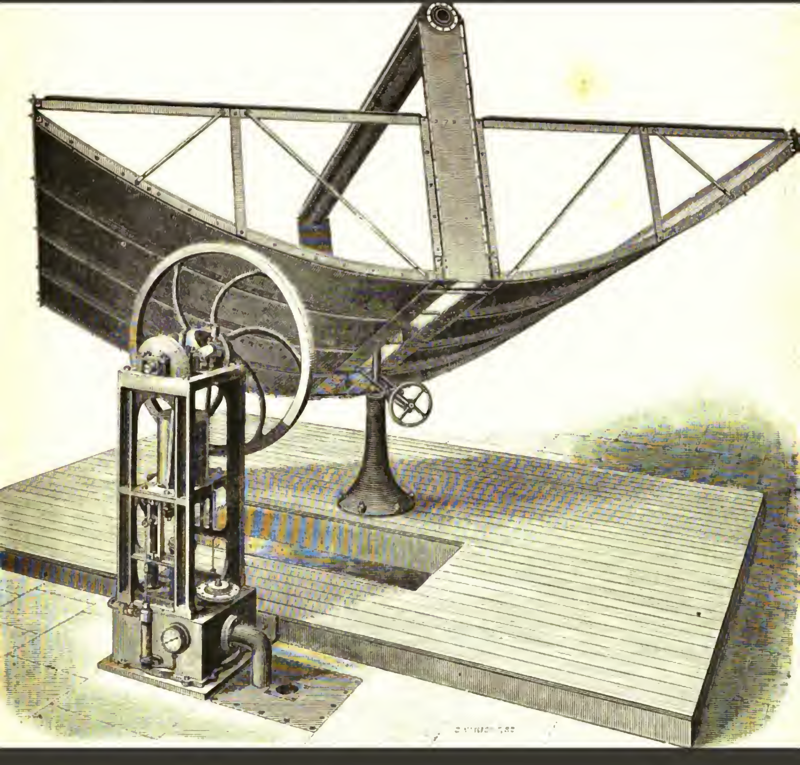

Nature

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A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XXIX

NOVEMBER 1883 to APRIL 1884

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

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THURSDAY, NOVEMBER 1, 1883

ZOOLOGICAL REPORTS OF THE VOYAGE OF H.M.S. "CHALLENGER"

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76, *under the Command of Capt. George S. Nares and Capt. F. T. Thomson.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, Director of the Civilian Scientific Staff on board, and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vol. V., 1882; Vol. VI., 1882; Vol. VII., 1883. (Published by Order of Her Majesty's Government.)

THE editor has made most excellent progress in the work of publishing the Reports of the scientific results of the voyage of H.M.S. *Challenger* during the past year, as the three bulky quarto volumes now before us well indicate. Vol. V. contains an elaborate Report on the Ophiuroidea by Theodore Lyman, who has made this group so long his special study, and who has in this monograph given us a most elaborate and beautifully illustrated contribution to science. The memoir contains the description of some twenty-one genera and of 170 species, but as several already described species were also collected, Mr. Lyman has judiciously given not only all these but also the names of all others previously described, arranged under their genera, constituting therefore this Report a more or less complete monograph of the Ophiuroidea. There are very elaborate tables of distribution, geographical, bathymetrical, and thermal, with brief remarks on their indications, and at the end of these is a note on the fossil forms and their relations to those living. In the descriptive part of the monograph Mr. Lyman has ventured to use simple words as often as possible, so as not to add to "the jargon in which zoology is now smothering."

Amid the three hundred pages of description of species there is of necessity little that will bear transcribing in a general notice of this important work; and still among them we find the following, which in the writer's mind awakened similar emotions to those referred to by Mr. Lyman:—"In my notebook of 1861 I find, '*Euryale exiguum*, Lamk., original of Peron and Leseur, 1803, young.' This prosaic line is poetical to me. It takes me back to the Jardin des Plantes as it was twenty years ago, and I can see the laboratories of the 'mollusques et zoophytes' where I studied under the kindly direction of old Valenciennes. He has gone, and so has his successor Deshayes, and their place is now worthily held by Perrier, who was a very young man when first I knew him. But still that poor little broken *Astrophyton exiguum* lies on its shelf, the survivor. It was with a real emotion that in unpacking the *Challenger* collection I drew from a large jar two fine specimens. I felt like a scholar who had found a duplicate of the Codex argenteus. After more than two generations the unique treasure of the Jardin des Plantes has at last other representatives, and to celebrate its rediscovery I could do no less than give a figure of the animal" (Plate 47).

So far as the geographical distribution of the group is concerned, it would appear that although deep-sea species are more inclined to extensive wanderings than those frequenting shallows, yet, speaking generally, they offer similar differences. Among littoral forms there are those which are found all over the great ocean from the Sandwich Islands to the east coast of Africa, and even south to the Cape of Good Hope. One species, *Amphiura squamata*, is found in the North and South Atlantic, at the Cape of Good Hope, and in Australia. Others, again, are considerably restricted; for example, the abundant fauna of the Carribean Sea, which reaches only Brazil on the south and the Carolinas on the north. *Ophiacantha vivipara* and *Gorgonocephalus pourtalesii* going to 140 and 600 fathoms, are remarkable for their extension in longitude, being found from the Kerguelen Islands on the west to the east coast of South America. As to the very deep-water species, *Ophiomusium lymani* occurs well up in the North Atlantic, in the extreme South Atlantic, near New Zealand, off Japan, and off the south-west coast of South America. *Ophiacantha cosmica* is found off the Brazil coast, between the Cape of Good Hope and the Kerguelen Islands, off the south-west coast of South America, and at intermediate points. Some of these deep-sea species are, however, quite restricted in their area, such as *Pectinura heros*, *Ophiomusium validum*, and *Astroschema arenosum*, the first living near the Celebes, the last two in the Carribean Sea. While species differ thus much in the extent of their migrations, there are certain bottoms where they seem to decline to live at all. Thus in all the deep water from the centre of the North Pacific to near the southwest coast of South America, there was not a single Ophiuran found. As to their distribution in depth, a very large proportion live exclusively on the littoral zone, and therein are included species both of cold and of hot water, though the number of the latter is much the larger. Some fifty species live exclusively below 1000 fathoms, and have to endure a degree of cold near to freezing, an enormous water pressure, and an entire absence of sunlight.

The forty-eight, rather crowded, plates have been drawn with skill and fidelity by Miss K. Pierson and Mr. L. Trouvelot with the exception of Plate 48, which represents half of an arm of *Gorgonocephalus verrucosus*, carried out to its extreme twigs, and which stands as quite a monument of patience on the part of Mr. Lyman's assistant, Miss Clark.

The Second Report in this volume is by Prof. D. J. Cunningham, on some points in the anatomy of *Thylacinus cynocephalus*, *Phalangista maculata*, and *Phascogale calura*, with an account of the comparative anatomy of the intrinsic muscles and the nerves of the mammalian pes. This Report gives details of the anatomy of three little known mammals, representing types which differ widely from each other both in physique and habits. A special interest attaches to the anatomy of the Thylacine, as it is rapidly becoming extirpated. In examining the intrinsic muscles of the marsupial manus and pes, Prof. Cunningham encountered a somewhat puzzling multiplication of the elements. To clear this up and at the same time to connect the condition with that found in other animals he was induced to extend his inquiries upon this point into mammals in general, and we are therefore favoured with the results of this comparative research in a very elaborate report on the comparative anatomy of the mammalian foot.

Vol. VI. contains also two memoirs: the first is a Report on the Actiniaria, by Prof. Richard Hertwig. As a considerable number of specimens did not reach Königsberg until this Report was finished, we are promised a supplementary report to describe these additional forms. Fourteen plates accompany this Report. Beginning with a detailed description of a typical Actinian, we have also a comparative survey of the chief characteristics of the several divisions and genera. Six tribes of Actiniana are distinguished: (1) Hexactiniæ; (2) Paractiniæ; (3) Monauleæ; (4) Edwardsiæ; (5) Zoantheæ; (6) Ceriantheæ. Objecting to Verrill's assertion that all specimens of Actiniæ which are only known from preserved specimens should be thrown away as of no scientific value, Prof. Hertwig has laboured manfully over the unfortunately rather badly preserved specimens of the *Challenger* voyage; and by keeping in view such factors in their description as the structure of the tentacles, of the septa, of the oral disk, of the circular muscle, &c., he has presented a most minute and elaborate description of an immense variety of new forms, the scientific value of which will go without dispute. As the collections of the *Challenger* were for the most part made in the open oceans, the littoral zone, which would have furnished the larger proportion of Actiniæ was almost entirely neglected, and but one littoral species occurs in the list. As a rule the number of the Actiniæ decreases as the depth increases; they have not been observed at a depth of over 2900 fathoms, but the greater the depth the more the fauna was found to vary from that of the coast. Of the twenty-one forms from 500 to 3000 fathoms described, no less than six species are found to have undergone some extreme modifications of their tentacles, whilst a like phenomenon has never been observed in a single one of the forms of the coast fauna, which greatly exceed the deep-sea fauna in number. These alterations lie for the most part in the direction of transforming the tentacles into tubes and openings, and Prof. Hertwig connects this with the nutriment of these deep-sea forms, which is not of a nature to be captured by tentacles.

The Second Report is on the Tunicata, by Prof. Herdman. It is Part I., on the Simple Forms. The collection generally was found to be in a state of excellent preservation, and consisted of eighty-two species, which are referred to twenty genera. Of these, seventy-four of the species and nine of the genera are new to science, but it has not been found necessary to form any new families The new genera are mostly instituted for very deep-sea species. In several instances the new genera have been of great interest, as they have demonstrated affinities between known forms, and have exhibited combinations of characters which in some instances necessitated a revision of the definitions of old genera, and even affected one's ideas with regard to the characters of the families. The new species are all beautifully illustrated in thirty-seven plates. The memoir has prefixed to it a history and bibliography of the group and a neat and well-written account of its anatomy, which is accompanied by an excellent series of woodcuts. So little is known as to the geographical distribution of the group that Prof. Herdman thinks any generalisation on this head would be of little value. A few facts of interest are, however, mentioned: thus the Tunicata are greatly more numerous in the southern than in the northern hemisphere, and they reach a maximum of abundance in the far south. As to their distribution in depth, the four families are found to have the following limits :—

The Molgulidæ range	from the shore	to	600	fathoms.
The Cynthiidæ	,,	,,	2600	,,
The Ascidiidæ	,,	,,	2600	,,
The Clavelinidæ	,,	,,	129	,,

Seven species were found at depths of from 2000 to 3000 fathoms.

Calcareous spicules are noticed as present in the tests of several species of the genera Culeolus and Cynthia. They are very different in the two genera, being irregularly branched and with smooth surfaces in Culeolus, while they are rod-shaped or fusiform, with their surfaces minutely echinulated in Cynthia. Neither of the two previously known genera in which the test is remarkably modified—Rhodosoma and Chelyosoma—were collected during the *Challenger* Expedition, but two of the new forms show notable peculiarities in the test, Pachychlœna having it greatly thickened all over, while *Hypobythius calycodes*, Moseley, has a series of symmetrically placed nodular cartilaginous thickenings in the otherwise thin and membranous test. This Report of Prof. Herdman's may be regarded as almost a monograph of the Tunicates, and is a most valuable addition to our knowledge of this little known group of forms.

Volume VII. contains four Reports. The first of these is by Prof. Morrison Watson, on the anatomy of the Spheniscidæ collected during the voyage. The collection contained three or four adult specimens of each of the species obtained, preserved for the most part in brine, but in some instances in spirit, as well as a number of immature birds taken from the nest, together with eggs in various stages of hatching, preserved partly in spirits and partly in bichromate of potash. In the present Report only the anatomy of the adult birds is treated of; that of the young being reserved for a second part. Selecting *Eudyptes chrysocome* from Tristan d'Acunha as a standard, the anatomy of the other seven species is compared with it; thus in every section the anatomy of the standard species is given in detail, and then the variations met with in each of the others is appended. In those cases in which no variations are reported the anatomy of the forms was identical. The descriptive anatomy of the various systems of tissues seems to leave little to future investigators to record. In the section devoted to osteology, while treating of the bones of the anterior extremity, the author remarks that in several particulars the penguin's wing differs from that of other birds—movements of pure flexion and extension in the joints beyond the shoulder can scarcely be said to be possible; the articulations, however, admit of a very considerable amount of rotation, and consequently, instead of the limb being converted into an absolutely rigid paddle or oar, the rotation in question converts the wing into a screw-like blade, the curvatures of which are constantly varying in accordance with the amount of rotation which the forms of the different joints permit. Upon carefully watching a living specimen of Aptenodytes in the Zoological Society's Gardens, the author observed that the wing of the penguin is never used in the manner of a rigid oar, which would imply the simultaneous movement of both wings in the same direction in order to propel the bird. On the contrary, the wings were often and indeed usually brought into use alternately, much in the same manner as the pectoral fins of a fish, and in every movement of the wing wiry, screw-like curvatures, which are due to the rotation of the different segments of the limbs upon one another, are strongly developed. In fact, a constant screwing and unscrewing of the separate alar segments upon one another takes place simultaneously with the forward and backward movement of the organ as a whole.

From general considerations of the anatomy of the penguin, Prof. Watson concludes that these birds together form a natural group, every member of which is possessed of certain anatomical peculiarities which serve at once to associate it with its fellows and to separate it from the members of other groups which may more or less closely resemble the Spheniscidæ. From an anatomical point of view he would recognise but three genera—Aptenodytes, Spheniscus, and Eudyptes. The remarks on the characteristics of these genera and the limits of the species contained in them are among the most interesting in this Report.

As to the phylogeny of the penguins the author concludes that they form the surviving members of a group which had early diverged from the primitive avian stem, but that at the time when the separation took place, the members of that stem had so far diverged from the primitive ornithoscelidan form as to be possessed of anterior extremities, which, instead of forming organs of terrestrial, had become transformed into organs adapted to aërial progression, or true wings. If this view be correct, palæontological research may, in the course of time, disclose the existence of Spheniscidine remains which may enable us to trace the line of descent of the penguins of the present day from the original avian stem, and through it the relationship which exists between the modern Spheniscus or Eudyptes, with their separate metatarsal bones and aborted wings on the one hand, and the majority of modern birds, with their conjoined metatarsal bones and perfect wings on the other.

The geographical distribution of these birds is of great interest. They are entirely confined to the southern hemisphere, none of them straying north of the equator. Within this area their distribution is very extensive, reaching from the Galapagos Islands on the equator, southwards to the Antarctic Islands. Prof. Watson surmises that this distribution does not depend on temperature, but may depend on a relative abundance of the food supply (Cephalopods and Crustacea) found in the two hemispheres respectively; but the editor, Mr. J. Murray, in a footnote, says: "The penguins reach the equator only on the coasts of Chili and Peru. Now the Peruvian current from the Antarctic skirts along this coast, and takes a low temperature as far north as the Galapagos Isles; the temperature of the sea being there (equator) 62° to 66°, while in the middle of the Pacific (equator) the surface temperature is 81° to 88°. Temperature, therefore, most probably has something to do with the limitation of the geographical distribution of the Spheniscidæ."

The second memoir is by Dr. F. Buchanan White, on the Pelagic Hemiptera collected during the voyage. These, the only truly pelagic insects, belong to the genera Halobates and Halobatodes. The first of these was founded sixty years ago by Eschscholtz for three species taken during the well-known voyage of Kotzebue round the world. But few species are known, and they are very rarely to be found in collections, though they seem to be abundantly distributed in tropical seas. Their structure would seem to indicate that they are archaic forms of great antiquity, and as doubtless many species yet remain to be discovered, it is to be hoped that some one with the will and the opportunity will be found to turn their attention to the group. In the meanwhile Dr. White has in this Report given a detailed account of the literature of these genera, followed by an account of the anatomy and description of the genera and species. Of the genus Halobates he describes eleven species, of which three were first described by Eschscholtz, one each by Templeton and Frauenfeld, and six for the first time in this memoir. In his remarks on the species we notice that, after a very bad fashion adopted by some entomologists, these are alluded to under their trivial names only, thus: "according to Frauenfeld, *micans* differs from *wüllerstorfii*." This is the only departure from the ordinary rules of nomenclature that we have as yet noticed in these Reports, and we call attention to it in the earnest hope that it will not occur again.

