of Cornwall and Devon—a body now amalgamated with the Mining Institute. In 1883, Mr. Hunt published a voluminous work on "British Mining." After the death of Dr. Ure he consented to edit the "Dictionary of Arts," and brought out successively the fifth (1860), sixth (1867), and seventh (1875) editions of this work. At the same time Mr. Hunt possessed great literary taste, which found scope in several lighter works, such as his "Poetry of Science," "Panthea, or the Spirit of Nature," and the "Romances of the West of England." Mr. Hunt's long, busy, and useful life was closed on the 17th ult. His remains were interred in Brompton Cemetery.

NOTES.

THE vacancy in the representation of Cambridge University, caused by the death of Mr. Beresford Hope, raises again the question of the desirability that the Universities should be represented in Parliament by men of distinguished culture, whether literary or scientific. Men of science will be glad to hear that a movement is on foot in Cambridge to induce the President of the Royal Society to allow himself to be nominated as a candidate for the membership of the University. A meeting will be held on Saturday for the purpose of considering the question of the representative. It is believed that Prof. Stokes, if he finds the feeling to be strong in favour of his acceptance, will regard it as his duty to place his services at the disposal of the electors. A more distinguished representative never offered himself for the suffrages of any University in this country. His presence in the House of Commons would be another pledge that questions involving the interests of science would be discussed with adequate knowledge in that assembly.

IN presenting the prizes to the successful students of the Bath Lane Science and Art School at Newcastle-on-Tyne, Lord Randolph Churchill expressed the opinion that when "the State has laid the foundation by freely contributing to elementary education, localities ought to come in and ought to build on that foundation whatever edifice may be necessary for the further and higher technical education of the artisan." "This school," he continued, "is essentially the result of pure local effort, pure local energy, and pure local pride. You have, I understand, carried on the whole work of this school without the smallest assistance from Government of any sort or kind. Now, I was saying that technical education is supposed to be a great requirement of the present day, and I was using the illustration of your school to show that localities can if they wish, if they have the energy and the determination, supply that technical education for themselves." In a letter to the *Times* a writer signing himself "Y." has exposed the ignorance displayed by Lord Randolph Churchill in this astonishing statement. The Newcastle school, instead of being carried on simply by means of "local effort," has been largely aided by the Government. As "Y." points out, the last Report of the Science and Art Department shows that in 1886 the payments on results made to the school were for science £1212 10*s*., and for art £238 10*s*., while the students' fees for instruction in science were £1228, and in art £150. It is discreditable that a man in Lord Randolph Churchill's position should be capable of making such a mistake as this. The incident is important, for it indicates the spirit in which too many of those who talk wildly about "economy" approach the consideration of the grave question as to the duty of the State with regard to education. Lord Randolph Churchill has been Chancellor of the Exchequer, and may some day be Chancellor of the Exchequer again. With his crude notions and inaccurate information, the injury he might do in this position to our educational system is simply incalculable.

THE College of State Medicine, lately incorporated, ought to be a remarkably successful institution, if we may judge from the names of its officers. The Chairman of Council is Sir Joseph Fayrer, K.C.S.I., F.R.S. The following are the members of the Council:—Sir John Watt Reid, K.C.B., Sir Thomas Crawford, K.C.B., Sir William Guyer Hunter, K.C.M.G., M.P., Sir Henry Roscoe, F.R.S., Sir Douglas Maclagan, Surgeon-General William Robert Cornish, C.I.E., Richard Quain, F.R.S., Edward Klein, F.R.S., Robert Brudenell Carter, and Arthur Trehern Norton. The following are *ex-officio* members: —The President of the Sanitary Institute, the President of the Society of Medical Officers of Health, the President of the Public Health Medical Society, the Professor of Public Health to the College. Mr. James Cantlie is the honorary secretary.

THE first Congress of the Dutch Society of Naturalists lately met at Amsterdam under the presidency of Dr. Stoknis, who delivered an address on nationality and natural science. Among the other addresses were the following: on Martinus of Marum, who made a large electric machine at the end of the last century, by Prof. Bosscha (Delft); and on the education of future naturalists, by Prof. Spruyt (Amsterdam).

AN Exhibition of Textile Goods and Machinery will be held at Warsaw about the middle of December next. It will be open to all countries.

THE expedition which the Finnish Archæological Society despatched to the Upper Yenisei last summer, to prosecute archæological researches in that locality, has just returned to Helsingfors. It has brought back drawings of about thirty stone figures, and copies of a large number of inscriptions, hitherto not deciphered, on a rock, on nine raised stone slabs, and on many stones along the upper course of the Yenisei. The expedition has also gathered a vast collection of objects belonging to the Siberian Bronze Age.

IN his latest Annual Report, Mr. Putnam, Curator of the Peabody Museum of American Archæology and Ethnology, says that during the past year several large collections of special interest have been added to the Museum. The most important is the Bucklin collection from ancient graves in Peru, principally at Ancon. This collection is particularly rich in textiles and in ornaments and implements made of silver and bronze; and among the objects in pottery there are many new forms and styles of ornamentation. Another collection of over 300 specimens of pottery obtained from the province of Piura, Peru, has also been purchased, and nearly every vessel adds some important feature to the already instructive Peruvian collection in the Museum. A third collection consists of 337 pottery vessels, a number of whistles and other objects made of pottery, 245 stone implements, and several large carved stones, some circular, and others resembling animals, supposed by some archæologists to be seats, and by others to be metates. This collection has been catalogued and placed in the exhibition cases with the other objects from the ancient graves in Chiriqui. It was obtained from the well-known collector of antiquities in Chiriqui, Mr. J. A. McNiel, who has resided in the State of Panama for many years. Mr. Putnam expresses much regret that Mr. McNiel has not been able to keep together the contents of each grave. He is dependent on the sale of the specimens for the means to carry on his work, so that many of the objects he obtained are now widely scattered, and archæologists have no means of tracing the development of the arts of the people, which could have been done had the collection been kept together and the associations of every object carefully noted.

WE have received the Proceedings of the U.S. National Museum during the year 1885. This is the ninth volume of the series. It contains many interesting and valuable papers, some by members of the scientific corps of the National Museum, others by writers who have made portions of the collections of the Museum subjects of special study. The volume opens with a list of fishes collected in Arkansas, the Indian Territory, and Texas, in September 1884, with notes and descriptions, by Mr. D. S. Jordan and Mr. C. H. Gilbert. Among the other papers are: notes on fulgurites, by Mr. G. P. Merrill; a review of Japanese birds, by Mr. L. Stejneger; a catalogue of animals collected by the Geographical and Exploring Commission of the Republic of Mexico, by Mr. F. Ferrari-Perez; a description of six new species of fishes from the Gulf of Mexico, with notes on other species, by Mr. D. S. Jordan and Mr. B. W. Evermann; and Norsk naval architecture, by Mr. G. H. Boehmer. At the end of the volume there are twenty-five plates, each accompanied by its explanation.

SOME of the difficulties with which the curator of a museum in tropical climates has to contend are described in the last report on the Colombo Museum. Mr. Haly states that naphthaline is not so powerful a protection against the effects of climate as was anticipated. It seems to prevent the attacks of mites, but it is powerless against fungus. It is hoped that it will ward off the attacks of the fish insect on the labels. As an instance of the rapidity with which this pest works, it is mentioned that one case was re-painted, and the objects rearranged and labelled. No naphthaline was procurable at the time, and in a fortnight several labels had been defaced and several numbers lost. Carbolic acid and corrosive sublimate have both been mixed with the gum, but their use is objectionable, as they discolour the labels, and do not afford permanent protection. Every object in a tropical climate, Mr. Haly says, ought to be exhibited on its own stand, and that stand labelled by hand in black or white paint. The Museum has also been attacked lately by a fungus. Not only have the specimens themselves been attacked, but the wood of the teak cases, and even the glass, has been covered. In one case the insects were absolutely rolled round and connected together by its fine filaments—filaments so fine as to be invisible through the glass. Naphthaline, benzine, cyanide of potassium, carbolic acid, and other substances have all been tried in vain: the only check to its growth was citronella oil.

THE "Educational List and Directory of the United Kingdom for 1887–88" (Sampson Low), edited by Mr. William Stephen, has just been published. This is the second issue of the work. The editor's aim is to concentrate within reasonable space the names of the chief educational institutions of the Kingdom. Besides being a guide for the use of parents and guardians, and a directory for all who give attention to educational matters, the volume is interesting, as Mr. Stephen claims, on account of the fact that it is the first methodical effort to unite for practical purposes the designations of our educational institutions, from the Universities downwards, in England, Wales, Scotland, and Ireland. No "descriptive matter" has been introduced.

THE Cardiff Naturalists' Society have issued a valuable descriptive list of the indigenous plants found in the neighbourhood of Cardiff, with a list of the other British and exotic species found on Cardiff Ballast Hills. The compiler is Mr. John Storrie, Curator of the Cardiff Museum.

A STALACTITE cave has been discovered near Steinbach in the Upper Palatinate. It can only be approached by a shaft 1 square metre in diameter and 40 metres deep. The cave is divided into several compartments, through one of which a stream of water slowly flows. The numerous stalactites are of great beauty. Another stalactite cavern, equalling the celebrated Dechen cavern, both in extent and peculiarity of form, has been discovered in the so-called Billstein, between Hirschberg and Warstein (Westphalia). The interior consists of several chambers. Numerous animal remains (probably prehistoric) have been found in the cave.

THE death is announced of Herr August Kappler, whose excellent book on Dutch Guiana is well known. He died at Stuttgart, aged seventy-one.

WE regret to announce the death of Dr. E. Luther, Professor of Astronomy at the Königsberg University, also Director of the Observatory. He was born February 24, 1816.

THE weather in Iceland during the summer has been very unusual. The ice did not leave the north and east coast till the middle of September, or quite a month later than usual. Storms and fogs have been very frequent. The last mail brings news that the weather was then (the middle of October) dry and fine. Frost had, however, set in in several parts. This is the last news we shall have from the island until next spring.

AT a recent meeting of the Wellington (New Zealand) Philosophical Society, Sir James Hector exhibited samples of trachyte tuff and breccia, constituting the auriferous deposit lately found in the level ground west of Te Aroha. The material, which appeared to be somewhat of the nature of an infiltrated quartz reef which had been decomposed and then distributed as a surface deposit, was found to contain gold at a rate varying from two ounces to fourteen ounces to the ton. The gold occurs in twisted angular flakes and grains, and is associated in a light feldspar sand with heavier grains of quartz mica and titanic iron. Sir James Hector is of opinion that it will probably prove to be the outcrop of an important reef, from which the sulphides have been removed by decomposition, so that gold is left in its free state. The gold is the usual alloy of the district—consisting of gold 80·47 per cent., silver 16·91, loss 2·62, previous assays having varied from 77 to 84 per cent.

THE last number of the *Excursions et Reconnaissances* of Saigon contains an account by M. Navelle of a journey which he made in Annam from the port of Thi-Nai, commonly called Quin-hon, to Bla. The route lay through the great town of Binh-Dinh, and by the ruins of Quin-hon, at one time the capital of the Chams or Ciampois. This leads the traveller to narrate the vicissitudes of the once powerful kingdom of Ciampa, which was overthrown in the fifteenth century, after seven centuries of contest with Annam. The narrative is mainly interesting from the circumstance that the traveller visited a number of important towns hitherto unseen by Europeans. At the town of Dong-pho, he met an official who at one time performed curious functions. The Kinh-li was an Annamite official appointed to reside beyond the frontiers to organize Annamites who fled from their native country, and to direct their raids against neighbouring States. These vagabonds, thus directed, acted as the van-guards of regular Annamite invasion. M. Landes, in the same number, continues his researches into the folk-lore of the races of French Indo-China. In the present instance he gives the tales and legends of the Tjames, Chams, or Ciampois, above-mentioned. They have long been subjugated, and are now divided into two groups, one inhabiting the Bin-thuan province, the other Cambodia. Until recently they were amongst the most unknown peoples of the peninsula, but M. Aymonier's accounts of his long exploration in Binh-thuan, which were published in recent numbers of *Excursions*, have thrown much light on the subject. The stories published by M. Landes were collected from the mouth of a Cham, and are mostly fairy tales.

DR. KARL PETTERSEN, Director of the Tromsö Arctic Museum, has lately written a pamphlet on the state of the drift-ice in the Arctic seas during the last few years. In this pamphlet he offers some suggestions as to the way in which attempts to reach the North Pole should be made. "It seems to me," he says, "that every year shows more and more clearly that it is a sheer waste of life and money to despatch casual and erratic expeditions to the North Pole. In my opinion the result would be attained most easily, surely, and cheaply by despatching every year, for a period of ten or eleven years, a certain number of well-equipped steamers from certain suitable spots towards the Pole. As the ice-masses in the Polar Basin are, without doubt, in a constant but varying motion, this plan would enable one or another of the expeditions to seize the right moment for a dash northward. We could not, of course, be absolutely certain of success, for experience has proved that the state of the ice in a particular locality at a particular time does not enable us to predict what it will be in the same locality in the following year. Still, the opportunity to reach a high latitude would present itself sooner or later. The expeditions of past years having almost conclusively demonstrated that it will be impossible to reach the North Pole along the west coast of Greenland, the *point d'appui* for the journeys on the plan advocated would be confined to the European and Asiatic Polar seas. The routes I should recommend are four: viz. one along East Spitzbergen to Franz Josef Land, and northwards, starting from the north of Norway; one east of Franz Josef Land, starting from the Yenisei or Obi; one *viâ* Franz Josef Land, starting from the New Siberian Islands or the Lena; and one from a suitable spot in Behring Strait. I have every reason to believe that if four such expeditions were in readiness in these localities every year during a period of eleven years, we should by the end of that time, by one or another of the routes, have solved the problems which still face us around the Pole. Probably the scheme might be carried out most advantageously by international co-operation, as in the case of the Polar Research Expeditions of 1882–83. In any case, I venture to think that the plan of any expeditions should not be finally formed before July, or, if possible, August. By that time many of the huntsmen have returned from their first voyage to several parts of the Arctic Sea, and the expeditions would be in possession of a fair knowledge of the state of the ice in each. I believe that, should the route chosen be *viâ* Spitzbergen or Novaya Zemlya, a careful study of the weather and wind in North Norway during the spring and early summer would benefit Polar expeditions immensely, showing whether the route to the north or east of Spitzbergen should be followed, or the more eastern one by Novaya Zemlya."

The additions to the Zoological Society's Gardens during the past week include a Grand Eclectus (*Eclectus roratus*) from Moluccas, presented by Miss P. Lockwood; a Goffin's Cockatoo (*Cacatua goffini*), habitat uncertain, presented by Miss Barton; a Water Rattlesnake (*Crotalus adamanteus*), a Water Viper (*Cenchris piscivorus*), two American Black Snakes (*Coluber constrictor*), a Chicken Snake (*Coluber quadrivittatus*), two Mocassin Snakes (*Coluber fasciatus*) from Florida, presented by the Natural History Society of Toronto; two Green Lizards (*Lacerta viridis*), twelve Spotted Salamanders (*Salamandra maculosa*), two Common Snakes (*Tropidonotus natrix*) from Italy, presented by Messrs. Paul and Sons; an Algerian Tortoise (*Testudo mauritanica*) from Algeria, deposited; an Aye-Aye (*Chiromys madagascariensis*) from Madagascar, purchased; six Painted Terrapins (*Clemmys picta*), two Corn Snakes (*Coluber guttatus*), two Milk Snakes (*Coluber eximius*), two Mocassin Snakes (*Tropidonotus fasciatus*), two Ribbon Snakes (*Tropidonotus saurita*), two Hog-nosed Snakes (*Heterodon platyrhinos*), two Grass Snakes (*Cyclophis vernalis*), six Dekay's Snakes (*Ischnognathus dekayi*), nine American Green Frogs (*Rana halecina*), ten Noisy Frogs (*Rana clamata*), a Wood Frog (*Rana sylvatica*), a Changeable Tree Frog (*Hyla versicolor*), nine Red-backed Salamanders (*Plethodon erythronotus*) from Canada, received in exchange; a Blood-breasted Pigeon (*Phlogœnas cruentata*), bred in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 *NOVEMBER* 6–12.

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 6

Sun rises, 7h. 4m.; souths, 11h. 43m. 44·2s.; sets, 16h. 24m.: right asc. on meridian, 14h. 45·2m.; decl. 15° 59′ S. Sidereal Time at Sunset, 19h. 26m.

Moon (at Last Quarter November 8, 17h.) rises, 19h. 50m.*; souths, 3h. 54m.; sets, 11h. 58m.: right asc. on meridian, 6h. 54·4m.; decl. 20° 14′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	9 9 ...	13 3 ...	16 57 ...	16 4·7 ...	23 21 S.
Venus ...	2 57 ...	8 59 ...	15 1 ...	11 59·6 ...	0 22 S.
Mars ...	1 16 ...	8 0 ...	14 44 ...	11 1·4 ...	7 59 N.
Jupiter ...	7 12 ...	11 53 ...	16 34 ...	14 54·4 ...	15 44 S.
Saturn ...	21 48*...	5 35 ...	13 22 ...	8 35·5 ...	19 0 N.
Uranus ...	4 17 ...	9 54 ...	15 31 ...	12 55·4 ...	5 14 S.
Neptune..	17 7*...	0 49 ...	8 31 ...	3 49·1 ...	18 16 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich).