Species of Halobates are recorded in Mr. Murray's journal as found twenty-one times in the Atlantic between latitudes 35° N. and 20° S., and thirty-eight times in the Pacific between latitudes 37° N. and 23° S. The majority of the specimens taken by the tow net were dead when brought on board, but some were taken alive and were observed skimming over the surface of the water in the glass globes. On one occasion a species was seen to dive. Of the species of Halobates now known, five occur in the Atlantic, but one only is restricted to that ocean, though the headquarters of another appear to be there. Six species, of which two are peculiar, occur in the Indian Ocean west of long. 100° E., while to the east of this, and chiefly in the West Pacific, eight species occur, of which four are restricted to that region. But taking the West Pacific and Indian Ocean together, we find that nine out of the eleven known species occur there, and five nowhere else. Of Halobatodes *H. lituralus* occurs in the Chinese Sea, *H. compar* is from India, *H. stali* from Ceylon. All the species are figured on three plates.

The Third Report is by Prof. Allman, on the Hydrozoa, Part I. Plumularidæ. Of the Hydroids, a large number of exotic species have been recently described, notably the collections made during the exploration of the Gulf Stream, and during the expedition of H.M.S. *Porcupine*, by Dr. Allman himself. But to this number the collection brought home by the *Challenger* makes a large and valuable addition. Of this collection the family of the Plumularidæ forms a considerable proportion. Only one form can be identified with a species occurring in the European seas. This species, *Cladocarpus formosus*, was dredged by the *Porcupine* from the seas lying to the north of Scotland, and by the *Challenger* from the seas at Japan. It is a well-marked species, and the great distance between the Atlantic and Pacific stations, without any intermediate station having been discovered, is a remarkable and significant fact. By far the larger number of the forms brought home by the *Challenger* consist of species new to science, while among these a considerable number have had to be assigned to new genera. Many of the species are of great interest from the light they throw on the external morphology of the group, and from the aid which they afford towards a philosophical conception of the significance of parts otherwise enigmatical. The Report is prefaced by some introductory remarks on the general morphology of the Plumularidæ. While not yet possessing the data necessary for a complete exposition of the geographical distribution of this group, it may be generally asserted that it attains its greatest development in the warmer seas of both hemispheres, and that in tropical and subtropical regions it has its maximum in multiplicity of form, in the size of the colonies and in individual profusion. The dredgings of the *Challenger* and of the United States Exploration of the Gulf Stream would further seem to point to two centres of maximum development within the area thus indicated—an eastern centre, which is situated in the warm seas around the Philippines and other islands of the East Indian Archipelago, and a western centre, which will be found in those which lie around the West Indian Islands and bathe the eastern shores of Central and Equinoctial America. In bathymetrical distribution the Plumularidæ present considerable variation. Among the species described some are quite littoral, having been dredged from depths ranging from between 8 and 20 fathoms. The greater number, however, have been obtained from depths between 20 and 150 fathoms, while three species, *Aglaophenia filicula*, *A. acacia*, and *Polyplumaria pumila*, are from a depth of 450 fathoms. The striking and beautiful genus Cladocarpus consists of eminently deep-water forms, and of the two species described, one—*C. formosus*—was obtained in the Japan seas from a depth varying between 420 and 775 fathoms; the same species from the north of Scotland was found at depths of from 167 to 632 fathoms. The second species—*C. pectiniferus*—was dredged off the Azores from 900 fathoms, being the greatest depth from which any Plumularidan is known to have been obtained. This Report is illustrated by twenty plates.

The last Report in this volume is on the genus Orbitolites, by Dr. W. B. Carpenter, with eight beautiful plates by Mr. George West, jun. Some thirty-six years ago Dr. W. B. Carpenter received from Prof. Edward Forbes some small discoidal bodies which had been dredged between 1842 and 1846 by Prof. J. Beete Jukes on the coast of Australia, with the hint that these were probably the Marginopora of Quoy and Gaimard. From this time to the present Dr. Carpenter has made a pretty constant study of these interesting Foraminifers, and he gives us a highly instructive account of the views held from 1823 by the various authors who have written on the genus, from the strange misconceptions of Ehrenberg to the accurate descriptions of Prof. Williamson, who first clearly determined the close affinity between Orbitolites and Orbiculina, thus disposing of the Bryozoic doctrine of Ehrenberg, and relegating these organisms to the Foraminifera. As the final result of Dr. Carpenter's laborious researches on this group, he concludes that while the ordinary notions of species will not apply to it any more than it will to any of the Foraminifera, still particular types of form are transmitted with marked genetic continuity, and he distinguishes four very well marked types of Orbitolites, around which the entire assemblage of specimens collected over a very wide geographical area, and from a great bathymetrical range, can be grouped without difficulty. Treating of the subject of descent, the author declares that "it seems to him that the evolution of this type from the simplest monothalamous Milioline has taken place according to a definite plan, of which we have the evidence in the wonderful uniformity and regularity of the entire sequence of developmental changes, whilst we are entirely unable to account for those changes without attributing to the subjects of them a capability of being affected by external agencies or modes so peculiar as to indicate a previous adaptation."

From an editorial note prefixed to this volume we learn that the various large incidental collections of terrestrial forms, such as insects, spiders, reptiles, &c., will not have any detailed reports published concerning them, but that they will be referred to in the narrative of the cruise, the first volume of which is announced for 1884.

OUR BOOK SHELF

Elementi di Fisica. Vol. IV., Elettricità e Magnetismo. By Prof. Antonio Ròiti. (Florence, 1883.)

SURELY, and not slowly, the views of Thomson, Maxwell, and the modern electricians generally are finding acceptance throughout the Continent. The absolutely unanimous acceptance of the British Association's system of electrical units since the indorsement of that system by the Paris Congress of 1881 has proved the immense gain to the electrical world of having a uniform means of expressing electrical quantities, and has compelled electricians not only to read but to comprehend the writings of the pioneers of this most important reform. The work now before us for review, though professing to be but a text-book for use in the lyceums and schools of Italy, gives ample evidence that its author, Prof. Ròiti, of the Royal Institute of Higher Studies in Florence, is not only abreast of all the latest developments of electricity, but that he has mastered the theory also. Few text-books of its size have we seen that will compare favourably with Prof. Ròiti's little volume of 356 duodecimo pages. The faults which have been hitherto so conspicuous in most of the Continental text-books on electricity are in this work conspicuously absent. As an example we may refer to the author's treatment of the relation between the capacities, potentials, and charges of similar conductors. The elementary theory of the magnetic shell and that of the mutual potential of two magnetic shells are neatly expounded in pages 131 to 133. The absolute electrometer and the quadrant electrometer of Sir W. Thomson are both described, and illustrative figures given. The system of absolute and derived (C.G.S.) units, and that of the practical units of electric quantities based upon them, are explained at length on pages 204-5. There is a short chapter on the electric light, and another on electric motors, in which the *anello elettromagnetico di Pacinotti* is described, the author remarking with emphasis that it contained the germ of almost all the machines by which the marvellous strides recently made in the applications of electricity have been achieved. The experiments of Deprez at Paris on the electric transmission of power, and the economic questions involved are also touched upon. Crookes's researches on "radiant matter" are mentioned and illustrated. Amongst points of novelty may be mentioned Pellat's method of measuring the electromotive force due to polarisation, which has not yet, we believe, found its way into any English text-book. Two points of criticism we have to offer in conclusion. The first is that the author defines electric *tension* as identical with the electric *force*, equal to 4π times the surface density of the charge, instead of defining it, in the sense of Faraday and Maxwell, as the stress on the dielectric, which is proportional to the square of the surface density, and therefore proportional also to the square of the electric force or electromotive intensity at the point of the surface considered. The only other complaint we have to make of the work—and this does not detract greatly from its value—is that the author does not acknowledge the sources from which some of his descriptions and cuts are taken. S. P. T.

Dr. H. G. Bronn's Klassen und Ordnungen des Thier-Reichs, wissenschaftlich dargestellt in Wort und Bild. Erster Band, Protozoa. Neu bearbeitet von Dr. O. Bütschli. (Leipzig and Heidelberg: C. F. Winter, 1880-83.)

THE first nineteen parts of this new edition of vol i. of Dr. Bronn's well known and important work on the classes and orders of animals, nearly completing the volume, prove that Prof. Bütschli has spared no pains to keep it up to the most modern investigations of the Protozoa. In no one division of the animal kingdom has observation gone so hand in hand with discovery as in this, the lowest of her classes. Glancing at the portion treating of the Gregarinida, what strides have been made in our knowledge of these forms within the last ten years. Adopting Leuckart's titles for the class of Sporozoa, under which are the sub-classes Gregarinida, Coccidia, Myxosporidia, and Sarcosporidia, we find 137 pages and eight plates crowded with figures devoted to a sketch of the characteristics of the class with diagnoses of the genera and the number of species, and references to the places where fuller details of these latter will be found. The illustrations are clear and effective, and copied from every available source. The bibliography appears to be well to date, and this volume when complete will be an indispensable handbook for the student of the lower forms of animal life.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

"Elevation and Subsidence"

THE view that the glacial subsidence was due to the pressure of the accumulating land ice, has been accompanied with the corollary that subsequent elevation was due to the removal of this pressure by the melting of the ice; but though I think the first is true, the corollary is not so, in England at least.

In my memoir "On the Newer Pliocene Period in England" (*Quart. Journ. Geol. Soc.* for 1880, p. 457, and 1882, p. 667), I have endeavoured to show how the inclination of this country changed during the progress of the major glaciation, and the flow of the land ice from the mountain districts to the sea altered in accordance therewith, as well as pointed out (p. 709) the connection of this change of inclination with the accumulation of the land ice on the mountain districts; but I have also traced in detail in it how the east side of England rose to an extent that brought Norfolk and Suffolk from a submergence of more than 300 feet to their present level at least, and Essex proportionately so, while the land ice continued to push over the sea-bed of sand and gravel, as this rose into land, covering it with its moraine, until by this rise the easterly movement of the ice was arrested, while the west and south of England still remained to a great extent submerged. Since that memoir was published, Mr. David has in the same journal described the glacial clay which represents the moraine of the Welsh land ice in East Glamorganshire, itself *un*covered by any marine deposit, as covering beds of stratified sand and gravel, which, from their containing many chalk flints, can be only the bottom of the antecedent sea, as low down as 80 feet above Ordnance datum. When this is compared with the evidence of more than 1300 feet of submergence afforded by the shell bearing gravels of North Wales; of 700 feet afforded by the Gloucestershire gravels to the east; and of between 500 and 600 feet afforded by the gravels of Devon to the south of Glamorganshire, it becomes evident that the amount of rise which took place in the west of England before the land ice began to retreat was even greater than in East Anglia. It is to subterranean movements engendered by this pressure, and not to its removal, that the rise in England seems to me to have been due; and I have given several sections in this memoir in illustration of the abrupt and violent character of the upthrows connected with it.

Although in this memoir I remarked upon the coincidence of the westerly increment in the great submergence with the augmenting quantity of the land ice on Cumberland, Westmoreland, and Wales, as the major glaciation went on, yet this coincidence between augmenting land ice and submergence is, I now see, more complete than had then occurred to me; for though I described the evidences that show the passage from the Crag to the glacial marine beds of Norfolk and Suffolk to have been accompanied by a northerly subsidence which submerged the valley of the Crag river, in the north of the former county, while the other extremity of its estuary (in East Suffolk) was elevated, so that islands formed of Crag beds came there into existence, around and up to which the earliest glacial marine accumulations of sand and shingle were bedded, and which, as subsequent southerly and westerly subsidence ingulphed all but the highest downs of the south of England, eventually spread over these islands, yet I did not connect this first movement with the pressure of the land ice. I have since, however, perceived that this connection exists; for, as the Glacial period came on, the precipitation must necessarily, on account of latitude, have taken more exclusively the form of snow in Scotland before it did so in Cumberland and Wales; and, by thus accumulating land ice earlier in Scotland, caused this northerly subsidence. As the cold increased the precipitation in the form of snow reached its maximum in Westmorland and Cumberland, and yet later somewhat in Wales; and as it did so, the pressure of the land ice engendered by it turned the depression increasingly in those directions, so that eventually all England, save the highest downs, and even the lower ends of the river valleys of North-Western France became submerged proportionately to their contiguity to the foci of pressure. These increments of depression I have in this memoir traced by more than one train of evidence, and shown how this change of inclination, by diverting the directions taken by the land ice to the sea, changed also the character of the materials of which the resulting morainic clay is made up, and so gave rise to those Upper and Lower clays of the major glaciation in Yorkshire, which have been seized upon to support the hypothesis of alternations of climate during that glaciation.

The connection between the augmenting weight of the land ice and subsidence seems to me so clear, that I cannot but think that American geologists have fallen into an error, in regarding the Champlain period as belonging to the wane of the great glaciation, instead of to its culmination. It seems to me that although the increasing volume of the land ice in the Lake (or St. Lawrence) basin caused this ice at its western extremity, where the parting between the two basins is very low, to invade the upper part of the great Mississippi basin, yet its weight where thickest —that is to say, towards its eastern extremity, which was that of greatest snow precipitation—so pressed this extremity down that the seaward termination of this ice in the Gulf of St. Lawrence retreated before the greater depth of sea there which thus resulted, and so allowed the sea to penetrate to Montreal and Lake Champlain, near the former of which places the remains of its inhabitants have been left at an elevation of about 600 feet.

With all this, however, we must not be led into regarding all movements of subsidence as a result of increasing accumulations, whether of sediment or otherwise; for such is evidently not the case, though to instance this would lead me beyond the object of this letter. SEARLES V. WOOD

Martlesham, near Woodbridge, October 11

THE above remarks require but little comment, and chiefly tend to show that Mr. S. V. Wood attaches increased importance to the idea that weight produces subsidence. He speaks of elevation commencing before the retreat of the glaciers, but that they would be enormously lightened before retreating is a fact that I can hardly suppose he has overlooked. In ascending the Jungfrau many years ago, when the Swiss glaciers were diminishing, I crossed from the Grindelwald on to the Aletsch, and had to descend a cliff of nearly vertical ice, which my recollection tells me was some sixty feet high, in order to pass from one to the other. The difference in level was caused by the extra rapid melting of the Aletsch, owing to its more southern aspect and exposure to the Fohn wind. This was at the head of the glacier, and the melting was much more rapid lower down, though the superficial area had not contracted to any appreciable extent. This loss of weight would lead to elevation long before the disappearance of the ice. J. STARKIE GARDNER

Snake Bite

I WAS an eye-witness to the following:—My brother was walking within a field of the Land's End when he stooped to pick up a large snake, apparently nearly a yard long, which bit him on the thumb. The bite became very painful in a few moments, and we realised for the first time that it was poisoned. In less than five minutes he was in the hotel and swallowed half a pint of neat brandy, and soon after some ammonia and water, without any effect. The wound had been well sucked and was steeped in ammonia, but the arm soon swelled to the size of the body, and the swelling began to extend down the ribs. The thumb was lanced while immersed in hot water, and the result was similar to the first gashes in a shoulder of mutton, the exposed flesh being dark mulberry colour, and not a drop of blood flowing. He recovered in seven or eight days, but was weak for some time. J. S. GARDNER

Park House, St. John's Wood Park, N.W.

The Observation of Meteors

ACCOUNTS of large meteors form a frequent subject of correspondence in the columns of scientific journals, but it is not often the case that the descriptions of these phenomena are sufficiently exact to be valuable for purposes of calculation. Rough estimates of the direction and position of flight are of little utility, and the vague statements often made occasion an endless source of difficulty in the satisfactory reduction of results. It is true that observers of fireballs are generally taken unawares by the suddenness of the apparitions, and that the visible paths are seldom to be noted accurately. Before the observer collects himself to record the facts of the display it has disappeared, and he has to rely solely upon the impressions retained in his memory.

But, notwithstanding this drawback, the observations of large meteors as published from time to time would possess far greater scientific value if observers would attend more scrupulously to that most essential detail, the *direction of flight*, and express it by some method of uniformity. Sometimes we find the path vaguely stated as being from "east to south," without any attempt to estimate the altitude of the beginning and end points of the course. On other occasions a meteor is described as passing above or below certain stars or planets. The latter method, though an improvement upon the former, is to some extent indefinite, and therefore unsatisfactory, as giving unnecessary trouble to those who undertake the reduction of such materials. For instance, a meteor is observed early in August, 1881, shooting from "some distance below Saturn towards Comet B." Now in reducing this account troublesome references have to be made to find the places of the two objects on the dates mentioned, and then we are left to guess at the "distance below Saturn" implied in the description. These objections would disappear, and the comparison of observations be greatly facilitated, could observers be induced to give the right ascension and declination of the beginning and end points of the visible paths. These elements admit of ready determination by projecting the observed flights upon a star chart or celestial globe and reading them off. Even in cases where the observations are uncertain, the observer should fix the path according to this method as nearly as possible, for it is manifest that it is infinitely preferable to the vague and often worthless attempts to guess altitudes, compass bearings, &c., and, moreover, it renders the after comparison of observations a work of greater facility and precision.

Though the direction of flight is the all-important element to be determined by meteor observers, there are some minor points which should also be carefully recorded. The time of appearance, brightness, approximate duration, and whether accompanied by phosphoric streaks or spark trains, are each important in their way, and must be stated whenever feasible. If this were done more systematically, the observations of fireballs would acquire additional value, and may quite possibly develop some new facts either as to their appearance or origin.

Bristol, October 22 W. F. DENNING

"Partials"

IT is a well known fact that no musical sound is produced alone, but the instant it is sounded a series of other sounds springs from it, and always in a certain order and ratio. Next to the primary tone, the octave is heard, then the octave fifth, the double octave, the double octave third, the double octave fifth, the extra flat double octave seventh, the treble octave, and so on. The origin of these "partials" has long been an interesting study, and a solution has occurred to me which I think is the true one.

We have the fact that an object seen by the eye for ever so short a time leaves its impression on the optic nerves about the eighth of a second *after it has passed away*. By analogy it seems highly probable that all our nerves, including those of the ear, retain impressions made upon them for a momentary period after the cause has ceased to act. If this surmise is correct, then the following would ensue. All musical tones being produced by vibrations striking upon the ear in rapid succession, the first vibration would continue to be felt during the strokes of a number of succeeding vibrations.

The second vibration coming upon the ear before the first ceased to be felt would produce the effect of two in the time of one, making the octave sound.

The third would produce the effect of three in the time of one, making the octave fifth; the fourth, four in one, the double octave; the fifth, five in one, the double octave third, and so on,

the order *exactly corresponding with that in which the partials are heard.*

Of course while the successive strokes occur the first is becoming fainter in effect, and thus each partial in the above order is heard with fainter intensity.

What the first vibration is to the second and its successors the second vibration is to the third and its successors, and thus the series of partials is kept up as long as the primary tone exists. This also accounts for the strong partials heard in the rough vibrations of the harmonium and the few partials heard from the smooth tones of the flute. W. C. JONES

Chester, October 18

The Green Sun

ON Sunday, September 9, the residents in Colombo, while enjoying their evening stroll on Galle Face, were astonished by a strange appearance in the heavens. The sky was cloudy, and frequent squalls were passing over the sea, one of which just touched Colombo. As soon as it was past, the sun emerged from behind a cloud, of a bright green colour. It was then about 10° above the visible horizon. The whole disk was distinctly seen, and the light was so subdued that one could look steadily at it; indeed I should say its intensity was scarcely half that of the full moon. The same phenomenon was also observed on Monday and Tuesday. Wednesday was overcast, and I have not heard of any observations being made; and on Thursday the sun had resumed its normal appearance. I was not in a position to observe it in the morning; but from reports from other parts of the island I learn that the sun appeared green at its rising, and afterwards changed to blue, like the flame of sulphur, giving little light till it had attained an altitude of about 20°, when it could no longer be watched with the naked eye. During the day the light had a bluish tinge; and in the evening the same phenomena were repeated in inverse order. The moon also, to some extent, was affected in the same way.

Can any of your correspondents give an explanation of this? It has been suggested that a convulsion in the sun may have given prominence to vapours emitting a green light; but to me it seems more probable that the cause is to be sought in the upper strata of the earth's atmosphere. Can it have any connection with the recent volcanic eruption in the Straits of Sunda?

Colombo, September 19 W.

IN a clear sky, as the disk of the sun sinks down beneath the horizontal line of the ocean, the parting ray is a brilliant emerald green. I have occasionally, but not often, had the pleasure of seeing this interesting phenomenon, as the clear atmosphere has to be accompanied with a cloudless region of the sky where the sun is setting. The same effect is not produced by the sun setting behind a distant bank of clouds. Probably the first ray from the rising sun would be the same unexpected colour.

Week St. Mary Rectory, Cornwall G. H. HOPKINS

Pons' Comet

THIS comet already has a tail, though a very faint one. With a 4½-inch refractor I traced it last night to a distance of 20' from the nucleus, at a position angle of about 75°.

October 26 T. W. BACKHOUSE

Earthquake

SEEING in your last issue (vol. xxviii. p. 623) that Mr. Cecil describes two distinct tremors of earthquake felt here by him, I write to say that the same phenomena were experienced by myself. I was disturbed in the night by what I mistook for an alarum going off, but found that it was a glass on my water-bottle vibrating violently. After a short pause the glass again vibrated. I found next morning that I could exactly reproduce this sound by shaking the washing-stand. I have never known the washing stand to tremble before, even in a gale.

H. HOWARD CRAWLEY

Pine View, Bournemouth, October 29

STUDIES MADE ON THE SUMMIT OF THE PIC DU MIDI WITH A VIEW TO THE ESTABLISHMENT OF A PERMANENT ASTRONOMICAL STATION[1]

THANKS to the indefatigable zeal of General de Nansouty and the engineer Vaussenat, a meteorological observatory has already been erected on the Pic du Midi. After visiting the place with the Director of the Higher Instruction on the occasion when this observatory was handed over to the State, Admiral Mouchez came to the conclusion that it might be possible to establish an unrivalled astronomical station on the summit, which is now perfectly habitable. In the month of August last he did us the honour of requesting us to study on the spot the advantages and possible drawbacks attending an installation made under such exceptional conditions. The details of our observations will form the subject of a special memoir far too extended for insertion in the *Comptes Rendus*. For the present our remarks must

[1] Note by MM. Thollon and Trépied, from *Comptes Rendus* of October 15.

be limited to a simple communication of the more interesting results obtained by us from August 17 to September 22.

On reaching the summit of the Pic du Midi (2877 metres), where the barometer maintains a mean height of 538 mm., everything presents itself to the observer as if the density of the veil formed above him by the atmosphere were diminished by about a third. The aërial region left behind him being unquestionably the most charged with mist, dust, and aqueous vapour, he may expect to find at once more light and less diffusion. Thus, during the mornings of September 19 and 20, by masking the sun with a screen held at some distance, and exploring the surrounding space with a small spectroscope with an aperture of 0·02m., we were able to observe the planet Venus at a distance of 2° from the solar disk. We could even subsequently distinguish it with the naked eye. But what most surprised us was the marvellous definition at this station. The limb of the sun projected on the slit of a spectroscope showed a spectrum with a boundary as sharp as if produced by a punching machine. We can positively state that we never elsewhere saw anything similar either at Nice, in Italy, Algeria, or even Upper Egypt. We should add that this complete absence of undulation was noticed only in the morning. After the slopes of the mountains had been exposed for several hours to the heat of the sun, the undulations were produced as they are everywhere else, and even became excessive for the rest of the day.

During clear nights, using a telescope with an aperture of 0·16m., and a reflector by Henry of 0·20m., we found the perfect definition observed in the case of the sun in the morning reproduced in the case of the moon, planets, and stars. Under such conditions observations of extreme precision could certainly have been obtained.

For the study of solar physics we had set up the horizontal telescope and the large spectroscope which we usually employ. On observing the solar spectrum at a favourable moment, it seemed streaked in its entire length with a considerable number of fine lines, some bright, others dark, at a mean distance of 3″ of arc from each other. They certainly belonged to the solar image, for they followed all its displacements, and they could have arisen from the granulations of the photosphere alone. Under the same conditions, that is, when the images were perfectly still, the hydrogen bands C and F had no longer any sort of continuity, but seemed formed of distinct bright and dark fragments, of the same magnitudes as the intervals between the lines.[1] This phenomenon was observed not merely at certain times and places, but constantly over the whole surface of the disk. We feel satisfied that the chromosphere presents a system of granulations analogous to that of the photosphere. The two systems thus superimposed become separated in the spectroscope, yielding, one a continuous, the other a linear, spectrum, and blending together in the telescope as on a photographic proof. If this chromosphere, thus rendered visible on the full disk, happened to be traversed by a protuberance, the band C increased in luminosity and for a greater length. By giving sufficient breadth to the aperture, we were then able to observe the protuberance itself, as when on the edge, although naturally with less brilliance, and foreshortened. Nor is this the first instance of protuberances thus observed on the full disk. On this subject the delicate observations of Young and Tacchini are well known. But instead of being accidentally visible, instead of being produced only under special circumstances, as for instance in the neighbourhood of a spot or on the bridge of a spot in process of segmentation, these phenomena were constant for us with varying degrees of intensity, and under the sole condition of using an image entirely free from undulations.

[1] These phenomena referred to by Messrs. Thollon and Trépied were bserved and recorded in England under exceptionally fine atmospheric contions during the last sunspot maximum.

The observations made outside the edge of the solar disk were no less pregnant with results. We know that in the spectrum of the chromosphere there are eight lines always visible under ordinary conditions. On the Pic du Midi, during the five days when we were able to make our records at favourable moments, we saw the number of these bright lines always visible increased to over thirty in the portion of the spectrum which is comprised between D and F. Here we subjoin a table of the wavelengths of these lines :—

5533·6	5273·2	5204·8	5122·6
5525·8	5258·9	5199·5	5114·4
5469·9	5254·3	5196·9	5112·1
5361·5	5252·2	5183·0	5087·0
5324·3	5248·8	5172·0	5029·8
5318·7	5233·9	5168·3	5017·9
5292·4	5225·6	5166·7	4983·6
5283·1	5207·4	5147·0	4923·0
5275·0	5206·8	5130·2	4882·9
			4854·2

It will be seen that, at the altitude at which our observations were made, an approach was made to the conditions prevailing during a total eclipse.

To resume. The observations we were able to make on the Pic du Midi during the five weeks of our sojourn on its summit justify us in concluding that science will gain much by the completion of the astronomical station begun by the directors of the Paris and Pic Observatories. Here we should have a permanent establishment always open to *savants* wishing to undertake special researches. To mention those points only towards which our attention was mainly directed, we are of opinion that good opportunities would here be found of furthering the solution of many problems connected with solar physics and the spectral analysis of the stars.

THE WHEAT HARVEST OF 1883

THE public must be somewhat puzzled with the divergent opinions of authorities upon the yield of the wheat crop of the present year. On the one side, for example, stands Sir John Lawes with his accurate balances and wonderful wheat field, which experience has taught him usually proves a fair criterion of the yield of the English crop. On the other side is arrayed a somewhat formidable party, which we may take as well represented and led by the very able article in the *Times* of Saturday last, headed "The Result of the Harvest." To put the matter briefly, there is a difference of opinion as to whether we have reaped an average crop or an underaverage crop of wheat. And there is also a good deal of difference in opinion as to what an average crop is. The point of greater interest no doubt to us is whether we have just secured an abundant harvest or not. It is a point of very great importance not only intrinsically but as a matter of opinion. If business men believe that our national wealth has been recently increased by an unusual augmentation of our food supply, they may make this opinion a basis for enterprise or speculation. If the opinion which prompted them to action should prove a false one, the results would be inflation, panic, and loss. It is therefore very essential that public opinion should be guided in a right direction upon this important point. Any person who has read our leading newspapers carefully upon the subject of harvests for a series of years will probably have observed a tendency to over-estimate production. The prospect is usually depicted *couleur de rose*, and the public is congratulated upon its harvest prospects, while practical farmers remain in doubt as to the yield of their cornfields. Of one thing we may be certain—that wheat needs heat. The average temperature of our islands is scarcely suitable to the wheat plant, which is rightly viewed as somewhat exotic in its requirements. A slight elevation above the sea-level, or a slight decrease in solar heat, invariably lowers the yield of wheat. Properly read with regard to its distribution throughout the season, the temperature of the summer months ought to guide us to a judgment with regard to the probable yield of wheat. It is the same with regard to wine. Good wheat and good wine years run together. 1868, 1870, and 1874 will probably all continue to be remembered as good wine years, and they are well known as among the best wheat years of the present half-century. In judging as to the effects of temperature upon the wheat crops, we must not only take average temperature but fluctuations between night and day. A single cold night may do incalculable damage, and a few cold days at blooming time may do much to blight a wheat-grower's prospects. Those who watch the weather closely will usually lay the foundation of a sound judgment upon wheat prospects. We require, first, a good seed time; second, a dry March; third, a hot June, July, and August. So much for the weather. We require also a good "plant," *i.e.* plenty of young wheat plants uniformly scattered over the surface. The growing crop must be fairly free from those unaccountable visitations known as "blights," both insect and vegetable, and if we can secure these good conditions we reap a good wheat crop. Let us then endeavour to apply these rules to the actual state of things during the months between seed time of 1882 and harvest of 1883, and let us glance at the various opinions expressed as to the yield of wheat for the present year in the light of these facts. First, then, we passed through a period of incessant rainfall during the time when farmers usually sow their wheat. A worse seed time we have rarely experienced. Constant rain and destructive floods were the characteristics of October, November, January, and February last. Now we owe to Sir John Lawes, in a great measure, the knowledge of the fact that a wet winter washes out that element of fertility which of all is the most important, namely, the nitrates. Here then we have to record a very wet winter, in which seeding was interrupted and nitrates were washed through into the drains and subsoil, and that to an unusual degree.

The consequence was that in the spring a thin plant was the rule upon all stiff soils. After this the wheat improved under the influence of a singularly fine spring, and farmers rejoiced in the opportunity afforded them to get on with their root cultivation. Unfortunately this state of things did not last. At the most critical period for the wheat crop summer forsook us. The nights became bitterly cold in June, and a continuation of wet weather set in which lasted almost up to harvest. Accompanying this untoward state of affairs were blights, and the ears became greatly affected with wheat-midge, smut, and ear-cockle, so that wheat-growers became sensible that their main crop was in extreme danger of ruin, and that before the papers began to publish their estimates.

This feeling among wheat-growers was quite general, as they knew that empty ears could not lead to full measures. Examination of the ears just before harvest showed clearly that small and shrivelled grains were only too common, and that many of the florets were barren. Accordingly crops were valued low, and the results from the threshing machine are bearing out the wisdom of these low valuations. As to Sir John Lawes' estimates, based on the experimental field at Rothamsted, no one knows better than Sir John that this coincidence between his average yield and that of the country generally must be liable to be upset by local disturbances. As a criterion of the harvest Sir John Lawes' field may be useful, but certainly cannot be infallible. A local frost, a local hailstorm, a local loss of plant, or faulty cultivation, must be always liable to affect any field and rob it of its general average character when compared with the harvest of millions of other acres. All this is simple truth, and in this season we are inclined to think that Sir John's field "told a flattering tale." The opinion of the writer of the present article is based, first, upon the meteorological conditions to which the wheat crop was exposed during its growth. Secondly, upon his own experience as a grower. Thirdly, upon information obtained from other growers, and from observation and reading.