Nov.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
6 ...	*g* Geminorum ...	5½ ...	22 34 ..	22 51 ...	338 302
8 ...	7 Leonis ...	... 6½ ...	22 30 ...	23 8 ...	90 182
9 ...	ψ Leonis ...	... 6 ...	1 52 ...	2 42 ...	78 181

Nov.	h.	
7 ...	8 ...	Mercury stationary.
8 ...	0 ...	Saturn in conjunction with and 1° 1′ north of the Moon.
9 ...	2 ...	Jupiter in conjunction with the Sun.
12 ...	1 ...	Venus in conjunction with and 3° 42′ south of the Moon.

Saturn, November 6.—Outer major axis of outer ring = 42″·2; outer minor axis of outer ring = 13″·5; southern surface visible.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	Nov. 7,	2 49	*m*
			,, 12,	2 29	*m*
U Monocerotis ...	7 25·4 ...	9 33 S. ...	,, 9,		*M*
U Ophiuchi	17 10·8 ...	1 20 N. ...	,, 7,	3 9	*m*
		and at intervals of		20 8	
U Sagittarii... ...	18 25·2 ...	19 12 S. ..	,, 7,	0 0	*m*
R Scuti	8 41·5 ...	5 50 S. ...	,, 7,		*m*
β Lyræ...	18 45·9 ...	33 14 N. ...	,, 6,	3 0	*M*
S Vulpeculæ ...	19 43·8 ...	27 0 N. ...	,, 8,		*m*
η Aquilæ	19 46·7 ...	0 43 N. ...	,, 8,	5 0	*m*
S Sagittæ	19 50·9 ...	16 20 N. ...	,, 6,	1 0	*m*
			,, 9,	1 0	*M*
δ Cephei	22 25·0 ...	57 50 N. ...	,, 10,	3 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near the Pleiades ...	60° ...	20° N. ...	Bright; rather slow.
From Camelopardalis	102 ...	73 N. ...	Very swift.
Near η Leonis	149 ...	22 N. ...	Swift; streaks.

GEOGRAPHICAL NOTES.

The Danish Government has decided upon hydrographically measuring and charting the Guldborg Sound, the new harbour at Odense, in the Island of Funen, and the Randers and Mariager fjords in Jutland. Two vessels will also be engaged in preparing a naval chart of the coast around Denmark. It has also been decided to despatch an Expedition—the cost being estimated at £4000—to Iceland next summer, for the purpose of effecting hydrographical measurements around that island. Great fjords and waterways are here still unmeasured—a danger to navigation and a loss to science. It is believed that these researches may lead to important scientific discoveries, principally as regards zoology, meteorology, and geography. Moreover, they would probably be of great benefit to the Iceland fisheries, which are far from being thoroughly developed on account of the ignorance of existing fishing-banks, the temperature of the sea, &c. The researches, which will be similar to those carried out around Norway for some years past, will be effected with the Government schooner *Ingolf*, a vessel particularly adapted for the purpose. It is intended to employ the months of May, June, July, and August in this work, which, it is estimated, will be fully accomplished in five years.

In the *Bollettino* of the Italian Geographical Society for September Signor E. Modigliani concludes his series of papers on Nias, with a detailed account of the physical features, natural history, and social condition of that island. The hilly surface is relieved in some places by extensive open plains covered with tall grasses, and the forest vegetation is rapidly disappearing, owing largely to the wasteful habits of the natives. The accompanying seismic tables contain records of the earthquakes that occurred between the years 1843–86, some of which were very violent and attended by marine disturbances destructive to shipping, and driving boats and barges hundreds of yards inland. But there are no active volcanoes, and the prevailing formation appears to be a much-weathered compact limestone resting on gray or bluish Miocene marls and other argillaceous clays. The geological as well as the zoological conditions show that Nias, like the other islands running parallel to the west coast of Sumatra, must have formerly been connected with the mainland; and as Sumatra itself at one time certainly formed part of the Malay Peninsula, this chain of insular groups would appear to mark the original line of the Asiatic seaboard in this direction. Signor Modigliani's collections include 178 birds, representing 62 species, of which 8 are described as new, but allied to corresponding species in Sumatra; consequently the separation must have taken place at a very remote period—a conclusion also confirmed by other considerations. His rich zoological collection, comprising over 7000 specimens, has been presented to the Museum of Genoa.

METEOROLOGICAL NOTES.

THE Report on the Meteorology of India in 1885, being the eleventh year of the series, has just been published, and contains an immense mass of valuable information. The accumulation of Indian statistics during the last ten years may be best shown by a comparison of the following figures:—The number of stations at which the mean temperature is recorded has increased from 51 to 127, and the rainfall stations from 134 to 471. From this huge volume of 516 large quarto pages we can only note here a very few general remarks. Considerable attention is paid to solar radiation, the chief feature of which is found to be that the maximum intensity generally occurs during the winter half of the year (October to March), when the sun is in southern declination, and the thickness of the absorbing atmosphere traversed by the sun's rays is at a maximum. This is said to be apparently due to the fact that over a large part of India the atmosphere is most cloudy in the summer and autumn months. It would appear from the mean result of the sun-thermometer readings in all parts of India that the average intensity of solar heat had reached a minimum in 1884, and in 1885 underwent an appreciable increase. The duration of bright sunshine is now regularly recorded at four stations, and Mr. Blanford considers that the sunshine-recorder promises to be even more important than the sun-thermometer, since the duration of sunshine is a more direct measure of the amount of solar heat reaching the earth's surface than the registry of its mean maximum intensity. Anemometers are in use at nearly all the stations, and fourteen of them are large anemographs of the Kew pattern. The resultant direction of the winds is, however, computed by Lambert's old formula, which is based on the assumption that the force of all winds is equal, an assumption which is obviously often very misleading. The work is accompanied by maps showing the positions of the meteorological observatories and the mean distribution of temperature, pressure, and wind.

M. GARRIGOU-LAGRANGE describes, in the *Annuaire de la Société Météorologique de France*, his apparatus for registering the ascending and descending air-currents. The experimental anemometer is fixed on a mast at Limoges, and consists of four small fans moving round a vertical axis, and recording, by electrical arrangements, on a drum covered with ruled forms. The curves obtained by this method show plainly the upward or downward movement of the air, and the velocity is easily read off. The experiments show that ascending winds are generally stronger and more frequent than the descending, owing no doubt to the eddies caused by obstacles met with by the currents.

IN *Das Wetter* M. Seemann discusses the results of the storm-warnings issued by the *New York Herald* between September 1886 and January 1887, and finds that out of twelve warnings only three were quite successful, and three partially so. The wording of the telegrams is not so absolute as formerly; many of the depressions pass to the northward of our islands, and our weather is *disturbed*, although the gales do not always strike our coasts; judged in this light, the warnings may be more successful than when actual storms are predicted. On pp. 83–87 of the same journal Dr. C. Lang describes his method of predicting night-frost, from the position of the dew-point. From the Munich observations for 1879–86 he finds that 441 predictions of night-frost could be given, of which 89 per cent. were successful. In 8 per cent. of the cases, night-frost did not follow, and in 3 per cent. frost occurred unexpectedly. This method may be of considerable benefit to agriculturists; reference to this subject has been made by Mohn, Buchan, and others.

DR. GROSSMANN has published "Meteorologische Divisionstafeln" (Hammerich and Lesser, Altona), which will be very useful to meteorological observers in the calculation of monthly means, and daily means from hourly observations. For a dividend of four figures the quotient is given by simple inspections, and for more figures by interpolation by means of a table of proportional parts. The principle of construction is due to Dr. Köppen, and some of the tables were printed in *Aus dem Archiv der Deutschen Seewarte*, vol. i. 1878. Dr. Crelle's well known "Tables de Calcul" (Reimer, Berlin, 1869) are equally useful, but being in a large volume are not easily accessible to observers generally. The chief merit of Dr. Grossmann's tables lies in their publication in a form specially suitable to the wants of meteorological observers, and at the low price of about sixpence for single copies. They extend to four pages only, and are intended to be pasted on cardboard.

THE Italian Central Meteorological Office has published its *Annali* for the year 1884, in three thick folio volumes, containing a mass of meteorological, magnetical, and astronomical data. The meteorological services of Italy are very complicated, as in addition to the Central Office there are many large and independent establishments from which we possess long series of observations, some of them dating from the middle of last century. The Government established a Committee for Weather Telegraphy in 1863, under M. Matteuci, and in 1865 the Meteorological Section of the Ministry of Agriculture commenced the issue of the *Meteorologia Italiana*; from this originated the present office in 1877, located at the Collegio Romano. The service is now under the able superintendence of M. Tacchini, and includes 135 stations of the second order, some of which, *e.g.* those of Stelvio, Valdobbia, Cimone, and Etna are important mountain observatories; in addition to which there are 515 rainfall stations, and stations at the military settlements of Assab and Massowah. The work contains valuable discussions on thunderstorms, evaporation, and on the microscopical examination of atmospheric dust.