He has come to the conclusion that the wheat crop of 1883 is below an average, and will be disappointing to the grower. Not only was the crop subjected to many bad conditions during its growth, but a large proportion of it was badly harvested, and is now in wretched condition. If we are not deeply disappointed with the 20 to 26 bushels of wheat per acre which our own liberally treated crops are yielding of *marketable* corn, it is because we have never expected more since those frosty nights of last June, when we resigned our hopes of a good wheat crop. The subject is almost too long for treating in a single article, and we must leave it here. If space had permitted, we should have entered upon the question as to what constitutes an average crop of wheat—a point upon which we appear to be in a state of great ignorance, unless we are to believe that an average which thousands of our best farmers have not been able to touch for the last ten or twelve years is that of the entire country with its millions of badly cultivated acres. This we cannot admit, and after a careful study of the estimates made as to average yield in various counties, we are driven to the same conclusion as that of the writer to the *Times* last Saturday, namely, that little reliance is to be placed upon them. Average, over-average, and under-average are somewhat vague terms, and difficult to fix. We can, however, base an opinion upon the fact that cheerless, cold, and wet summers that are unfavourable for fruit, bees, and vines, or even to pleasure parties, lawn tennis, and picnics, are not going to be favourable to wheat-growers. We have not touched upon barley and oats, but are prepared to allow that circumstances have been more favourable towards these crops than towards the most important cereal.

JOHN WRIGHTSON
College of Agriculture, Downton, Salisbury

ON A NEW METHOD OF SINKING SHAFTS IN WATERY, RUNNING GROUND

WHEN an attempt is made to sink a shaft in very watery deposits of gravel, sand, and mud in the ordinary way—that is, by digging out the solid matter by hand and pumping the water to keep the bottom dry—it is found that, after a certain depth has been reached, the current of water which flows up through the bottom brings solid matters along with it as fast as they can be removed, and further downward progress is then completely arrested. Under these circumstances it is necessary to resort to certain special methods of sinking, two of which have been hitherto employed with more or less success. According to one of these methods the shaft-lining consists of an air-tight iron cylinder fitted with an air-tight cover. When the excavation is continued below the natural level of the water, compressed air is forced into the interior of the shaft so as to drive back the water and leave the bottom dry. The workmen can then stand in the bottom and remove the solid matter by hand as easily as if the ground had been naturally free from water. The lining sinks downward as its lower end is laid bare, and is lengthened at the top as required. The pressure of the air is gradually augmented as the depth increases, but unfortunately this process cannot be carried beyond three atmospheres without prejudicially affecting the health of the workmen. When the depth of the watery running ground surpasses the limit represented by a pressure of three atmospheres, it is necessary to resort to the second method. In this case the water is allowed to stand at its natural level in the shaft, and the solid matters are removed from the bottom by a revolving dredger. The lining or casing consists of a cylinder of masonry or iron provided with an iron shoe or cutting ring, and sinks downwards at first in virtue of its own weight, being lengthened at the top as in the previous case, but after a time it generally becomes necessary to force it down by the pressure of screws, assisted by the blows of an instrument resembling a pile-driver. When it cannot be made to sink deeper, another similar cylinder of smaller diameter is introduced into its interior, the same series of operations are again gone through, and so on until the solid ground is reached.

Simple as the last described process may appear, its application is sometimes attended with difficulties of almost incredible magnitude. As an example we may mention two shafts which were sunk through about 400 feet of the kind of ground in question at the Colliery Rheinpreussen, near Ruhrort in Germany. One, begun in 1857, was not finished after more than eighteen years' constant perseverance; while the other, begun in February, 1867, was only completed down to the solid ground in June, 1872.

The new method invented by Herr Poetsch is described by Bergassessor G. Kohler in the *Berg und Hüttenmännische Zeitung*, No. 38, xlii. *Jahrgang*, September 21, 1883. It consists in freezing the water contained in that portion of the running ground which occupies the position of the intended shaft into a solid mass of ice, and then sinking through it by hand without having to pump any water. To this end a preliminary shaft of larger dimensions than the intended shaft is sunk down to the natural level of the water. A number of vertical bore-holes about one metre apart are then put down round about its sides at the bottom, so that they pass through the ground just outside the lining of the intended shaft. Others are put down within the area of the intended shaft, and one is put down in its centre. All of these bores are continued down to the bottom of the running ground. They are made by means of the sand-pump, and are lined with sheet-iron tubes in the usual way. A circular distributing pipe with small copper tubes branching from it is placed at the bottom of the preliminary shaft. One copper tube extends to the bottom of each bore-hole, and each tube is provided with a stopcock. At the surface are several ice-making machines of the Carré type. The liquid intended to circulate through the bore-holes and effect the operation of freezing consists of a solution of the chlorides of magnesium and calcium, whose freezing-point lies between -35° C. and -40° C. By means of a small force-pump it is made to circulate at such a rate that it leaves the cooling-trough with a temperature of about -25° C. It descends into the distributing pipe, passes through the copper tubes to the bottom of the bore-holes, ascends outside the copper tubes to the top of the bore-holes, finds its way into a collecting-tube, reascends to the surface, passes through the cooling-trough, and then commences the downward journey again.

Herr Poetsch estimates that, under ordinary conditions —that is, when the outer ring of bore-holes can be made in the ground outside the lining of the intended shaft— the freezing process will occupy from ten to fourteen days.

When it has been ascertained by means of bore-holes that the wall of ice round about the intended shaft is thick enough, the operation of sinking is commenced. The ice is cut out by hand, and a descending cylinder of masonry or iron is carried down at the same time. The lining prevents the surrounding ice-wall from breaking inwards, and the bottom cannot burst upwards.

Herr Kohler made a personal inspection of this process at the shaft Archibald now being sunk to the lignite beds at Schneidlingen, in Germany. The shaft passes through a bed of running sand four metres thick. Twenty-three bore-holes were employed in two rows near its sides. The freezing process was completed on August 10 last, when the running sand had become a compact mass of such great hardness that no impression could be made on it by the finger-nail, and it was with considerable difficulty that a flake 15 mm. thick could be broken from it.

Sufficient data do not yet exist for estimating the cost of this process as compared with those already known, but we are of opinion that if the operation of freezing can be effected in two or three weeks, or even months, it will compare favourably with them in this respect under almost any circumstances. We believe also that it is capable of application under a variety of circumstances not mentioned in Herr Kohler's article, such as damming back an excessive flow of water in solid ground, driving horizontal drifts or tunnels through mud and sand, and so on. We would therefore recommend the inventor rather to turn his attention in this direction than to think of condensing the intake air of mines by the application of cold, with the view of dispensing with ventilating furnaces and enabling winding operations to be carried on in upcast as well as in downcast shafts. The former field, if we mistake not, will be a large one; the latter, we can safely promise him, will be a very small one.

WILLIAM GALLOWAY

NORDENSKJÖLD'S GREENLAND EXPEDITION

IN a series of letters to Mr. Oscar Dickson, Baron Nordenskjöld has given a detailed report of the leading incidents and results of his recent expedition, though it will still be some time ere we can learn what are the full gains to science. The leading novelty of the expedition was, of course, the journey into the interior of Greenland. We have already given some account of Dr. Nathorst's visit to the Cape York region, and in the present article will confine ourselves mainly to Nordenskjöld's own journey up the interior. We reproduce a sketch map of this journey, which Mr. Dickson has been good enough to send us. After mentioning his attempt to approach the south-east coast of Greenland, Nordenskjöld says:—

The ice much resembled the big rough blocks which are encountered north of Spitzbergen. The surface here carries a cold current which sets the ice on shore. The polar current is however not very voluminous; thus in a depth of a couple of fathoms Herr Hamberg discovered, through careful survey, a decided warm current from the south. The depth of the sea was not great, and the bottom consisted of large blocks which tore the trawling net and prevented dredging.

After landing Dr. Nathorst and his party at Waigatz Sound, Nordenskjöld went back to Egedesminde, which he reached on June 29. He then proceeds:—

The following day I left for Auleitsivik Fjord, from which my expedition was to start. This fjord is about 130 kilometres long, and very narrow in the middle, not unlike a river, which widens at the bottom into a bay, Tessiusarsoak, into which an arm of the inland ice shoots. This remarkable formation, and the great tides which favour this part of Greenland, make the navigation here very difficult. As in most of the Greenland fjords the sea is deep and free from reefs. A remarkable feature, too, is that icebergs coming athwart the narrows in the fjord cause the water in the bay suddenly to rise some ten to twenty feet. The Esquimaux relate that some years ago a boat with men, women, and dogs was drawn under here by the whirl currents. They are, in consequence, afraid of rowing in the narrows.

In 1870 I had paid a visit to this fjord and examined these difficulties, which I believed would have increased rather than otherwise during the last thirteen years, through those changes which so often occur in the position and size of the moving glaciers which shoot down from the inland ice. On inquiry I was told that no European had been in the fjord since 1870. Still my knowledge of the feasibility of getting at least some 50 kilometres inland from this spot decided me to select it as my *point d'appui.*

On July 1 the *Sophia* anchored in the bay just north of the inland ice. We found here a splendid harbour with clay bottom, some seven fathoms deep, surrounded by gneiss rocks from 600 to 1000 feet in height, the sides of which are in some places covered with low but close shrubs, or clothed with some species of willow, mosses, and lichen, which, when we arrived, were ornamented with a quantity of magnificent blossoms. From one of the slopes a torrent descended, the temperature of which was 12°·3 C. The weather was fine, the sky cloudless, and the air very dry. July 1 to 3 were employed in making preparations for the ice journey, while the naturalists made excursions to various places in order to collect objects relating to the conditions of the country. On the night of the 3rd everything was ready for a start, and after some difficulty in reaching the spot where the baggage was we were fairly off. The spot from which we set out on the journey was only five kilometres from the actual shore, and situated below a little lake into which a number of glacier rivers fell. We proceeded up the river in a Berton boat purchased in England. On the night of the 4th we camped for the first time on the ice. The expedition consisted of nine men besides myself. After a great deal of hard work in getting the sledges over the ice, which was here very rough, we found on the morning of the 5th that it was impossible to proceed eastwards, but were compelled to return to the border of the ice and then continue to the north or north-east until finding smoother ice. This first part of the ice was furrowed by deep crevasses and ravines, causing us much trouble. We covered, however, a good distance that day, and pitched our tent near a land ridge in the ice 240 m. above the sea.[1] On July 6 I sent the Lapp Lars forward to reconnoitre, and he reported that it was still impossible to proceed eastwards, but if we marched for a day or so to the north we would find the country accessible to the east. As I feared, however, the impossibility of dragging the sledges with the weight on them over the rough ice, I selected provisions, &c., for forty-five days and left the rest in a depot in the ice. We now resumed the march. It was very interesting to witness the great ease with which the Lapps proceeded among the ice ravines, how easily they traced a road discovered, and with what precision they selected the least difficult track.

The Lapp Lars carried, instead of an alpenstock, a wooden club, with which he had slain more than 25 brown bears, full of marks from their teeth, and his eyes sparkled at the thought of encountering a white one. On the night of the 6th we held our third camp on the ice, and now several officers and men from the *Sophia*, who had accompanied us thus far, left us. Besides the most advantageous requisites for such a journey, we had with us a cooking apparatus for petroleum, and here I beg to say that I found this kind of oil far more suitable than train or vegetable oils, which I had used on my former expeditions, and I recommend the same most warmly to Arctic explorers. Of scientific instruments I may mention compasses, two chronometers, a circle by Pistor and Martin, a small sextant, in case of the former being damaged, a mercury horizon, three aneroid barometers, thermometers, magnets, for the study of the clay deposit in the snow, a topographical board, a photographic apparatus, blowpipes, flasks, nautical tables, &c. The sledges "kalkar," six in number, were of the same kind as those on which Swedish peasant women bring their wares to market; the harness was made so strong that it would hold a man in case of his falling into a crevasse. In addition to these things we had a manilla rope specially spun for the expedition at the Alpine purveyor's in Paris. The food supplied per day may perhaps interest explorers. It was—breakfast: coffee, bread, butter, and cheese (no meat or bacon); dinner: 42 cubic c.m. Swedish corn brandy (*bränvin*), bread, ham or corned beef, with sardines; supper: preserved meat, Swedish or Australian. Sometimes preserved soup was served with dried vegetables. Five men were teetotalers, but there was no need of supplying them with extra rations. For cooking, 0·7 litres of spirits were consumed per day. Our whole baggage weighed a ton, a weight which might easily have been drawn across a smooth snow or ice field, but which was very difficult of transporting over the rough and cut-up surface we had to traverse. Our daily march, between July 7 and 9, was, therefore, not great, viz. 5 kilometres a day. In addition to the crevasses and ravines, we encountered innumerable rivers, swift, and with steep banks which were difficult of crossing, which was generally accomplished by laying three alpenstocks across them. If I had not selected these of the toughest wood obtainable, we should often have had to make detours of many kilometres.

[1] The altitudes were ascertained by comparing three aneroid barometers, while observation was simultaneously made at Egedesminde with a splendid sea barometer I had left there for that purpose. As the figures have, however, not yet been verified, they may be slightly altered. They seem on the whole too low.

On these days we found on several occasions large bones of reindeer on the snow, and it was but a natural and pardonable conclusion to arrive at, that they were those of animals who had fallen in their wandering over the "Sahara of the Arctic regions." But that good signs are not always true ones we soon discovered.

During the entire journey we had great difficulty in finding suitable camping places. Thus either the ice was so rough that there was not a square large enough for our tent, or else the surface was so covered with cavities, which I will fully describe later on, that it was necessary to pitch it over some hundred smaller, and a dozen larger, round hollows, one to three feet deep, filled with water, or else to raise it on a snow-drift so loose and impregnated with water that one's feet became wet even in the tent. An exception to this was the place where we camped on July 9, viz. camping-place No. 6. We encountered here a small ice-plain, surrounded by little rivers, and almost free from cavities, some thirty metres square. All the rivers flowed into a small lake near us, the water from which rushed with a loud roar through a short but strong current into an enormous abyss in the ice plateau. The river rushed close to our tent, through a deep hollow, the sides of which were formed of magnificent perpendicular banks of ice. I had the spot photographed, but neither picture nor description can give the faintest idea of the impressive scene, viz. a perfectly hewn aqueduct, as if cut by human hand in the finest marble, without flaw or blemish. Even the Lapps and the sailors stood on the bank lost in admiration.

At first we had followed the plan of bringing the baggage forward in two relays, but, finding this very fatiguing, I decided to bring all with us at once. I found this to answer better. On July 10 we covered thus nine and a half, on the 11th ten, and on the 12th eleven, kilometres. The road was now much better than before, although stiff enough. An exception to this was, however, formed by the part we traversed on the 11th, when we proceeded alongside a big river, the southern bank of which formed a comparatively smooth ice plain, or rather ice road, with valleys, hills, cavities, or crevasses, some five to ten kilometres in width, and five kilometres in length. This plain was in several places beautifully coloured with "red" snow, especially along the banks of the river. It was the only spot on the whole inland ice where we found "red" snow or ice in any quantity. Even yellow-brown ice was seen in some places, but, on the other hand, ice coloured grayish-brown or grayish-green, partly by kryokonite, and partly by organisms, was so common that they generally gave colour to the ice landscape.

Even on July 12—between camps Nos. 7 and 8—we found blades of grass, leaves of the dwarf-birch, willows, crackberry, and pyrola, with those of other Greenland flora, on the snow. At first we believed they had been carried hither from the interior, but that this was not the case was demonstrated by the circumstance that none was found east of camp No. 9. The only animals we discovered on the ice were, besides the few birds seen on our return journey, a small worm which lives on the various ice algæ, and thus really belongs to the fauna of the inland ice, and two storm-driven birds from the shore. I had particularly requested each man to be on the look-out for stones on the ice, but after a journey of about half a kilometre from the ice border no stone was found on the surface, not even one as large as a pin's point. But the quantity of clay dust ("kryokonite") deposited on the ice was very great; I believe several hundred tons per square kilometre.

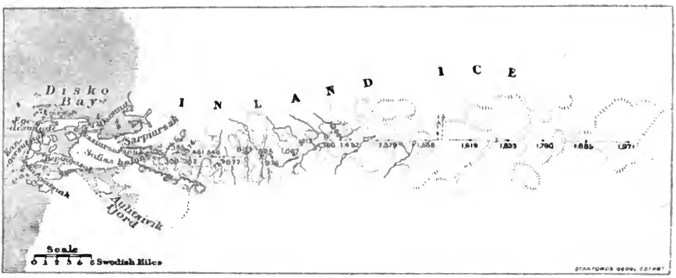
We now ascended very rapidly, as will be seen from the subjoined statement of our camps :—

3rd camp,	300 metres above the sea.			
4th	,,	355	,,	,,
5th	,,	374	,,	,,
6th	,,	382	,,	,,
7th	,,	451	,,	,,
8th	,,	546	,,	,,
9th	,,	753	,,	,,

The 9th camp lay on the west side of an ice ridge close by a small, shallow lake, the water from which gathered as usual into a big river, which disappeared in an abyss with azure-coloured sides. From this spot we had a fine view of the country to the west, and saw even the sea shining forth between the lofty peaks on the coast; but when we reached east of this ice ridge the country was seen no more, and the horizon was formed of ice only.

Through an optical illusion, dependent on the mirage of the ice horizon, it appeared to us as if were proceeding on the bottom of a shallow, saucer-shaped cavity. It was thus impossible to decide whether we walked up or down hill, and this formed a constant source of discussion between us, which could only be decided by the heaviness of the sledges in the harness. The Lapps, who seemed to consider it their sole business that we should not be lost on the ice, came to me in great anxiety and stated that they had no more landmarks, and would not be responsible for our return. I satisfied them, however, with the assurance that I would find the way back by means of a compass and solar measurements. In spite of this the Lapps easily traced our route and our old camps with an accuracy quite marvellous.

During our outward journey I determined the site of each camp astronomically, and thus the distances which, when the determinations have been calculated, will be given on the map to be drawn of the journey will be absolutely correct. But the distances covered by the Lapps have been made according to their own judgment. The kilometres we covered every day, including the numerous detours, were ascertained by two pedometers.



The heights are given provisionally in metres. Swedish mile = 6·64 English miles.

Up to the 9th camp we were favoured by the finest weather, generally with a slight south-east wind, cloudless sky, and a temperature in the shade, three feet above the ice, of 2° to 8° C., and in the sun of even 20° C. The centre of the sun's disk sank in this spot for the first time below the horizon on July 15, and the upper rim, if allowance is made for refraction, on July 21. After the middle of July, when at an elevation of 4000 to 7000 feet, the nights became very cold, the thermometer sinking to 15° and 18° below freezing-point of Celsius.

The constant sunshine by day and night, reflected from every object around, soon began to affect our eyes, more so, perhaps, because we had neglected to adopt snow-spectacles at the outset of our journey, and snow-blindness became manifest, with its attendant cutting pains. Fortunately Dr. Berlin soon arrested this malady, which has brought so many journeys in the Arctic regions to a close, by distributing snow-spectacles and by inoculating a solution of zinc vitriol in the blood-stained eyes. Another malady—if not so dangerous, at all events quite as painful—was caused by the sunshine in the dry, transparent, and thin air on the skin of the face. It produced a vivid redness and a perspiration with large burning blisters, which, shrivelling up, caused the skin of the nose, ears, and cheeks to fall off in large patches. This was repeated several times, and the pain increased by the effect of the cold morning air on the newly-formed skin. Any similar effect the sun has not in the tropics. With the exception of these complaints none of us suffered any illness.

On July 13 we covered thirteen, on the 14th ten, and the 15th fourteen, kilometres (9th to 12th camps). At first the road gradually rose, and we then came to a plain which I in error believed was the crest of the inland ice. The aneroids, however, showed that we were still ascending : thus the 9th camp lies 753, the 10th 877, the 11th 884, and the 12th 965 metres above the sea. Our road was still crossed by swift and strong rivers, but the ice became more smooth, while the kryokonite cavities became more and more troublesome. This was made more unpleasant by rain which began to fall on the afternoon of July 13, with a heavy wind from south-east. It continued all the night, and the next morning turned into a snowstorm. We all got very wet, but consoled ourselves with the thought that the storm coming from south-east argued well for an ice-free interior. When it cleared a little we strained our eyes to trace any mountains which would break the ice horizon around us, which everywhere was as level as that of the sea. The desire soon "to be *there*" was as fervent as that of the searchers of the Eldorado of yore, and the sailors and the Lapps had no shadow of doubt as to the existence of an ice-free interior. And at noon, before reaching camp No. 12, everybody fancied he could distinguish mountains far away to the east. They appeared to remain perfectly stationary as the clouds drifted past them, a sure sign, we thought, of its not being a mass of clouds. They were scanned with telescopes, drawn, discussed, and at last saluted with a ringing cheer. But we soon came to the conclusion that they were unfortunately no mountains, but merely the dark reflection of some lakes further to the east in the ice desert.

A. E. NORDENSKJÖLD

(*To be continued.*)

THE RE-ENTOMBMENT OF WILLIAM HARVEY

FOR two hundred and twenty-six years the mortal remains of the immortal discoverer of the circulation of the blood rested, unburied, in a vault of a little church in the parish of Hempstead, about seven miles from Saffron Walden, in Essex.

Harvey died on the 3rd of June, in the year 1657, being then in his eightieth year, but the precise place of his death is not known. He fell, full of days and honours, and retained his faculties so completely to the last day of his life that he directed his apothecary, Samboke, what to do in the way of treatment. He beckoned to Samboke to take blood from under the tongue as the speech was failing,—a line of treatment which would have little favour in these days,—and as the sun of June 3 went down he went down also. His death, no doubt, took place in London, and probably near to Smithfield.

On June 26, twenty-three days after the death, the body of William Harvey was laid in the vault at Hempstead. In the interval a cast had been taken from the face for a rough and ready sculptor to work from, and the body, after a custom of the time, rolled first, in all probability, in a cere cloth, had been inclosed in a leaden chest. It was then conveyed to Hempstead, a distance of about fifty miles, in those days a journey of no slight importance. The body was followed by many of the Fellows of the College of Physicians out of town, and it may be that some of them went as far as Hempstead. Certainly one scholar, though he was not a Fellow, namely Aubrey, the historian, was present when the body was put into the vault. "I was at his funeral, and helpt to carry him into the vault." These are Aubrey's words. The vault referred to had been built by Eliab, the merchant brother of the anatomist, and over it was erected a chapel connected with the church at the north-eastern corner. The vault was afterwards filled with the bodies of members of the Harvey family, some few "lapt in lead," like their great relative, others laid in coffins.

For nearly two centuries little seems to have been recalled of the remains of the anatomist. They lay with their kindred in the village sepulchre without reference being made to them. In 1847 Dr. Richardson, F.R.S., then assisting Mr. Thomas Browne, a surgeon in Saffron Walden, was told one day by a cottager that the great Dr. Harvey was buried in Hempstead Church, and next day discovered that it was really Harvey the anatomist and physiologist, and that the body, "lapt in lead" as Aubrey described, lay there probably as it had originally been placed.

At that time the foot of the leaden chest lay under the open window of the vault. There was then no opening in the lead, but the upper surface towards the middle of the body was beginning to show signs of sinking in. There was much dust and several stones on the chest, which were removed. The remains were reported upon after this by Dr. Tyler Smith, who had visited the place, to the Royal College of Physicians, and in 1859 the College deputed the late Dr. Alexander Stewart and Dr. Quain to visit and report. They made their report, and some changes were carried out in the vault; but the window, although protected by the addition of iron bars, was left open, and, under the influence of air and damp, the lead began to give way.

From time to time Dr. Richardson visited the place and reported on the changes which were in progress. In the lower part of the lid of the leaden chest the sinking became so increased that a kind of oblong basin was formed, in which rain water, beating in from the window, accumulated. Then an opening, taking the shape and size of one of the sound openings in a violoncello, was formed, and water was admitted into the shell itself. Twice it seemed filled with thick pitchy-looking fluid, and although the opening was temporarily filled up with solder, the repair did not last very long.

In 1878 Dr. Richardson made another visit to Hempstead, and on November 30 of that year published in the *Lancet* a full report on the condition of the remains, together with six illustrations. The report created considerable attention, and led the way to the alteration that has been recently effected. In January, 1881, the beautiful tower of the old church at Hempstead suddenly fell, dragging a portion of the church with it. It was found that the Harvey vault and chapel were not injured, but that the leaden shell in which Harvey was laid was again filled with water, and that the preservation of the case could not be much longer insured. In February, 1882, the Royal College of Physicians, formed a committee to undertake the duty of placing the remains in a position in which they would be permanently retained. The result was that the College obtained permission of the representatives of the Harvey family to remove the remains from the vault and to place them in a solid marble sarcophagus in the Harvey chapel above. Such is a succinct history of the proceedings previous to the removal and re-entombment on October 18 of this year.

The ceremony of the 18th was extremely simple. As was befitting, a number of the Fellows of the College—eight in all—bore the remains from the vault along the northern side of the church to the western entrance, and so through the aisle to the entrance of the Harvey chapel, on the left of the chancel. The vicar of Hempstead, the Rev. R. H. Eustace, and the curate, the Rev. J. Escreet, led the procession; then came the bearers with their charge on a bier; after them, four of the representatives of the Harvey family; and, next in order, the President, all the office-bearers, and the Fellows of the Royal College of Physicians who had come to take part in the ceremonial.

After a short service the leaden case was placed in the sarcophagus. On the breastplate of the case the original inscription—

Doctor
William . Harvey
Decesed. The . 3.
Of Jvne 1657.
Aged 79 years

was still quite perfect, as was also a rough metal cast of a face with a small imperial from the lower lip to the chin. After the remains had been laid in the marble, the President of the College, Sir William Jenner, placed on them a leaden case containing the College edition of the complete works of Harvey. The volume was the Latin edition of 1766, edited for the College by Mark Akenside, including in the first pages a life of the illustrious anatomist and discoverer. Together with this volume there was also put into the sarcophagus a memorial bottle cased in lead and containing various details relating to the removal. The bottle included views of the church, before and after the fall of the tower, executed on wood; a description of the church and the vault, and the time the remains had been in the vault; several photographic views of the church; a beautiful photograph of the bust of Harvey; a scroll of vellum on which was engraved a description of the reasons why the remains had been put into the marble, with the names of all who had taken part in the ceremony; and a printed account of the proceedings that were carried out at the second interment on October 18th, 1883. The sarcophagus was then finally closed by rolling on and cementing down the massive cover or lid. On the western side of the sarcophagus is engraved the following:—

THE REMAINS OF WILLIAM HARVEY,
DISCOVERER OF THE CIRCULATION OF THE BLOOD,
WERE REVERENTIALLY PLACED IN THIS SARCOPHAGUS
BY THE ROYAL COLLEGE OF PHYSICIANS OF LONDON
IN THE YEAR 1883.

At the foot are inscribed the words,

WILLIAM HARVEY.
BORN 1578. DIED 1657.

NOTES

WE are glad to learn that M. Dumas is much better, though it is probable he will have to spend the winter in the south of France.

THE arrangements for beginning work at Ben Nevis Observatory will be completed this week, and Mr. Omond will take up his post on the summit in the middle of next week, when observations will be at once begun. The telegraph cable has now been completely laid.

THE Fisheries Exhibition was closed yesterday with much ceremony; its success as a popular exhibition is almost unprecedented, and, as we have pointed out in several articles, some of the exhibits have been of real scientific value.

WE regret to announce the death, last Saturday, of M. Breguet, the well known electrician, member of the French Institute and of the Bureau des Longitudes. M. Breguet's second son, a promising electrician, died about twelve months ago, and was deeply regretted. The death of M. Breguet has been all the more noticed that a few days ago the death of M. Niaudet-Breguet, his nephew, was announced. M. Niaudet-Breguet was also devoted to electricity. The well-known Breguet firm will not be extinguished by these multifarious losses, having been made lately a joint stock company. It is one of the oldest in Paris, having been established in 1783.

THE arrangements for the International Forestry Exhibition which is to be held in Edinburgh next year have been settled. The classification of the exhibits ranges over a wide and interesting field. Practical forestry will be illustrated by implements, models of huts, appliances for floating and transporting timber, and wood-working machinery of every description. The department of forest produce will include a collection of the chief uses to which the raw and the manufactured material of the woods may be applied. The class of scientific forestry will deal with the botany of the forests, forest entomology, preservative processes applied to timber, fossil plants, parasites, and numerous other subjects. Growing specimens of rare and ornamental trees and shrubs, rustic work in arbours, bridges, gates, and seats, and dried specimens of ornamental objects will exemplify the division of ornamental forestry. The remaining departments will include pictorial illustrations of the trees, foliage, and scenery of all countries, and the effects of blight, accident, parasitic growth, and abnormal conditions, together with the literature of forestry, working plans of plantations, and examples of the economic condition of foresters and woodmen. The entries for the Exhibition will close on October 4, 1884.

LAST Thursday, October 28, the three classes of the French Institute held their annual meeting. The addresses were delivered this year by the members of other classes than the Academy of Sciences. In the evening the members of the Institute held a great banquet by subscription among themselves. This is the first time that the annual meeting has been so solemnised.

THE seventh International Geodetic Conference terminated its labours on October 24, when the acting president, Col. Ferrero, proclaimed the result of the new election of the permanent committee, as follows:—Lieut.-General Ibanez, Director-General of the Geographical and Statistical Institute, Madrid, President; Col. Ferrero, President of the Italian Geodetic Commission, Vice-President; and Dr. Hirsch, Director of the Observatory at Neuchâtel, and Dr. von Oppolzer, Professor of Astronomy at the University of Vienna, Secretaries. Prof. Bauernfeind read his report on refraction, which was followed by a proposal, made by Major Hartl, and approved, to the effect that the Conference expressed a hope that all the European States represented in the Association would institute thorough investigations into terrestrial refraction, in order to ascertain the influences which the different characteristics of the ground and of the climate exercise upon refraction. Prof. Schiaparelli, Director of the Observatory at Milan, read the report of the special committee named to consider the proposal made by Prof. Fergola regarding systematic observations of latitude, with the intent of verifying the stability of the terrestrial axis of rotation, and ascertaining the movements of the poles; which report, after some discussion regarding the manner in which the observations should be carried out, was approved.

BARON NORDENSKJÖLD has, in consequence of the attacks which have been made in foreign journals in connection with the unfortunate *Dijmphna* expedition, on his theory as to the navigability of the Kara Sea, telegraphed to Lieut. Hovgaard inquiring whether he considered it would have been possible to reach the Yenisei this summer. Lieut. Hovgaard replied that he was fully convinced that had he been prepared to proceed he could easily have reached Siberia this autumn, and further points out that he could have done so last year also had he not, by signals of distress from the *Varna*, been compelled to leave the lead along the shore of the Waigatz Island, which was open as far as the eye could reach, and enter the pack ice where he was frozen in.