A SPECIAL meeting of the Meteorological Society of Mauritius, in honour of the Queen's Jubilee, was held on August 6, on which occasion Dr. Meldrum gave an interesting sketch of the origin and labours of the Society, and of the Royal Alfred Observatory. Charts were exhibited showing the tracks of the cyclones in the Southern Indian Ocean in each year from 1856 to 1886, also magnetograms showing simultaneous disturbances at Zi-ka-wei and Mauritius on January 9, 1886; and curves showing the apparent connection between solar, magnetical, and auroral phenomena, and also between solar phenomena and the frequency of cyclones, rainfall, and the depth of water in rivers, together with other articles of interest. Dr. Meldrum stated, with reference to the history of meteorology in the island, that a memorial was presented to the Governor in April 1851, suggesting the desirability of systematic observations, and the Meteorological Society was consequently founded on August 1 of that year. Shortly afterwards the office of Government Meteorological Observer was created, to which office Mr. Meldrum succeeded in 1862, and the two institutions, although distinct, have co-operated with each other. Regular observations were commenced at the new Observatory (*see* NATURE, vol. xxxvi. p. 546) in November 1874. We cannot enumerate here the many useful works which have been carried on, but the Hydrographer to the Admiralty has expressed the wish that the track charts should be published, and Mr. Meldrum has been informed that the Meteorological Council would probably publish them. He also states that tide-gauges will soon be erected at two points on the coast, and expresses a desire for the establishment of a high mountain station.

IN the *American Meteorological Journal* for September, Mr. H. Allen discusses the theory of the outflow of air under falling rain. It has been assumed by some meteorologists that the rain-drops carry with them and compress the air, which, flowing out-produces at times a considerable wind velocity (see article on

"Lightning" in Johnson's Encyclopædia). Several hypothetical cases are considered, and the author concludes that, although his computations may need some modification after further study, we can safely say that no appreciable velocity of air is produced by compression from falling rain. The same journal contains a long paper on the theory of the wind-vane by Prof. G. E. Curtis, reprinted from the *American Journal of Science* for July last. He discusses the relative stability of a straight vane, and that with a double or spread tail. The first reference to the latter is apparently in *Voigt's Magazin*, 1797, and this form has been in common use in England since about 1840. The formulæ show that for a frictionless bearing (1) that the oscillations of both vanes are smaller as the vanes are longer and larger; (2) that the spread vane is always more stable than the straight vane; and (3) that this advantage in stability is greater for long vanes than for short vanes, and is independent of the wind velocity. The author finds that, with equal friction, a spread vane is the more sensitive, and that consequently for two vanes of equal sensitiveness the spread vane will have the greater friction and will come to rest more quickly.

THE *Jahresbericht* of the Central Physical Observatory of St. Petersburg for 1885 and 1886, and the *Annalen* for the year 1885, have recently been published. The Russian system is very important, not only as being the most extensive on the globe, but on account of the great climatic contrasts and the completeness of the observations. The present Director, Dr. H. Wild, of Berne, was appointed in 1867, and under his able superintendence the number of stations has greatly increased and the quality of the observations has much improved. The central Observatory is situated about a mile from the sea, on the island of Wassili-Ostrow; the principal observing department has been transferred since 1878 to Pawlowsk, about four miles distant, and is placed under the superintendence of Dr. E. Leyst. The observations for 1885 are contained in two quarto volumes of about 700 pages altogether. In addition to the first class observatories, the number of stations of the second order amounts to 255, and of these the monthly and yearly results of 208 are published on the international scheme; from 38 of the stations the observations are published *in extenso*. Many new stations have been added recently, especially in Siberia, and in newly-acquired territories, *e.g.* Merv, Batoum, &c. One of the Siberian stations, viz. Werchojansk (lat. 67° 34′, long. 133° 51′) is stated by Dr. Köppen to be the coldest known point of the earth. The mean temperature there for the year was − 2°·9 F. The mean for January and December was − 62°·9, and the minimum in January − 88°·6 (far beyond the range of the usual tables). The mean temperature of July rose to 60°·6, and the minimum for that month was 39°·2. The number of rainfall stations for which the observations are given is 650, against 252 in the previous year; the data published are the monthly values, the maximum fall in 24 hours, and the number of days of rain and snow. A complete catalogue of the meteorological observations in Russia and Finland, by Dr. E. Leyst, giving the life-history of each station, has been published in the *Repertorium für Meteorologie* this year. This work also contains many valuable discussions of the vast amount of materials available for the purpose. The index of the *Annalen*, being mostly in Russian, is difficult to refer to.

THE WORK OF THE INTERNATIONAL CONGRESS OF GEOLOGISTS.[1]

I.

ELEVEN years ago the Association met at Buffalo. It was the year of the Centennial Exhibition, and we were honoured by the presence of a number of European geologists. This naturally opened the subject of the international relations of geology, and the proposition to institute a Congress of Geologists of the world took form in the appointment by the Association of an International Committee. The project thus initiated found favour elsewhere, and there resulted an international organization, which up to the present time has held three meetings. It was convened first at Paris in 1878, then at Bologna in 1881, and at Berlin in 1885. Its next meeting will be held in London next year, and an endeavour will be made to secure for the United States the honour of the fifth meeting. The original Committee of the Association has been continued, with some change of membership, and has sent representatives to each session of the Congress.

[1] Vice-Presidential Address read to Section E of the American Association for the Advancement of Science, August 10, 1887, by Mr. G. K. Gilbert.

The work of the Congress, as originally conceived and as subsequently undertaken, has for its scope geologic nomenclature and classification, and the conventions of geologic maps. The particular classifications attempted are the establishment of the major divisions used in historic and stratigraphic geology and the subdivision of volcanic rocks. In nomenclature three things are undertaken: (1) the determination of the names of historic and stratigraphic divisions, (2) the formulation of rules for nomenclature in palæontology and mineralogy, and (3) the establishment and definition of the taxonomic terms of chronology (period, epoch, &c.) and of stratigraphy (system, series, &c.). The map conventions most discussed are colours, but all signs for the graphic indication of geologic data are considered. The Congress has also undertaken the preparation of a large map of Europe, to be printed in forty-nine sheets.

The work was for the most part planned at the Paris meeting, and Committees were appointed to formulate subjects for action by the Congress at subsequent sessions. Briefly stated, the work accomplished to the present time is as follows. Agreement has been reached as to the rank and equivalence of the taxonomic terms employed in chronology and stratigraphy, a set of rules for palæontologic nomenclature has been adopted, and many sheets of the map of Europe have been prepared for the engraver. A partial classification of stratified rocks has been agreed to, and also a partial scheme of map colours, but the reports of proceedings indicate that action in these matters is tentative rather than final.

It is understood that both of these subjects will have prominent place in the proceedings at the London meeting, and the American Committee is endeavouring to prepare itself for representative action at that meeting by ascertaining the opinions of all American geologists on the various subjects. It has asked this Section to set apart a day for the discussion of some of the more important questions, and it can hardly be doubted that the Section will realize the mutual advantage of thus assigning the time requested. I am personally so impressed with the importance of the possible work of the Congress that I shall devote the present hour also to its consideration.

The first thing the Congress did was to select names for a set of categories to express the taxonomic rank of stratigraphic divisions on the one hand, and of chronologic divisions on the other. In the terminology of zoology and botany the words kingdom, class, order, family, genus, species, and so forth, however difficult of definition they may severally be, nevertheless are used always in the same order of inclusion. No systematist in those sciences would think of grouping orders together and calling them a family, or of styling a group of families a genus. But in geology there is no such uniformity of usage. With some writers a group is larger than a series, with others it is smaller. With some an age includes several periods, with others a period includes several ages. There are even writers who ignore the distinction between stratigraphy and chronology; and among the classifications submitted to the Congress is one in which an age is subdivided into systems. There is a manifest advantage in bringing order out of this chaos, and so great is the utility of uniformity and perspicuity that the decisions of the Congress in this regard will unquestionably be followed by future authors. The terms and the order adopted by the Congress are as follows. Of stratigraphic divisions, that with the highest rank is *group*, then *system*, *series*, and *stage*. The corresponding chronologic divisions are *era*, *period*, *epoch*, and *age*. This order of rank is strange to most English readers and writers, and so is one of the terms—*stage*; but the strangeness is only a temporary disadvantage, and will not seriously retard the adoption of the convention. The fact that we have previously used the words in a different sense, or that their etymology might warrant a different meaning, need not deter us, for we know from frequent experience that the connotations of a word transferred from one use to another quickly disappear from consciousness, leaving it purely denotative. The introduction of the word *stage*, which can hardly be said to have had an English status heretofore, or at least the introduction of some new word for that part of the column, was necessitated by the restriction of the word *formation* to a special meaning—the designation of mineral masses with reference to their origin.

The same restriction vacated another office that had been filled by formation, and to this office no appointment was made. I refer to the use of the word to denote indefinitely an aggregate of strata—as in saying, this formation should be called a series rather than a system. This is an important function, for which some provision must be made. I suggest that we may advantageously enrich our language by the permanent adoption of *terrane*, a word whose English meaning has not been well established.

The fixation of the chronologic terms creates a similar difficulty. We have crystallized out of our magma the terms *era*, *period*, *epoch*, and *age*, and there remain in the ground-mass only *eon*, *cycle*, and *time*. Of these, *eon* has a poetic connotation which seems to unfit it for this particular use; *cycle* implies repetition or recurrence; and *time* has been so generally applied to unlimited duration that it is difficult to apply it also to limited duration, even though the nature of the limitation be indefinite. On the whole, *time* seems open to the least objection, but I cannot help regretting that either *period* or *age*, both of which have heretofore passed current in the indefinite sense, was not reserved by the Congress for that function. With English-speaking peoples the word *eon* could have been better spared for the definite series.

But while the terms selected by the Congress are not beyond criticism, the benefits to be derived from an agreement in an orderly system are so great that I for one shall unhesitatingly adopt them as they stand—provided, of course, that the Congress makes no effort to improve its selection. A small reform of this nature yields its profit to this as well as future generations, and I hold it a duty to favour even those reforms which involve so much effort and pains that their blessings cannot be realized by those who initiate them. Such are the exchange of our English spelling for a rational system, and the exchange of decimal notation in arithmetic for a binary notation. My application of the new nomenclature begins with this address, in the preparation of which I have experienced its utility. That you may have no difficulty in interpreting my reformed language, I have placed the taxonomic legend on the wall, with the addition of the complementary indefinite terms—terrane and time.

Terranes.		Times.
Group.	...	Era.
System.	...	Period.
Series.	...	Epoch.
Stage.	...	Age.

There are propositions before the Congress to distinguish the names of individual groups, systems, series, and stages by means of terminations, those of the same rank having the same termination. Thus it is proposed by a Committee that every name of a group shall end in *ary*—Tertiary, Primary, Archeary; it is proposed that names of systems end in *ic*—Cretacic, Carbonic, Siluric; it is proposed that names of series end in *ian*—Eifelian, Laramian, Trentonian; and it is proposed that stage names terminate with *in*. Another Committee suggests that *ic* be used for stages instead of systems. The adoption of such a plan would enable a writer or speaker to indicate the taxonomic rank of a terrane without adding a word for that purpose. If he regarded a certain terrane taking its name from Cambria as a system, he would call it the Cambric; if he esteemed it only a series, he would say Cambrian; and there would be no need of adding the word system or series in order to express his full meaning. Conversely, the reader or hearer would always learn its taxonomic rank, or supposed rank, whenever a terrane was mentioned. These I conceive to be the advantages derivable from the change, but they would not be the only effects. It would become impossible for a geologist to name or allude to a terrane without declaring its rank, and the consequences of this would be evil in many ways. In the first place, one could not discuss terranes from any point of view without expressing an opinion as to their taxonomy, and the change would thus contravene one of the most important rights of opinion—namely, the right to reserve opinion. Again, geologists who differed as to the rank of a terrane would necessarily terminate its title differently, and a needless synonymy would thus be introduced. In the third place, the created necessity for taxonomic discrimination on all occasions would tend to direct undue attention to taxonomic problems. Taxonomy would be conceived by many geologists as an end instead of a means, just as correlation has been conceived, and energy would be wasted in taxonomic refinement and taxononomic controversy. It is convenient for purposes of description and comparison to classify the strata that constitute a local columnar section in phalanges of various magnitude or rank, but the criteria on which we depend for discrimination are in the nature of things variable, and offer ground for endless difference of opinion; and it would be extremely unfortunate to have such differences perpetually brought to the foreground.

Another subject considered by the Congress is the nomenclature of palæontology. A Committee appointed for the purpose formulated rules for the establishment of the names of genera and species, and their report was adopted by the Congress. I have no opinion to express as to the wisdom of the rules, but it is a matter of surprise that a body of geologists assumed to speak with authority on the subject. From one point of view palæontology is a part of geology; from another point of view it is a part of biology. In so far as it names genera and species it is purely biologic, and it would seem proper that the students of fossils unite with the students of living animals and living plants in the adoption of rules of nomenclature.

A similar remark applies to the nomenclature of mineralogy, in regard to which no action has yet been taken. The most intimate relations of systematic mineralogy are with chemistry.

Yet another projected work of the Congress is the classification of eruptive rocks. Up to the present time action has been deferred, and it may reasonably be hoped that no scheme of classification will be adopted. If there existed a system of classification which gave general satisfaction and had stood the test of time, there would be little harm—and little or no advantage—in giving it the official stamp of approval. If the main features of a classification were well established and the residuary discrepancies were recognized as unessential, it is conceivable that some benefit might be derived from the submission of the matter to an assembly of specialists. But the actual case is far different. Not only is there wide difference as to the classification of volcanic rocks, but there is no agreement as to the fundamental principles on which their classification should be based, for we still lack an accepted theory of volcanism. At the same time observation is being pushed with great vigour, and with the aid of new and important methods. With the rapid growth of knowledge and ideas, classifications are continually remodelled, and the best is in danger of becoming obsolete before it has been printed and circulated. Should the Congress enter the lists, one of two things would occur. Either its classification would be treated like that of an individual, and ignored as soon as a better one was proposed; or it would be regarded as more authoritative, and new facts would for a time be warped into adjustment with it. In either case the reputation of the Congress would eventually suffer, and in one case science would suffer also.

There remain to consider the two most important undertakings of the Congress, the classification of terranes and the unification of map colours. The Congress is attacking these subjects indirectly by means of a third undertaking, the preparation of a geologic map of Europe, and this method of approach has had the effect of making it difficult properly to interpret its action. There can be no doubt that those who originally organized the work contemplated the enactment of a stratigraphic classification to be applied to the entire earth, and the selection of a colour scheme for use either in all geologic maps or in all general geologic maps. But at the Berlin session the Committee in charge of work on the map of Europe pressed the Congress for the determination of questions on which hung the completion of the map, and many hasty decisions were reached, while not a few disputed points were referred to the Map Committee. The debates indicate that much or all of this work was provisional or of merely local application, but the resolutions adopted show little qualification. It should be added that the official minutes of the meeting are still unpublished. In view of the uncertainty thus occasioned I shall not attempt to characterize the attitude of the Congress on the subject of classification, but shall merely develop my individual view.

It is the opinion of many who have discussed the general classification of terranes by convention of geologists that the smallest unit of such classification should be the stratigraphic system. What is a stratigraphic system? The Congress implies a definition in saying that a system includes more than a series and less than a group, and that the Jurassic is a system; but this gives only a meagre conception, and we need a full one. As the problem of classification demands a true conception of a system, and as there is reason to believe that a false conception is abroad, it is proper that in seeking the true one we begin with the elements.

The surface of the land is constantly degraded by erosion, and the material removed is spread on the floor of the ocean, forming a deposit. This process has gone on from the dawn of geologic history, but the positions and boundaries of land and ocean have not remained the same. Crust movements have caused the submergence of land, and the emergence of ocean bottom, and these movements have been local and irregular, districts here and there going up while other districts went down. The emergence of ocean bottom exposes the deposit previously made on it, and subjects it to erosion. In this way every part of the known surface of the globe has been the scene of successive deposition and erosion, and in many districts the alternations of process have been numerous. It is manifestly impossible that either erosion or deposition should ever have prevailed universally, and it has been established by the study of stratigraphic breaks that a time of erosion has often interrupted deposition in one region while deposition was uninterrupted in another.

In transportation from its region of erosion to its place of deposition detritus is assorted, and it results that the simultaneous deposits on the bottom of an ocean are not everywhere the same. Equal diversity is shown in the ancient deposits constituting geologic formations. It is a general fact that synchronous formations have not everywhere the same constitution.

Many of the variations in deposits are correlated with depth of water and distance from shore, and it results that elevation and subsidence in regions of continuous deposition produce changes in the nature of the local deposit.

The animals and plants of the earth are not universally distributed, but are grouped in provinces. In the geologic past similar provinces existed, but their boundaries were different, shifting in harmony with the varying geography of the surface. From time to time the barriers separating contiguous provinces have been abolished, suffering them to coalesce; and conversely new barriers have arisen, creating new provinces. From the earliest Palæozoic to the present time the species of animals and plants have been progressively modified, the nature of the modification depending on local conditions. The faunas and floras of different provinces thus become different, and the longer the provinces remain distinct the greater is the divergence of life. The removal of a barrier either produces a new fauna by the fusion of the two previously separated, or else obliterates one and extends the area of the other. In either case there is a change toward the unification of life, and in either case there is an abrupt change in a local fauna. Thus the secular evolution of species, combined with the secular and kaleidoscopic revolution of land areas, leads to two antagonistic tendencies, one toward diversity of life on different parts of the globe, the other toward its uniformity. The tendency toward uniformity affords the basis for the correlation of terranes by comparison of fossils; the tendency toward diversity limits the possibilities of correlation.