IN No. 3, vol. vi. of the *Deutsche Geographische Blätter* is an article by Prof. Börgen, in which he discusses the objects proposed and the theories entertained by Nordenskjöld in connection with his expedition to Greenland. The paper was written before the expedition left. Dr. Börgen adduces some particulars which make him incline to the supposition that the watershed of Greenland lies rather towards the east than the west. In any case, in consideration of the comparatively short distance of any part of Greenland from the sea, and of its low average temperature, Dr. Börgen argues that winds both from the east and the west must deposit snow everywhere on the weather side of the mountains against which they strike, and so maintain the conditions for the formation of glaciers. These glaciers, again, must in the course of time drift down into the valleys and the lowest levels, the temperature of Greenland even down to the level of the sea being everywhere below the freezing-point. This view is further supported by ascertained facts and by conclusions drawn from the direction of the winds, as given in Coffin's work, "The Winds of the Globe." The article in other respects communicates important details and arguments regarding the geography of Greenland.

The Association Internationale Africaine has been so satisfied with the services of the Swedish officers who assist Mr. Stanley in his exploits on the Congo, that four more, who have volunteered their services, have been engaged, and will leave Europe on November 15. We announced some time back that the Royal Geographical Society of Sweden had conferred the *Vega* medal, the greatest honour at the disposal of the Society, on Mr. Stanley. At the last meeting of the Society the President, Dr. Montelius, read a letter received from the explorer, dated Stanley Pool, in which he thanked the Society for the great honour conferred on him.

The last number of the *Isvestia* of the East Siberian Geographical Society contains a valuable paper by MM. Agapitoff and Khalganoff, on the Shamanism of the Balagansk Buriats of the province of Irkutsk; several letters from the Lena Meteorological Station (already noticed in Nature), with a plan of the station; meteorological observations made at Markha in August and September, 1882, and at Magan (ten miles to the north-west of Yakutsk), from July, 1882, to March, 1883; and a paper on the settlements of the 14,000 Chinese, Mantchous, and Dahours, who have remained under Chinese rule, although settled on the left bank of the Amur, at and below its confluence with the Zeya. We notice in this paper that during the three great summer inundations of 1881, the level of water in the Amur, one mile wide at this place, and the Zeya 1·3 mile wide, rose as much as 19 feet in a few days, and that the whole change of level of the Amur was, during the summer, as much as 28 feet. This figure, although much below those which are found for the Amur below its confluence with the Sungari, and exceeded during the inundations of 1872, gives some idea of the mass of water poured on the Pacific slope of the great Siberian plateau during the season of the summer rains.

An interesting relic of the past has just been unearthed in the parish of Pulborough, Sussex, in the shape of a canoe, which was partly embedded under the River Arun, and partly in land on the south side of that river. The boat is of solid oak, and hewn from a single massive trunk. That it was made before the knowledge of metal is evident, as there is not a trace of building or planking. It must have been hollowed by means of the stone axe and of fire. Further evidence in favour of the antiquity of this boat appears to be afforded by the various accumulations which had formed over that portion of it which was embedded in the earth. These strata, to the depth of nine feet, have been ascertained to be loam, yellow clay, a thin layer of leaves, followed by a stratum of blue mud, beneath which lay the boat embedded in drift sand. The prow portion of the boat lay in the river, and this is by far the most dilapidated. The stern is comparatively intact. The present dimensions of the boat are fifteen feet by four feet; but originally it was probably eighteen feet long.

On Monday, September 24, about 9 p.m., a remarkable phenomenon occurred at Käringön, in the province of Bohus, Sweden. During a perfect calm a violent whirlwind suddenly arose from the south-east, carrying with it a quantity of sand, earth, and straw, when suddenly a bright light lit up every object and made the night as clear as day. This was caused by a magnificent meteor, egg-shaped in form, which appeared in the zenith, and which at first seemed to consist of myriads of large sparks, gradually changing into a star shining with a blinding lustre, and which burst, with all the colours of the rainbow, in the north-west, four to five metres above the horizon. When the meteor had disappeared the wind suddenly fell, and it was again perfectly calm. The phenomenon lasted about sixty seconds. The wind had throughout the day been south and very slight.

Dr. Meyer asks us to state that in our note on his paper on jadeite the name *Montevideo* should be *Monteviso*, and he thinks it better, to avoid misunderstanding, to use *jadeite* instead of *jade*. Moreover, the material from Monteviso is only doubtfully jadeite. At Suckow, Uckermark, only one piece was found, but this is the fourth "in North Germany." "At the same time," Dr. Meyer writes, "I take the liberty of drawing the attention of your readers to Prof. Arzruni's recently-published paper on the jade question in the Berlin *Zeitschrift für Ethnologie*, pp. 163-190. The mineralogist of Breslau comes to the same conclusion as myself, *i.e.* that the raw materials were *not* imported from Asia; and the chief reason upon which he relies is that he found the nephrite and jadeite varieties from the different localities to possess *typical* microscopical differences. This alone would suffice to put aside the importation hypothesis. I discovered last September in Graz, Styria, a boulder of nephrite from the alluvium of the river Mur, and shall soon send you a separate copy of the paper which I am about to publish on the same."

A Palæolithic implement of large size was found a week or two ago by Mr. G. F. Lawrence, of 49, Beech Street, in gravel excavated in the Clerkenwell Road, near the Sessions House. The implement weighs 1 lb. 3 oz., and is slightly larger than the historical implement found near Gray's Inn Lane at the close of the seventeenth century, and now in the British Museum.

A sharp shock of earthquake was felt at Bermuda on October 20, but no damage was done. A shock was felt at Tashkend at twenty minutes past two on the morning of the 27th, accompanied by loud subterranean rumblings. A despatch from Smyrna dated October 28 reports that the wall surrounding the town, the Aqueduct, and the Hadji Hussein Mosque have been damaged by an earthquake. The minaret and dome of the Hadji Ali Mosque at Capan Vourla have also been injured. At the last-named town one hundred and sixty-nine persons have been seriously, and sixty-one slightly, hurt. Seventy-nine wounded people are in the hospitals.

A Roman city has been discovered in Tunis by Lieut. Massenat, who lately accomplished a scientific mission in the vicinity of Bograra (Gulf of Gabes). This city is said to be located in the southern part of Djerba. The circuit of the ruins is about three kilometres.

An extraordinary case of subsidence has been observed in the vicinity of Bone. The Naïba, an isolated mountain of 800 metres altitude, is gradually descending into the bosom of the earth. A deep excavation has been made all round, encircling the whole ingulfed mass.

With reference to our notice of "The Fishes of Great Britain and Ireland," last week (p. 611), Mr. Day wishes us to state that the work will be in two volumes, and that the parts published reach to p. 176 of the second volume.

The additions to the Zoological Society's Gardens during the past week include a Striped Hyæna (*Hyæna striata*) from Morocco, presented by Mr. Ernest H. Marquis; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mrs. M. J. Mitchison; a Black Rat (*Mus rattus*), British, presented by Mr. Camp; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. S. J. W. Colman; a Kestrel (*Tinnunculus alau-*

darius), British, presented by Mr. T. E. Gunn; two Pintails (*Dafila acuta*), two Wigeons (*Mareca penelope*), European, presented by Mr. Charles E. Boultbee; a Margined Tortoise (*Testudo marginata*) from the Ionian Isles, presented by Miss Mansell; a Purple-faced Monkey (*Semnopithecus leucoprymnus* ♀) from Ceylon, a Pinche Monkey (*Midas œdipus*) from Brazil, two Common Marmosets (*Hapale jacchus*) from South-East Brazil, deposited; a Chimpanzee (*Anthropopithecus troglodytes* ♂), a Chimpanzee (*Anthropopithecus calvus*? ♀) from West Africa, a Chipping Squirrel (*Tamias striata*) from North America, two Bramblings (*Fringilla montifringilla*), European, purchased; two Simon's Dwarf Jerboas (*Dipodillus simoni*) from Arabia, received in exchange; six Long-nosed Vipers (*Vipera ammodytes*), born in the Gardens.

BIOLOGICAL NOTES

OBSERVATIONS ON THE EMBRYOLOGY OF THE TELEOSTS, by J. S. Kingsley and H. W. Conn. The observations were made during the summers of 1881 and 1882 at the Summer Laboratory of the Boston Society of Natural History at Annisquam, Mass., on the egg development of *Ctenolabrus cœruleus*. The eggs were obtained by surface skimming, and were usually equally abundant during the day and in the evening, and as a rule were more so on the flow than on the ebb of the tide. Half an hour's skimming would produce on an average 150 eggs. These eggs all floated at or near the surface of the water, and presented a marked contrast to those of either an Elasmobranch, Batrachian, Reptile, or Bird, in that the germinative portion is invariably downward or on the lower surface of the egg, while the deutoplasm is uppermost. The stages observed were: the maturation of the ovum, the phenomena of segmentation until the formation of the germ layers, the formation of the three primary layers, the segmentation cavity, the invagination of the hypoblast, and the appearance of nuclei in the intermediary layer of Van Bambeke, the formation of the notochord and neural cords, the former arising from the hypoblast at first as a longitudinal median thickening of that layer, and subsequently becoming segmented off and taking its place among the mesoblastic tissues, the development of the optic bulbs and protovertebræ.

EMBRYOLOGICAL MONOGRAPHS.—Under this title Prof. Alexander Agassiz proposes to issue a series of selections from embryological monographs, so as to give the student in an easily accessible form a more or less complete iconography of the embryology of each important group of the animal kingdom. It is not intended that these monographs should be handbooks to the subject, but rather act as atlases to accompany any general work on the subject. The plates will be issued in parts, each part covering a somewhat limited field, and occasional appendices may be published to prevent the plates from becoming antiquated. The illustrations will be accompanied by carefully prepared explanations, and by a bibliography of the subject in octavo. This work, planned out in 1873, has only now been matured. The first part is on the embryology of Crustacea, with fourteen plates, edited by Walter Faxon. The figures on these plates are taken from all the most reliable sources, and an important volume of bibliography accompanies the atlas. The parts devoted to Echinoderms, Acalephs, and Polyps are well advanced, and it is intended to figure the phenomena connected with fecundation and maturation and the history of the formation of the embryonic layers in a separate part, without regard to the systematic zoological connection of the observations.

CERATODUS FORSTERI.—Mr. Morton got twelve specimens of this fish in the Mary River, Queensland, one only in a net; all the others were trapped by the blacks by being forced through a narrow passage in the river formed by a kind of brushwood. He noticed a curious circumstance as regards their habits. At the time of his visit a number of Eucalyptus trees were in full flower by the banks of the river, and as the blossoms dropped into the water they were eagerly seized and swallowed by these fish. The stomachs of each of the specimens captured were literally crammed with these flowers. An old resident told Mr. Morton that during June to August these fish go in pairs, that they make slight indentations in the muddy bottom in from six to ten feet of water, in which the spawn is deposited, that the male and female fish remain near the spawn, and are not then easily disturbed, that they frequent the same place every year, and that the spawn is frog-like. He had taken it and hatched it in a tub of water keeping the young alive for some weeks. (W. Macleay in *Proc. Lin. Soc. New South Wales*, vol. viii. part 2, July 17, 1883).

GLYCOGEN was lately found by M. Errera in fungi of the order Ascomycetes (before, it had only been observed in the animal kingdom and in Myxomycetes, organisms which naturalists have placed, sometimes among animals, sometimes among plants). Continuing his researches, he now finds the substance (*Bull. Belg. Acad.*, No. 11, 1882), not only in Ascomycetes, but in many Mucorineæ, such as *Phycomyces nitens*, *Mucor mucedo*, and *stolonifer*, *Pilobolus crystallinus*, *Chætocladium Jonesii*, *Piptocephalis Freseniana*, *Syncephalis nodosa*. He has specially studied *Phycomyces nitens*, the large size of which is an advantage. In it the glycogen does not occur in localised masses, as in the *Asci* of Ascomycetes. When the mycelium filaments are young it is distributed throughout the protoplasm; later it is carried to the top of the cell which is destined to give rise to the sporangium. Its quantity does not diminish notably during formation of the sporangium, so it does not seem to have a preponderant *rôle* in growth of the membrane. It is found in the spores, and probably another portion serves for respiratory combustion; the rest may be utilised for growth of membranes of the sporangium-filament and the spores. Having got 40 grammes of dried *Phycomyces*, M. Errera extracted glycogen with all its reactions, confirming the results of micro-chemical analysis.

MARINE ZOOLOGICAL LABORATORIES[1]

[THE following communication has been forwarded to us by an eminent biologist, with the request that it be reproduced in our pages]:—

Nearly all the European States except England have on their sea-coast marine zoological laboratories; it may therefore, especially in view of the recent proposals of Prof. Lankester, and the manifesto of biologists which has followed it, perhaps be interesting to your readers to peruse the following description of these laboratories; they will then be able to appreciate their utility, indeed absolute necessity, in order to study or pursue investigations in certain branches of science.

These seaside laboratories, or *stations zoologiques maritimes*, have nearly all been founded by zoologists for the purpose of advancing zoological science. Fortunately they also help both students and scientists in other branches of science than that of zoology, the one to arrive at a proficiency of knowledge, the other to carry out interesting and valuable researches which, but for this brotherly help, would be impossible. The countless species of marine animals attract physiologists, histologists, and comparative anatomists to work in a field which may reveal facts hitherto undiscovered in that more limited area which is included in the study of terrestrial and fresh-water animals.

The success of these laboratories is doubtless increased by the fact that they are always in a healthy locality on a bracing seashore, so as to allow a realisation of the apparently anomalous combination of work and rest. The scientist, worn out by fatiguing researches made in town laboratories, finds fresh elements of health and a fresh field for research by passing three or four months at a seaside laboratory.

The first of this class of laboratory is the one founded at Naples by Herr Dohrn, a private enterprise almost exclusively German, which nevertheless has received substantial aid from the city of Naples, and some years hence will become the town property.

In order to work in the Naples laboratory a heavy fee is exacted. Nearly all the tables are retained yearly by different universities or scientific societies; the British Association has two tables. The revenue is greatly increased by the fees of admission to an aquarium of marine animals.

This laboratory is admirably organised; there is an agreement between the authorities and the fishermen that the latter shall take to the laboratory all rare animals that they may chance to find; likewise there is every necessary arrangement for dredging excursions and for diving into the depths of the sea to find such animals as are required for study. There are several sailing boats and a steamboat belonging to the laboratory, which is also

[1] From the *British Medical Journal*, October 13, "Special Correspondence, Paris."

well provided with diving dresses. The animals are kept in a large tank, which is large enough for specimens of considerable dimensions.

France, apart from the laboratory of the Science Faculty at Marseilles, which has an aquarium and a boat, possesses five seaside laboratories. They are distributed as follows: one at Villefranche, superintended by M. Barrois; one at Banyuls, near Port Vendres, superintended by M. Lacaze Duthiers; another at Concarnean, on the south coast of Brittany, superintended by MM. Robin and Pouchet; another at Roscoff, on the north coast of Brittany, superintended by M. Lacaze Duthiers; and one at Havre, superintended by M. Paul Bert. Besides these principal establishments, there are two or three others, such as those of Arcachon and Lucques, which have been founded either by provincial scientific societies, or by professors who have received some slight aid from the corporations of the towns where these laboratories are established; but these laboratories possess neither special tenants, boats, nor sailors, therefore they are only of use to their founders and a limited number of pupils.

The laboratories of Villefranche, Roscoff, Concarnean, Banyuls, and Havre are founded and kept up by the French Government; in some cases the corporations have given money or granted land. The laboratories of Concarneau and Roscoff present two varieties widely different.