If now we direct attention to some limited area and study its geology, we find that under the operation of these general processes it has acquired a stratigraphic constitution of a complex nature. Its successive terranes are varied in texture. Breaks in the continuity of deposition are marked by unconformities. The fossils at different horizons are different, and when they are examined in order from the lowest to the highest, the rate of change is found to vary, being in places nearly imperceptible and elsewhere abrupt. It is by means of such features as these —that is, by lithologic changes, by unconformities, and by life changes—that the stratigraphic column is classified into groups, systems, series, and stages. A system is a great terrane separated from terranes above and below by great unconformities or great life breaks or both. Smaller unconformities, smaller life changes, and lithologic changes are used for the demarcation of series and stages; and, on the other hand, exceptionally great unconformities and life breaks are used to delimit groups. As the same criteria determine groups, systems, and series, differing only in degree, the precise definition of the term system is impossible, and in many cases the gradation of a terrane as a group, a system, or a series is largely a matter of convenience. From this point of view a system is somewhat artificial, but there is a more important sense in which it is natural. It is limited by stratigraphic or palæontologic breaks above and below, and these breaks are natural. The taxonomist is not warranted in dividing systems where no such break exists.

Transferring now our attention to some other area, distant from the first, and studying its stratigraphy, we find that the same principles enable us to divide it independently into stages, series, systems, and groups. Its fossils are not the same, but they are to a certain extent similar, and the sequence of life is approximately parallel. We cannot compare stage with stage, nor series with series perhaps, but we can compare system with system, and making the comparison we discover that the breaks are at different places. While one area was upraised and subjected for a time to erosion, the other received continuous deposition. While life in one area, enjoying constant conditions, was almost unchanged for long ages and even epochs, it was revolutionized in the other by the irruption across some obsolescent barrier of strong and aggressive faunas and floras. The systems of one area, therefore, do not coincide with the systems of the other in their beginning and ending. They may differ in number, and they may differ greatly in magnitude, and in the duration they represent. They are, in fact, a different set of systems.

The case I have described is ideal, but not false. It represents the common experience of those who have developed the geologic histories of remote districts, and attempted to correlate them with the geologic history of Europe. There does not exist a world-wide system nor a world-wide group, but every system and every group is local. The classification developed in one place is perfectly applicable only there. At a short distance away some of its beds disappear and others are introduced; further on, its stages cannot be recognized; then its series fail, and finally its systems and its groups.

If I have properly characterized stratigraphic systems—if they are both natural and local—it goes without saying that the classification of the strata of all countries in the dozen or so systems, as proposed by some of the members of the Congress, is impossible.

I hasten to add that from the point of view of these gentlemen what they advocate is not necessarily impossible, for they have a different conception of a system. They regard it not as local but as universal. It is their privilege to define their terms as they please, and we will not dispute about mere words, but I cannot too strongly or too earnestly insist that a system which is universal is artificial. It may be natural in one geologic province, but it is artificial in all others. Take for example the Jurassic. It is a natural system in Europe. In the eastern United States no strata are called Jurassic with confidence, and at the west the rocks called Jurassic merge with those called Triassic. In India, Medlicott tells us, a Jurassic fauna occurs at the summit of a great natural system containing a Permian fauna near its base. In New Zealand, according to Hutton, a continuous rock-system, dissevered by great unconformities from other systems, bears at top fossils resembling those of the lower Jurassic, and lower down fossils of Triassic facies. To establish a Jurassic system in either of these countries it is necessary to divide a natural system, and a Jurassic system thus established would be necessarily artificial.

This is the sort of classification implied by the assumption that systems are world-wide. It is not impossible, but it is highly unadvisable. It is classification for the sake of uniformity, and its uniformity is Procrustean. The natural systems of a region are the logical chapters of its geologic history. If you group its strata artificially according to the natural divisions of another region, you mask and falsify its history. The geologic history of the earth has as great local diversity as its human history. As in human history, there are inter-relations and harmonies and a universal progress, but these are perceptible only in the general view, and the student whose preconceptions lead him to exaggerate the harmonies and ignore the discrepancies perverts the meaning of every page.

I prefer, therefore, my own definition of system, making it natural and consequently local, and I earnestly oppose any attempt to coerce the geology of one country in a rigid matrix formed over and shaped by the geology of another country.

The ideas I oppose have arisen in connection with the work of correlation. Some geologists appear to regard correlation as the determination in distant localities of identities; the more philosophic regard it as the determination of the actual relations, whether they be of identity or difference. With the former the basis of correlation is the universality of geologic systems; with the latter it may be said to be the universality of geologic time.

Now in the comparative study of local geologic histories, just as in the comparative study of local human histories, it is a matter of convenience to have a common scale of time. It is not essential, but it is highly convenient. In human history we use an astronomic scale of equal parts, designating each unit by a number. In geology no scale of equal parts is available, and we employ the eras and periods, and to some extent the epochs, of the local geologic history first deciphered—that of Europe. These time-divisions bear the same names as the groups, systems, and series of strata whose deposition occurred within them.

So far as the science of geology is concerned the selection of Europe as its first field of study was a matter of chance, and the adoption of the European time scale as a general standard may therefore be said to have been accidental. Though the local rock scheme on which it is based is natural, the time scale, considered as universal, is arbitrary. Another locality would have afforded a different scale, but its authority would neither be greater nor less. The scale being recognized as arbitrary, and a mere matter of convenience, it is legitimate to modify and fix it by formal convention. The Congress can do good service to geologic technology by putting it in the best possible shape and giving it an official status. In my judgment only a small number of divisions should be admitted, not more than the number of periods of the European scheme. In a general way the durations represented by the co-ordinate divisions should be as nearly equal as practicable, but a certain concession might be made to chronologic perspective on account of our superior opportunities for studying the later history. Some of the shorter periods might perhaps be united under new names. Each line of division between periods should be defined by means of a stratigraphic plane of division, and this can be done with precision if a locality is made part of the definition.

Especially should pains be taken to declare the arbitrary nature of the scale. Even with this precaution it will be misconstrued by many, for there is a tendency of the mind to attach undue weight to classification. Wherever we draw lines of separation, we lose to a certain extent the power to recognize continuity. When, for example, the clock strikes twelve on New Year's Eve, time seems to stop and begin again. We speak of the achievements of the nineteenth century—and despite ourselves we think of them too—as though a new industrial epoch began in A.D. 1800. And so it is easy for the beginner in geology to accept as discontinuous the eras and periods of which his text-book treats, and it is hard for him afterward to unlearn the lesson.

There is reason to believe that confusion of ideas in regard to geologic classification has been fostered by the employment of the same set of names for the divisions of the time scale and for the local terranes on which they are founded. It might be well to furnish the time scale with names suggesting times—such names as the brothers Rogers applied to the terranes of Pennsylvania; but so radical a change is hardly feasible, especially as we should thus lose the mnemonic connection of times with corresponding terranes. I propose, as a means of accomplishing the end with the least inconvenience, that a set of time words be derived from the terrane names by modifying the final syllables. The time words should all have the same termination, and that should differ from any terminations occurring in the terrane names. I suggest for the ending of time words the syllable *al*. With such a nomenclature, Jurassic and Devonian would denote only certain European rock systems, while Jural and Devonal would denote periods of the standard time scale; and we could speak of the Chico-Tejon series as partly Eocenal and partly Cretaceal without seeming to imply the existence in California of the Eocene and Cretaceous systems of Europe.

A few minutes ago I opposed the differentiation of words by terminations because it abrogated the power of indefinite expression; I now favour it for the same reason. It is well to be indefinite as to the taxonomic rank of terranes while their characters are imperfectly known, but it is not well to confuse terranes with times.

It is not to be assumed that a time scale adopted now as the best possible will continue indefinitely to be the best possible; the day will inevitably come when it can be improved. In the fuller light of the future we may recognize as very unequal periods that we now deem equivalent, and the possibilities of defining pre-Cambrial periods are unlimited. Even now there are announced beneath the lowest fossil-bearing terrane of the Lake Superior region two systems of clastic rocks limited above and below by great unconformities, and Irving demands their recognition as a group, distinct from the Archæan. If his voice is heard, the time scale will include an era between the Palæozoal and the Archæal, and this era will supply the needs of the systematist until great additions have been made to our present knowledge of the older rocks.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The resignation of Prof. Prestwich and the continued illness of Prof. Moseley have produced two gaps in the scientific professoriate this term. Though the Professor of Geology has left Oxford, his successor will not be appointed until after Christmas. In Prof. Moseley's absence the work of the morphological department is being carried on by Mr. Hatchett Jackson and Mr. G. C. Bourne, who has just been elected to a Fellowship at New College.

In the department of physics, Prof. Clifton is giving no honour lectures, but has an elementary course on mechanics and acoustics. Mr. Selby is lecturing on elasticity and on electrostatics, both treated mathematically. At Christ Church, Mr. Baynes gives lectures and practical instruction in electricity and magnetism. Sir John Conroy and Rev. F. J. Smith are lecturing on elementary physics at Balliol and Trinity.