The laboratory at Concarneau is situated at the entrance to the port; it was founded by Coste, the well-known embryologist, who wished to study the different conditions attending the reproduction of marine animals. The building consists of two stories: the ground floor is used for the aquariums, three in number; on the first floor are the workrooms. The rocks facing the laboratory have been utilised, and are transformed into eight basins or reservoirs of water, each from 300 to 1200 feet square, and from 15 to 20 feet deep. The aquariums are filled with water by means of a pump set in motion by the wind. There is only one boat belonging to this laboratory, but the French Government always place a war sloop at the disposal of its director; this summer some of the laboratory workers wanted to dredge a long way out at sea, and the Government lent them a despatch-boat. The coast abounds in marine animals, but is poorer in invertebrates than that of Roscoff; it is more especially a coast for sardine fishing. The surrounding scenery is lovely.

Roscoff perhaps offers greater advantages, though fewer attractions. Cabbage-fields and tracts of land devoted to the cultivation of artichokes, though a proof of the mild and delightful climate of this little seaport, are by no means an acceptable substitute for the beautiful scenery of Concarneau, but the treasures of the sea here, more abundant than on the coast of Concarneau, or indeed on any other part of the whole French coast, are ample consolation to the crowd of workers who annually avail themselves of the facilities for studying and carrying out researches which the Roscoff laboratory, founded by M. Lacaze Duthiers, affords them free of cost.

The coast of Roscoff offers peculiar advantages for a seaside laboratory, or, in French terminology, *station zoologique maritime*. The numerous boulders of granite serve as places of shelter for the neighbouring marine animals. It also presents a vast expanse of sand sea-shore and a large bay of slime, thus all the different kinds of marine animals are within reach.

Notwithstanding these remarkable qualifications which M. Lacaze Duthiers quickly detected, he had considerable difficulty to get a footing for his laboratory. It now consists of a large house bought by Government, to which has been recently added the village schoolhouse (*École Communale*), abandoned, since education has become compulsory, for another affording increased accommodation. A third house, opposite to the one bought by Government, is hired for the convenience of the laboratory workers. It must be remembered that Roscoff is only a little fishing village, and it is often difficult to find a room during the summer season, therefore M. Lacaze Duthiers offers a bedroom to all who work in his laboratory.

There are two sailors belonging to the laboratory; and one of the attendants from the Sorbonne laboratory is on duty at Roscoff during the summer months. The garden of the laboratory reaches down to the sea. A large reservoir, measuring 4200 feet, has been constructed, where are kept marine animals, either at liberty or in cases. On a small island opposite the laboratory there is a "bed" where animals of sedentary habits are kept almost at liberty.

The laboratory has three sailing boats adapted for taking excursions among the rocks and on the neighbouring shores, also for dredging either with the usual drag, oyster-drag, or with a coral-fishing apparatus. The fishermen also take a considerable quantity of marine animals to the laboratory.

This Roscoff *station zoologique maritime*, which M. Lacaze Duthiers had so much trouble to found, is now in its fifteenth year. The French Government by degrees added to its local habitation, which, if even at the present time not perfect, is nevertheless of immeasurable utility to scientific workers, and therefore contributes to the progress of science.

The Roscoff laboratory is perhaps more frequented than any other, and is an enduring testimony to the patience and laudable determination of its founder and director. The expenses are defrayed from the fund annually voted by the French Parliament for public instruction. Here, as in all establishments in France for higher education, no fees are paid; but this success was hardly won; the necessary sum was with difficulty wrung from the Government, and the local authorities, notwithstanding the evident advantages such an establishment brings to the village, were equally tardy to grant the concessions eventually obtained, unlike those of Banyuls, who conceded a building site, also a yearly revenue, and subsequently presented the laboratory with a boat.

The most recently organised seaside laboratory is at Havre; the building it occupies was formerly a public aquarium, which the corporation handed over to M. Paul Bert. It is supported from Government and corporation funds, and is more especially destined to facilitate physiological research. Doubtless, when the arrangements now in course of completion are perfected, they will offer all the requirements for studying this branch of science, a qualification evidently all but absent in laboratories founded by zoologists.

It must be admitted that all these seaside laboratories, or *stations zoologiques maritimes*, taken both separately and in the aggregate, render important service to biologists of all nations. Every year there is a large percentage of foreigners among the workers, the English element bearing always the largest proportion, a proof that our countrymen fail to appreciate their good fortune in possessing a more extensive sea-coast than that of any other country, or they would be able to offer this useful form of hospitality as well as seek it. Nevertheless, considering the scanty encouragement given by the public and the English Government to biological science, it is to be feared that many years will pass by before *stations zoologiques maritimes* exist on the English coast.

The only similar laboratory in Holland belongs to the Universities of Utrecht and Leyden. The Dutch coast is not rich enough in marine animals to suggest the advisability of establishing many zoological laboratories, therefore a movable or migratory laboratory has been organised, which consists of a wooden house, easily taken down and put up again; there are three rooms in it, a large workroom, and two smaller ones used for the aquarium and fishing apparatus. At the beginning of every summer it is set up on the coast on a piece of land hired for the purpose, or more frequently lent by the nearest village; thus the Dutch scientists visit the entire coast, study its marine animals, and even that of their neighbours. Russia has a laboratory on the Black Sea, and Austria possesses one at Trieste.

In connection with the above communication, we may state that Mr. Romanes writes to Tuesday's *Times* forcibly pointing out the need of a thoroughly equipped zoological station on the British coast, and its value both to science and to our fisheries. Referring to the recent manifesto, so influentially signed, printed in our columns, Mr. Romanes hopes the executive committee will see their way to adopting its suggestions.

THE ASSOCIATION OF GERMAN NATURALISTS AND PHYSICIANS

THE fifty-sixth annual meeting of this flourishing association was held this year in the city of Freiburg, Baden, under the presidency of Dr. A. Claus. The proceedings opened with an informal gathering in the Concert Hall on Monday, September 17, and concluded on the following Saturday with an excursion to the romantic watering-place of Badenweiler. During the four intervening days the several Mathematical, Physical, Biological, and Medical Sections met regularly in the old University, the High School, Gymnasium, Chemical Laboratory, and other local institutes. All were fairly well attended, and amongst the distinguished savants present mention may be made of Professors Stickelberger, Fischer, Hildebrand, Weismann, Maier, Drs. Hack, Nicolai, Lehmann, and Thiry. As many as 120 papers and monographs in nearly all branches of science were either read or submitted to the Association, and summaries of most of them inserted in the official journal (*Tageblatt*) of the proceedings. Of this journal four numbers altogether were issued, and their varied contents convey a tolerably accurate idea of the immense amount of work got through during the four days devoted to the special objects of the Association.

In his inaugural address the President dwelt mainly on the vast changes that had taken place in the social and political relations of Germany, and on the great progress made in all departments of human knowledge since 1838, the last year that the Association had met in the city of Freiburg. The five sections, which at that time were found sufficient for its purposes, had developed into twenty-four distinct divisions corresponding to the present conditions of science, and many of these already formed special branches of themselves, with their own independent gatherings and separate organisations. With the progress of discovery in the natural sciences this tendency to constant subdivision of labour became inevitable, and the great encyclopædic minds of former times would henceforth be replaced by specialists compelled to devote all their energies to the cultivation of one or two minor sections of particular physical or biological categories.

A discussion followed on the selection of next year's place of meeting, which was ultimately decided in favour of Magdeburg.

In the Chemical Section, Dr. Frank of Charlottenburg read a paper on siliceous sinter and on its application to chemical and medical purposes. This substance, composed of the remains of microscopical organisms, and entering into the composition of extremely porous siliceous masses, combines the properties of asbestos with those of lightness in the highest degree. It is thus capable of absorbing moisture to the extent of 94 per cent. of its own volume, and may be used without any risk as a disinfectant and for draining damp places.

In the Zoological Department, Dr. Gräff of Aschaffenburg described the results of his investigations of some new species of Myzostoma, completely confirming his former views regarding the relationship of the Myzostomidæ to the Tardigrade family. He explained the reproductive processes of the Myzostomæ, and the form of their cysts, and reported the discovery of these cysts on fossil crinoids. He also gave an account of the germs of *Volvox viridis* in filtered water exceptionally developed from colourless individuals. Dr. Döderlein described some fossil sponges from Japan of highly intricate structure, but all developed originally from simple Radiate types. They were related to Tetractinellidæ, and more particularly with Pachastrella.

The journal for Friday, September 21, is largely occupied with an extremely interesting monograph by Prof. Hertwig of Jena on "Symbiosis in the Animal Kingdom." This term symbiosis, first suggested by De Barry in connection with certain phenomena of the vegetable world, is here extended to the whole organic system. As distinguished from ordinary parasitism, it is explained to mean the normal fellowship or association of dissimilar organisms, which dwell together in a common abode for their mutual welfare. In the case of parasites the connection is altogether one-sided, one of the two organisms attaching itself to the other, and flourishing at its expense, as, for instance, the mistletoe on the apple-tree. But in this newly revealed phenomenon of symbiosis, which appears to pervade the whole biological world, both associates are mutually beneficial, and in some instances even indispensable to each other. They act, so to say, like two partners in a well-regulated business concern, cooperating in the work of life, taking part in all its toils and troubles, and honourably sharing the common profits. An illustration is drawn from the familiar hermit crab, one species of which, after taking possession of the first available empty shell, goes into partnership with a sea-anemone (*Adamsia palliata*). This lovely creature, bright orange spotted with red, attaches itself to the roof of the common abode in such a position that its mouth and prehensile apparatus are always turned towards the head of its associate. It is thus enabled to join in all the expeditions of the restless hermit crab, and conveniently share in the common plunder. In return for this service the anemone protects its companion from his many enemies by means of the numerous long threads which it shoots out at the least alarm, and which are provided with millions of capsules charged with a stinging acid like that of the common nettle. So close is the compact entered into by the two partners, that both have become indispensable to each other, as appears from a series of experiments made at the Neapolitan Aquarium. If the crab be removed from his house, and this be stopped up, so as to prevent his reentering it, he will cast about for another shell, and never stop until his old associate is also transferred to their new abode. A still more remarkable illustration is drawn from the *imbauba*, or candle-nut tree, of South America, which strikes up an alliance with a species of small black ant to their mutual benefit. The whole subject of symbiosis, which naturalists are only beginning to study, is calculated to throw great light on the Darwinian theory of biological evolution. The various cases of fellowship between animals and plants of different orders, and even between members of the animal and vegetable kingdoms show how, in the perpetual struggle for existence, the individual organism avails itself of the smallest advantage to secure a place in the household of nature. It often thus acquires marvellous habits of life, which it is afterwards unable to lay aside, and in consequence of which it becomes gradually modified in its bodily form and organisation. Thus *abyssus abyssum invocat*, one change superinduces another, altered conditions require fresh combinations, and the organic world resolves itself into an everlasting ebb and flow of life, in which the individual counts for nothing, the species—itself transitory—for but little, and the sum of existence alone is considered in the self-adjusting scheme of the universe. Symbiosis thus leads at once to a broader and more searching study of various branches of human knowledge. To prosecute the subject successfully vegetable and animal organisms must be examined, normal and morbid conditions attended to, anatomical and physiological questions investigated. For this boundless theme belongs to a border land, in which zoology, botany, anatomy, physiology, and pathology meet as on common ground.

In the Physical Section the subject of the pyroelectricity of crystals was discussed by Prof. A. Kundt of Strasburg, who explained his recently-published method for the observation and investigation of this phenomenon.

In the Mineralogical Department papers were submitted by Dr. Petzholdt of Freiburg, on the formation of coal; by Dr. Dölter of Graz, on his attempts to produce artificial gems, in which he pointed out that the mineralogical composition does not depend directly on the chemical alone; by Dr. Kloos of Karlsruhe, on the change of labrador to an albite and a zeolitic mineral. Dr. Fischer of Freiburg dealt with the question of the natural presence of nephrite, jade, and chloromelanite in various parts of the Old and New Worlds, and the great importance of these minerals in connection with prehistoric remains and early migrations. Special reference was made to the work recently published by Dr. A. B. Meyer, of Dresden, "On Jade and Nephrite Objects," and in the discussion that ensued none of the members present subscribed to the views advocated in that work.

In a paper "On the Higher Cryptogams" Prof. Michaelis bases an objection to Darwinism as a scientific hypothesis on the grounds first that the accepted theory of the fertilising process, especially in the case of the heterospores, rhizocarps, and dichotoms, rests on pure analogy, without any actual demonstration, and secondly, that in the mosses the sexual origin of the sporogonium from the mother plant shows a fresh formation of a totally distinct organism out of that previously existing. Nature thus yields an unanswerable argument against the Darwinian assumption, inasmuch as here the second individual is dependent, and under no circumstances capable of a separate existence.

Prof. Nüsslin of Karlsruhe described a new protozoon from Lake Herrenwies, Baden, the *Zonomyxa violacea*, holding a middle place between the Pelomyxa and Amphizonella of Greeff.

In the Geographical and Ethnological Sections, which were on the whole rather poorly represented, Dr. Passevant-Basel gave an account of his residence in the Cameroons, West Coast of Africa, during the months of February to June, 1883. A paper was read by the same naturalist on the African races, with special reference to the unity or diversity of the negro type. The author agrees with those anthropologists who subdivide the Negroes into several stock races, basing his conclusions on a comparative study of the hand and skull.

Prof. Doelter, of Graz, discussed the hypothesis of a vanished Atlantis, and the former possible connection of Africa and

America. From a careful study of the geological conformation of the north-west coast of Africa, of the Cape Verde, Canary, and Azore Archipelagos, he considers that a union of the two continents in remote epochs is scarcely conceivable. On the other hand, the former existence of a large island, comprising the Canaries, Azores, and Cape Verde group, may be regarded as not improbable. But whether this island was at any time itself connected with the African mainland is a question which cannot be decided without further investigation of the local conditions.

LOCAL SCIENCE SOCIETIES AND THE MINOR PREHISTORIC REMAINS OF BRITAIN[1]

IN the annual address which I had the pleasure of delivering to the Essex Field Club at the beginning of this year I ventured to put forward a suggestion which I will take the present opportunity of enlarging upon in the presence of this gathering of the representatives of so many of the local societies of this country.

Of the various branches of natural science cultivated by our respective societies perhaps no subject possesses so widespread an interest as the early history of man. It is only in recent times that materials have been gathered with anything like scientific method from the fragmentary records of the past. By the methods of modern research these materials have been coordinated into that imperfect sketch of the physical characters and mode of life of the early inhabitants of this and other countries which constitutes our present knowledge of prehistoric archæology. But vast as have been the strides in this department of knowledge within the last quarter-century, it is certain that even now we are only on the threshold of a dim region into which advance is becoming more and more difficult with the increasing scantiness of the evidence the further we penetrate backwards into the history of our race. The labours of cave-hunters and searchers into our ancient river gravels—the excavators of our earthworks and tumuli have garnered a rich harvest of facts upon which is based the existing knowledge of ancient man. The old method of solving problems in prehistoric archæology by attaching a tradition to any ancient monument of which the history was unknown has been weighed in the balance and found wanting. The erudite verbiage of the old-school antiquarian has been displaced by the shovel and pick of the modern investigator.

While the spirit of scientific inquiry is thus gradually enabling us to reconstruct some few chapters of the past history of man from such remains as have been preserved to us, the extreme importance of the relics themselves is as a natural consequence becoming more and more recognised. It must have been with the greatest satisfaction that anthropologists heard that the ancient monuments of this country, thanks to the foresight of Sir John Lubbock, were to receive Government protection. For years past the destruction of the most venerable relics has been going on, partly through local ignorance of their value, partly through wilfulness, and partly through the unavoidable clearance of ground for building and agricultural purposes. But although the larger and better-known remains are now secured from demolition, there are numerous smaller and less-known relics scattered over the country, which in the course of time are doomed to destruction by the advancing tide of civilisation. As may be seen on reference to good topographical works, the irreparable losses which anthropological science has already incurred in this way are enormous. The most deplorable feature in these cases of destruction is that they have occurred without adequate scientific supervision, and any evidence that might have been gathered by competent watchers has been for ever lost.