The chemical department at the Museum has been strengthened by the addition of Mr. V. H. Veley to the staff; the usual courses of lectures are being given by Mr. Fisher and Dr. Watts, and Prof. Odling is lecturing on glycerine and its derivatives. At Christ Church, Mr. Vernon Harcourt has a class for quantitative analysis, and lectures on elementary chemistry. Sir John Conroy is lecturing on chemical physics at Balliol.

The Physiological Laboratory is continuing its usual work with little alteration. Prof. Burdon Sanderson's lectures are on circulation, respiration, and bodily motion.

Prof. Balfour, besides lecturing on extinct plants for the Professor of Geology, is giving a course on general morphology. Dr. Tylor continues to expound the Pitt-Rivers Collection, a fresh portion which will shortly be rearranged and opened to the public.

Mr. Primrose McConnell is lecturing on the principles of agriculture, mainly for the benefit of India Civil Service candidates.

During this term there will be an examination for Scholarships in Natural Science at Balliol, Exeter, Christ Church, and Trinity jointly, beginning on November 17.

A pamphlet has just been issued from the Clarendon Press giving full information as to the methods of obtaining medical degrees in Oxford, and the instruction in medicine provided by the University.

CAMBRIDGE.—The Museum and Lecture Rooms Syndicate have issued another report pressing for new accommodation for Pathology and Physiology, and suggesting that the department of Pathology, including its Museum, could be located in the old chemistry buildings when the new laboratory is completed. They recommend the building of new rooms for Human Anatomy and Physiology on the Corn Exchange site at the northern end of the Museum site. It is an important feature of this scheme that it would leave free the present Human Anatomy Schools and Museum to be added to the frontage available in Downing Street for a Geological Museum.

Messrs. W. H. Macaulay and W. B. Allcock have been appointed Moderators for the year beginning May 1, 1888. Messrs. J. Larmor and W. Welsh are appointed Examiners in Part I. of the Mathematical Tripos for the same year.

Dr. Smith's prizes for the present year have been adjudged as follows:—(1) Mr. Augustus Edward Hough Love, St. John's College, for an essay on "Small Free Vibrations and Deformation of a thin Elastic Shell," and on "The Force and Forced Vibrations of an Elastic Spherical Shell containing a Given Mass of Liquid." (2) Mr. Arthur Berry, King's College, for an essay on "Joint Reciprocants."

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for August 1887, vol. xxviii. part 1, contains the following papers:—On the anatomy of the Madreporia, part 3, by Dr. G. Herbert Fowler, (plates i. and ii.) In this memoir the author deals with the anatomy of *Turbinaria mesenterina* (?), of *Lophohelia prolifera*, of *Seriatopora subulata*, and of Pocillopora, with a note on the skeleton of Flabellum.—On the anatomy of *Mussa corymbosa*, and *Euphyllia glabrescens*, and on the morphology of the Madreporian skeleton, by G. C. Bourne (plates iii. and iv.)—On the intra-ovarian egg of some osseous fishes, by Dr. Robert Scharff (plate v.)—Observations on the structure and distribution of striped and unstriped muscle in the animal kingdom, and a theory of muscular contraction, by C. F. Marshall (plate vi.) The author concludes that in all muscles which have to perform rapid and frequent movements a certain portion of the muscle is differentiated to perform the function of contraction, and this portion takes on the form of a very regular and highly modified intracellular network. This network, by its regular arrangement, gives rise to certain optical effects, which cause the peculiar appearances of striped muscle; the contraction of the striped muscle-fibre is probably caused by the active contraction of the longitudinal fibrils of the intracellular network; the transverse networks appear to be passively elastic, and by their elastic rebound cause the muscle to rapidly resume its relaxed condition when the longitudinal fibrils have ceased to contract; they are possibly also paths for the nervous impulse.—On the fate of the muscle-plate and the development of the spinal nerves and limb plexuses in birds and mammals, by Dr. A. M. Paterson (plates vii. and viii.)—On the ciliated pit of Ascidians and its relation to the nerve-ganglion and so-called hypophysial gland, and an account of the anatomy of *Cynthia rustica* (?), by Lilian Sheldon, Bathurst Student, Newnham College (plates ix. and x.). Suggests that the original function of the ciliated pit was the aëration of the brain, with which it communicates in the case of Clavellina; where also its posterior part acts as a reservoir to carry off the secretion of the gland.—On the tongue and gustatory organs of *Mephitis mephitica*, by Dr. Frederick Tuckerman (plate xi.) This memoir is preceded by an interesting account of the literature relating to the position and structure of the taste organs of vertebrates.—On the quadrate in the Mammalia, by Dr. G. Baur. He thinks that there is little doubt but that the quadrate of the lower vertebrates is contained in the sygomatic process of the mammals.—On the hæmoglobin crystals of rodents' blood, and on an easy method of obtaining methæmoglobin crystals for microscopic examination, by Dr. W. D. Halliburton.

Bulletin de l'Académie Royale de Belgique, August.—Note on the oscillations of a pendulum produced by the displacement of the axis of suspension, by E. Ronkar. The object of these researches is to ascertain the possibility of recording the slight oscillations in the crust of the earth by means of a freely suspended pendulum. It is shown that the pendulum retains a movement imparted by a certain number of horizontal undulating impulses, whenever the duration of the oscillation of the pendulum is the same as that of the axis, but not otherwise. From this may be deduced an experimental process for determining the periodical irregularities in the movement of diurnal rotation.—On the colloidal sulphuret of cadmium, by Eug. Prost. To the colloidal solutions of arsenious, stannic, and other sulphurets already determined, the author here adds the sulphuret of cadmium, which was hitherto known only in the insoluble state. He obtains a colloidal solution of this compound by passing hydrosulphuric acid through water holding in suspension freshly precipitated cadmic sulphur, and afterwards eliminating by the action of heat the hydrosulphuric acid dissolved in the liquid. A spectroscopic study of this clear yellowish liquid shows that the cadmic sulphur is really in a state of solution, the solution presenting all the characters hitherto ascribed to all dissolved colloidal substances.—Description of some new Cucurbitaceæ, by M. Alfred Cogniaux. This paper contains an account of fourteen new species and of several varieties, forming an important addition to the author's general monograph of this family published in De Candolle's "Monographiæ Phanerogamum."

SOCIETIES AND ACADEMIES.

London.

Entomological Society, October 5.—Dr. Sharp, President, in the chair.—Mr. Jacoby exhibited a specimen of *Aphthonoides beccarii*, Jac., a species of Haltica having a long spine attached to the posterior femora; also a specimen of *Rhagiosoma madagascariensis*.—Mr. Stevens exhibited a very dark specimen of *Crambus perlellus* from the Hebrides, which its captor supposed to be a new species. Mr. Porritt remarked that this brown form of *Crambus perlellus* occurred at Hartlepool with the ordinary typical form of the species, and was there regarded as only a variety of it.—Mr. Slater exhibited a specimen of *Gonepteryx cleopatra*, which was stated to have been taken in the North of Scotland. Mr. Jenner Weir remarked that although the genus *Rhamnus*—to which the food-plant of the species belonged—was not a native of Scotland, some species had been introduced, and were cultivated in gardens.—Mr. South exhibited about 150 specimens of *Boarmia repandata*, bred from larvæ collected on bilberry in the neighbourhood of Lynmouth, North Devon, including strongly marked examples of the typical form, extreme forms of the var. *conversaria*, Hüb., a form intermediate between the type and the variety last named, and examples of the var. *destrigaria*, Haw. Mr. South said that an examination of the entire series would show that the extreme forms were connected with the type by intermediate forms and their aberrations.—Mr. Poulton exhibited young larvæ of *Apatura iris*, from the New Forest; also eight young larvæ of *Sphinx convolvuli* reared from ova laid on the 29th of August last. He said the life-history of the species was of extreme interest, throwing much light upon that of *Sphinx ligustri*, as well as upon difficult points in the ontogeny of the species of the allied genera *Acherontia* and *Smerinthus*. Mr. Stainton said he was not aware that the larvæ of *Sphinx convolvuli* had ever before been seen in this country in their early stages. Mr. McLachlan remarked that females of this species captured on former occasions, when the insect had been unusually abundant, had been found upon dissection to have the ovaries aborted.—Mr. R. W. Lloyd exhibited specimens of *Elater pomonæ*, and of *Mesosa nubila*, recently taken in the New Forest.—Mr. Porritt exhibited a series of melanic varieties of *Diurnea fagella*, from Huddersfield, and stated that the typical pale form of the species had almost disappeared from that neighbourhood.—Mr. Goss exhibited, for Mr. J. Brown, a number of puparia of *Cecidomyia destructor* (Hessian Fly), received by the latter from various places in Cambridgeshire, Norfolk, Suffolk, and Wiltshire. He also exhibited a living larva of *Cephus pygmæus*, Lat. (the Corn Sawfly), which had been sent to Mr. Brown from Swaffham Prior, Cambridgeshire, where, as well as in Burwell Fen, the species was stated to have been doing considerable damage to wheat crops. Mr. Verrall, in reply to a question by Mr. Enock, said he believed that the Hessian Fly was not a recent introduction in Great Britain, but had been here probably for hundreds of years. He admitted that he was unable to refer to any but recent records of its capture. Prof. Riley said he was unable to agree with Mr. Verrall, and believed that the Hessian Fly had been recently introduced into this country. Its presence here had not been recorded by Sir Joseph Banks, by Curtis, by Prof. Westwood, by the late Mr. Kirby, or by any other entomologist in this country who had given especial attention to economic entomology. It seemed highly improbable, if this insect had been here so many years, that its presence should have so long remained undetected both by entomologists and agriculturists. Prof. Riley said it had been stated that the insect was introduced into America by the Hessian troops in 1777, but this was impossible, as its existence at that date was unknown in Hesse. Mr. McLachlan, Capt. Elwes, Mr. Verrall, Mr. Jacoby, and Dr. Sharp continued the discussion.—Mr. J. Edwards communicated the second and concluding part of his "Synopsis of British *Homoptera-Cicadina*."—Prof. Westwood contributed "Notes on the life-history of various species of the Neuropterous genus *Ascalaphus*."—Capt. Elwes read a paper "On the Butterflies of the Pyrenees," and exhibited a large number of species which he had recently collected there. Mr. McLachlan said he spent some weeks in the Pyrenees in 1886, and was able to confirm Capt. Elwes' statements as to the abundance of butterflies in that part of the world. The discussion was continued by Mr. Distant, Mr. White, Dr. Sharp, and others.

Mineralogical Society, October 25.—Anniversary Meeting.—Mr. L. Fletcher, President, in the chair.—After the reading of the Report, the following were elected Officers and Council for the ensuing session:—President: L. Fletcher. Vice-Presidents: Rev. S. Haughton, F.R.S., W. H. Hudleston, F.R.S. Council (in place of Messrs. Burghardt, Danby, Dobbie, and Lewis, the retiring Members): Prof. A. H. Church, Townshend

M. Hall, Colonel C. A. M'Mahon, J. Stuart Thomson. Treasurer: Rev. Prof. T. G. Bonney, F.R.S. General Secretary: R. H. Scott, F.R.S. Foreign Secretary: T. Davies. Auditors: B. Kitto, F. W. Rudler.—The following papers were read:—On a meteoric iron, containing crystallized chromite, found in Greenbrier Co., West Virginia, about the year 1880, by L. Fletcher, President.—On the nature and origin of clays, by J. H. Collins.—Note on the occurrence of what may prove to be a new mineral resin, by J. Stuart Thomson.—On a variety of glaucophane from the Val Chivone (Cottian Alps), by Rev. Prof. T. G. Bonney, F.R.S.—On the discovery of leucite in Australia, by Prof. J. W. Judd, F.R.S.—On proustite containing antimony, by H. A. Miers and G. T. Prior.—Description of a new student's goniometer, by H. A. Miers.—On rutile needles in clays, by J. J. H. Teall.

PARIS.

Academy of Sciences, October 24.—M. Janssen in the chair.—On naphthol as an antiseptic, by M. Ch. Bouchard. From the experiments here described it is shown that naphthol, hitherto limited to the local treatment of certain cutaneous diseases, may with perfect safety be applied inwardly. Its antiseptic and toxic properties have been accurately determined, with the result that, owing to its slight solubility, it is to be preferred in certain cases to all known antiseptic medicines.—Remarks on the physical principle on which is based M. Clausius's new theory of steam-motors, by M. G. A. Hirn. The view here contested is that the cylinder may be regarded as impermeable to heat, and consequently that the exchange of heat between its walls and the steam at each stroke of the piston is a factor which may be neglected by the practical mechanician. M. Hirn claims that most English and American engineers have adopted his views in the "Hirn-Zeuner controversy."—On the congelation of ciders, by M. G. Lechartier. The author's experiments make it evident that the fermentation of ciders is not destroyed but only diminished even after being kept for nine days at a temperature of 18° C. below freezing-point.—Remarks accompanying the presentation of the "Statistique de la Superficie et de la Population des Contrées de la Terre," by M. E. Levasseur. This work, which appeared originally in the *Bulletin de l'Institut international de Statistique* for 1886–87, comprises 103 tables, in three parts—the first devoted to Europe, the second to the other divisions of the globe, the third to general conclusions and comparative details for the whole earth. In this part the area and population of the various divisions of the world are thus tabulated for the year 1886:—

	Area in millions of square kilometres.	Population: In millions.	Population: Density per square kilometre.	Population: Ratio to the whole population of the world.
Europe	10·0	347	34	23·4
Africa	31·4	197	6	13·3
Asia	42·0	789	19	53·2
Oceania	11	38	3·5	2·6
North America	23·4	80	3·4	5·4
South America	18·3	32	1·7	2·1
	136·1	1483	10·9	100·0

It is pointed out in the introduction that nearly two-thirds of mankind are concentrated in a relatively small space, about 11 millions of square kilometres, or one-twelfth of all the dry land, divided into three great groups: West, Central, and South Europe (245 millions of inhabitants, and 3·5 millions of kilometres); the Anglo-Indian Empire (254 and 3·6); and China, with Manchuria and Japan (430 and 4).—On the third scientific voyage of the *Hirondelle*, by Prince Albert of Monaco. Besides many hundreds of floats sent adrift between the Azores and Newfoundland, several captures were made from great depths with the sounding-gear, which worked easily down to 3000 metres from the surface. Amongst the prizes were several undescribed fishes, Gorgons, siliceous Sponges of the Hexactinellid family, a soft Urchin (*Phormosoma*), numerous Amphipod and Isopod Crustaceans, Solasters, Ophiures, and Hyas of great size, besides a moon-fish weighing nearly 300 kilogrammes, and furnished with a true caudal appendage.—On Newton's chromatic circle, by M. G. Govi. It is shown that this law, of which Newton himself offered no demonstration, is often at fault, because it expresses no certain theoretic principle, nor any rigorously observed theoretic fact. Nevertheless it may still yield approximately correct useful results when it is required to express the complex sensations experienced by the organ of sight.—Positions of Brooks's Comet (January 22, 1887) measured with the 8-inch equatorial of the Observatory of Besançon, by M. Gruey. The positions are calculated for the period ranging from February 24 to April 29.—On magnetizing by influence, by M. P. Duhem. The author communicates the chief results of some studies based on the principles of thermodynamics, and undertaken for the purpose of removing some of the difficulties presented by Poisson's theory.—Action of sulphureted hydrogen on the salts of cobalt, by M. H. Baubigny. Some years ago the author showed that all the salts of nickel are transformed to sulphides when their solutions are treated with hydrosulphuric acid at the ordinary temperature. He now shows that a like treatment of the salts of cobalt yields very similar results.—On the quantitative analysis of titanic acid, by M. Lucien Lévy. A new method of analysis is described, which is more rapid and yields more accurate results than that hitherto in use.—On certain processes capable of increasing the resistance of the organism to the action of microbes, by M. Charrin. It is shown, by experiments carried out on rabbits, that under specified conditions the resisting power of the animal may be greatly increased and rendered more or less complete and lasting by inoculating or injecting the soluble products of the cultivated virus of certain microbes.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Philip's Handy Volume Atlas of the British Empire (Philip).—Practical Chemistry: Muir and Carnegie (Clay).—Elementary Chemistry: Muir and Slater (Clay).—Essays relating to Indo-China, 2nd series, 2 vols. (Trübner).—On a Surf-bound Coast: A. P. Crouch (Low).—The Mammoth and the Flood: H. H. Howorth (Low).—The Natural History of Commerce, 3rd ed.; The Technical History of Commerce, 3rd edition; The Growth and Vicissitudes of Commerce, 3rd edition; Recent and Existing Commerce, 3rd edition: Dr. J. Yeats (Philip).—Proceedings of the American Academy of Arts and Sciences, December 1886 to May 1887 (Boston).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1887, No. 3 (Moscou).—Zeitschrift für Wissenschaftliche Zoologie, xlv. Band, 4 Heft (Williams and Norgate).—Morphologisches Jahrbuch, Eine Zeitschrift für Anatomie und Entwickelungsgeschichte, xiii. Band, 1 Heft (Engelmann, Leipzig).—Encyklopædie der Naturwissenschaften. Zweite Abth. 44 und 45 Lief. Handwörterbuch der Chemie; Erste Abth. 52 und 53 Lief. Handwörterbuch der Zoologie, Anthropologie, und Ethnologie (Williams and Norgate).—Journal of the Scottish Meteorological Society, 3rd series, No. iv. (Blackwood).—Animals from the Life, edited by A. B. Buckley (Stanford).

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