The systematic exploration of earthworks, barrows, tumuli, &c., by the method of excavation is necessarily expensive work, and it is to me a matter of some surprise that the munificent example set by men like General Pitt-Rivers and Canon Greenwell has not been more widely followed by those who, with the knowledge of this difficulty, have it within their means to promote this branch of research. As in the case of one of the societies which I have the honour of representing (the Essex Field Club), which at the instigation of General Pitt-Rivers undertook the investigation of the ancient earthworks in Epping Forest, good work can sometimes be done by a local society by raising a fund for the purpose of exploring such remains in its own district, and this leads me to the immediate object of the present paper.

In attempting to draw up any suggestions for the guidance of local societies, the great difficulty appears to be the impossibility of finding any subjects for research of a sufficiently general scope to be open to all societies. The subjects already proposed by the committee appointed last year by the conference of delegates are, as you are aware: (1) underground waters, (2) erratic blocks, (3) underground temperature, (4) rainfall, (5) periodical natural phenomena, (6) injurious insects. To these I am now about to suggest the addition of another subject, viz. (7) prehistoric remains. Here, as it seems to me, there is a useful field for cooperation among the societies of all counties. Thanks to the increasing interest in scientific matters now making itself felt throughout the country, there is perhaps no corner of Britain which does not or could not be made to fall into the province of some local society or field club. In view of the imminent destruction of many of the minor remains on the one hand, and the scheduling of the larger remains for State protection on the other hand, I believe that occupation of the greatest scientific importance exists for all local societies.

The time has perhaps not yet arrived for laying down any rigid system for dealing with the proposed subject, and I therefore think it advisable at present to confine myself to a few general observations respecting the nature of the work which it is desirable that local societies should take in hand. It must be understood that these remarks are limited to prehistoric archæology, as the remains belonging to the historical period are generally dealt with by archæological societies, and do not come within the range of science subjects admitted by the British Association.

Assuming then that all societies have prehistoric remains of some kind within their districts, the first and most essential thing to be done is to draw up catalogues of these relics, giving their position, external form and structure, and bibliographical references. If the societies of each county would undertake this task, arranging matters so that no relic, however apparently insignificant, escaped their vigilance, we should thus in time come to possess a complete catalogue of all the ancient remains of Britain, and at the same time we should gradually get together a most valuable collection of literary references. The bibliography is essential, because so many of our ancient remains have from time to time been investigated and the results buried in some obscure archæological paper, the disinterment of which is in itself a piece of antiquarian research. A catalogue such as the one now proposed would thus serve many useful purposes. We should have an index-guide indicating precisely where prehistoric remains exist at the present time, and further whether they had ever been systematically explored, and if so with what results. At the same time, attention would be directed to many relics which the local society and the Government inspector might deem worthy of being scheduled for State protection. By this means I am disposed to believe that the operation of the Ancient Monuments Bill would be considerably accelerated, and its effectiveness thereby increased.

It will be as yet premature to suggest any general form in which the proposed catalogue should be cast. Each society would no doubt at first work upon a plan of its own. But whatever form be adopted it is advisable that publicity should be given to the results in the Transactions or Proceedings of the respective societies, as the purely local interest in the work would be thus greatly enhanced, and the working up of the whole into one compendious catalogue might possibly be done later by a committee of the British Association composed partly of delegates from local corresponding societies, and partly of other eminent authorities in prehistoric archæology whose assistance and advice it would be most desirable to secure.

If the scheme now broached should be deemed worthy of consideration by your respective societies, it would be essential, in order to carry out the work effectively, to appoint from your councils and members ancient monument committees, whose function it would be to draw up the proposed catalogue, visiting the remains to be entered in all cases where possible, and exhausting the topographical literature in order to avoid including any fictitious remains. Where no literary references are to be found, and in cases where doubtful structures exist, it would be

[1] A paper read at the Conference of Delegates from Local Societies and before the Anthropological Section of the British Association at Southport, by Raphael Meldola, F.R.A.S., &c., Delegate of the Essex Field Club and the Braintree and Bocking Natural History Society. Communicated by the Author.

all the more advisable to enter these in the catalogue, with appropriate remarks, so that systematic explorations might be made when the opportunity presented itself for raising a fund for the purpose. Even when local histories or traditions are decided respecting the age of any earthwork or other ancient structure, but little credence can be attached to such traditions until actual investigations have been made. As far as my own experience goes, and from information derived from other sources, it would appear that local tradition is the bane of the scientific archæologist. There is, for instance, hardly any prehistoric monument in this country that has not been pronounced Roman by some antiquarian authority, an opinion which not only has often been proved by excavation to be erroneous, but which has also had the pernicious effect of checking further inquiry.

In recommending to your societies the actual investigation of the minor prehistoric remains of your districts as a task well worthy of the attention of any scientific body, it is perhaps not wholly necessary to urge that any excavations attempted should be carried out with the most scrupulous care, and the materials removed restored if possible on the completion of the work, so as to avoid any permanent disfigurement. The so-called "exploration" of many ancient structures whose venerable antiquity should have rendered them sacred has often been conducted in a manner which can only be called an act of desecration. How frequently do we read in local histories such statements as the following:—"On —— Common there formerly stood a large mound of earth supposed to be a tumulus, which was opened by Mr. —— in the year ——, but nothing of any interest was found *except a few fragments of pottery and some decayed bones*"! Such passages as this, which is not a verbatim extract but simply an ideal specimen illustrating the kind of destruction that has been going on, lead to the supposition that the prevailing idea in opening a tumulus is the discovery of hidden treasure. Any other find is considered devoid of interest, and the scientific value of the structure is for ever lost by the scattering of its contents.

The ancient monuments committees of local societies, in addition to the preparation of catalogues and the conduction of explorations, would have another important function to fulfil: they might take upon themselves the duties of vigilance committees, keeping a watchful eye upon the ancient remains in their neighbourhood, and preventing as far as possible their destruction. In the case of minor remains which were not considered worth scheduling for State protection, opportunities would often occur for investigating without incurring the expense of systematic excavation. In the course of building or agricultural operations old ramparts are frequently cleared away in perfect ignorance of their value to the archæologist; or again, a new road has to be made, which in its course passes through the remains of some ancient earthwork now almost obliterated by the hand of time. In such cases the vigilance committee, having previously catalogued the remains threatened, would endeavour to come to some arrangement with the owner of the property, and obtain permission to appoint watchers for the purpose of recording the nature and position of any relics that might be found. The fact that local societies have not in past times been sufficiently alive to the important work which might thus have been done by taking advantage of any unavoidable demolition of prehistoric remains has led to the destruction of a vast amount of material which, under proper supervision, might have furnished facts of lasting importance to anthropological science. It remains with your respective societies to determine whether such ruthless waste of evidence is to be allowed in the future.

OBSERVATIONS ON HEREDITY IN CATS WITH AN ABNORMAL NUMBER OF TOES

DURING the last few years I have had occasional opportunities of studying heredity in various families of cats with an abnormal number of toes, and whose ancestors for some few generations at least, have possessed the same peculiarity. The observations have now been continued over a period long enough to render their publication a matter of interest. I first became acquainted with these cats in the winter of 1878, when staying near Haverfordwest. I made inquiries on seeing one of them for the first time, and ascertained that it had been obtained from Mr. Edward Vaughan, of Fern Hill, Haverfordwest, a relation of the friend with whom I was staying. Shortly afterwards I saw Mr. Vaughan, and had a long talk with him about the peculiarity. At the time I took notes of his experience, and he has since kindly written to give further information. He first became acquainted with two generations of tortoiseshell cats with the normal number of toes (living respectively to the ages of eleven and twenty). Then in the third generation the extra toes appeared (this cat died aged nineteen, and was also a tortoiseshell). This cat or the mother was brought from Bristol to Haverfordwest. The peculiarity was inherited by "Punch"—a cat now living, and fifteen years old last May, also a tortoiseshell—making four generations. "Punch" has six toes on each fore foot, and six on each hind foot, but two of her kittens have had seven on hind and fore feet, and all varieties between the extreme and normal form have occurred commonly. It is a very curious and interesting fact that now in her old age all her kittens have the normal number of toes. Mr. Vaughan is of opinion that the peculiarity is also dying out among "Punch's" descendants, but this is by no means my experience with the branch of the family I have observed. He also gained the impression that the female kittens were more affected with the peculiarity than the males. Mr. Vaughan also made the interesting observation that the peculiarity reappeared in the kittens of a normal female cat (a daughter of "Punch's"), although in smaller proportions.

FIG. 1.—Right fore paw from above, with extra toes.

FIG. 2.—Right fore paw from below, with extra toes.

FIG. 3.—Right fore paw from above, normal.

FIG. 4.—Right fore paw from below, normal.

In the spring of 1879 Mr. Vaughan very kindly sent a female tabby kitten to my home at Reading. This was a daughter of "Punch's," and it possessed six toes on each fore foot and six on each hind, thus rendering the feet very broad and giving them a most remarkable appearance. This cat, although rather wild, was very clever, being easily taught to "shake hands," and catching birds and even fish with surprising ease. When a little over a year old the first family (of four) was born, in the middle of June, 1880.

All the four kittens were tabbies, and I made the following notes of them:—(1) male: fore paws, five toes, but the insignificant innermost toe being absent, the foot appeared broad like the mother's; hind paws, five toes. (2) female: fore paws, five toes, same as (1); hind paws, six toes. (3) and (4) females: normal; five toes on fore paws, four on hind. No. (2) in this list was given to a friend, and will be again referred to. One normal female was also given away, but was soon lost without offspring; the other female was killed. There is nothing in the above list to support the view that the females are more affected than the males with the mother's peculiarity.

The next family of which I have notes was born May 13, 1881. The three kittens were tabbies as before:—(1) male: normal. (2) female: normal. (3) female: six toes on each fore and hind foot, as the mother. Here the only affected kitten is a female.

The next and last family of which I have notes was born August 26, 1881. I received notes of three kittens, but there may have been more:—(1) and (2) females: six toes on each fore and hind foot, as the mother. (3) sex not observed: six toes on all feet, as the mother.

After this I was unable to obtain notes, although many families were born, and a large proportion always possessed the peculiarity. Few people are aware of the immense difficulty in obtaining accurate notes of a simple observation such as this.

The mother was subsequently killed.

I now return to No. (2) of the first family, which was given to a friend on the condition that I received accurate notes of all families. I received *one* such account. This was of a family of four born in June, 1881:—(1) male: normal. (2) female: normal. (3) female: with five toes on the fore paws, six on the hind, same as mother. (4) female: the same as mother, but five toes on the hind feet. Here again the females possess the peculiarity. The mother was also a small, very clever cat, catching birds with the most wonderful ease. There were many families, in each of which quite half possessed the peculiarity, and many of the kittens had the same number of toes as the mother.

At last, about a year ago, a female tabby kitten appeared with *seven* toes on each fore paw, and six on each hind. This was given to me, and is now a small tabby cat, with a tendency

FIG. 5.—Right hind paw from above, with extra toes.

FIG. 6.—Right hind paw from below, with extra toes.

FIG. 7.—Right hind paw from above, normal.

FIG. 8.—Right hind paw from below, normal.

towards tortoiseshell coloration on the back. A rough drawing of the right fore foot, as seen from above and below, is seen in Figs. 1 and 2. Drawings of a normal right fore foot are given in Figs. 3 and 4, for comparison. It is seen that the extra toes are those labelled A and B, and they confer the extraordinary breadth upon the foot. The most recently added is B, which is still partially coalesced with A, and has but one pad in common with it (Fig. 2). This last toe, B, was absent in the cat which I received from Mr. Vaughan. In the first family described, Nos. (1) and (2) possessed the largely developed extra toe, A, while the insignificant pollex (Fig. 1, 1) was absent, and thus the foot appeared extremely broad, although with only the normal number of toes. In walking the pollex does not touch the ground, but the claws A and B come down a little later than the rest of the foot, making a very distinct click when the cat is walking on floorcloth. This sound is particularly audible when the cat is coming down stairs. Comparing the pads on the underside of the foot with those of a normal animal (Figs. 2 and 4), there is seen to be an extra pad behind the additional toes, of which there is no trace in the normal foot. The left foot is similar to that drawn, except that there are traces of more complete fusion between the toes A and B in the slighter tendency towards division shown by their common pad. The right hind foot from above and below is given in Figs. 5 and 6, and a normal hind foot for comparison in Figs. 7 and 8. The correlation of the toes is more difficult here, but there is little doubt that the innermost toe (Figs. 5 and 6, 1) is the hallux, lost in the normal foot.

Comparison with the fore feet renders it likely that the second extra toe is that labelled A in Figs. 5 and 6. On the underside (Fig. 6) all the toes have separate pads, and there is an additional pad behind the extra toes. This, in the left hind foot of the same animal is fused with the pad behind the other toes.

On July 10 last the cat I have just described produced a family of four tabby kittens. Strangely enough, they are all males, but they possess the mother's peculiarity to a remarkable extent.

(1) Forepaws: exactly similar to the mother's, but toes A and B are more distinct, in that they have separate pads in both feet. Hind paws: precisely the same as the mother's, even to the fact that the left hind pads are continuous and the right hind pads slightly discontinuous (as in Fig. 6). Thus this kitten exhibits on the whole an intensification of the characters.

(2) Fore paws: the pads of the toes A and B are fused as with the mother. The claw of B is broken off, but its base is seen almost springing from the outer side of the base of claw A. Both feet the same. Thus the character is rather less developed than in the mother. Hind paws: the large hind pads are continuous on both feet. All the six toes are distinct on both feet, as with the mother, but A and 2 on the left foot are united by skin, although considerable freedom of movement is possible. Here again the character is rather less than in the mother.

(3) Fore paws: pads of A and B are distinct on the right side. The claw of B is accidentally broken off. On the left side the pads are also distinct, although the toes A and B are joined by skin. Hind paws: all six toes distinct on both feet; the large hind pads continuous on both. Thus this kitten is beyond the mother in the separation of the pads of A and B on the fore paws. A and B were more distinct on the right side, where also in the mother the pad showed a greater tendency towards division.

(4) Fore paws: the greater tendency towards separation on the right side was very strongly marked here, inasmuch as the toe B is entirely absent on the left side, and the pad of A simple. On the right B is present, and its pad is joined to that of A, but a little more distinct than with the mother. Hind paws: all six toes distinct and large; hind pads continuous in both feet. Thus the character is, on the whole, less than in the mother.

This is the last observation made up to the present time, and it is a very remarkable one, in the entire absence of anything approaching the normal form, and in the fact that two of the kittens go beyond the mother, while the other two are but little behind. When the two sides differ, the difference is invariably as with the mother. At the same time the immense strength of heredity in all these cases is seen when we remember that it is practically certain that the fathers of the families have always been normal. It is quite certain with this last family, for the mother was brought as a kitten from Reading to Oxford, where there is a normal male cat living in the house with her. I have never heard of cats with the abnormal number of toes in either Reading or Oxford apart from these. Mr. Vaughan says exactly the same for his cats in South Wales. Thus we must conclude that the heredity is entirely through the females, and yet the character has gone on increasing in my branch of the stock in spite of the normal element which we should expect to be introduced and to make itself felt at each stage. I have known of the family through eight generations, and three of these have started from entirely new localities (*i.e.* Haverfordwest from Bristol, Reading from Haverfordwest, Oxford from Reading) to which they were sent as kittens. This is, of course, very important, as it has prevented the possibility of interbreeding between the abnormal cats derived from the same stock.

I hope to contribute a paper to a future number upon further observations, and upon the skeletal peculiarities that accompany the abnormality.

EDWARD B. POULTON

ON THE ELECTRICAL RESISTANCE OF THE HUMAN BODY[1]

THE writer, after premising that hitherto electricity in its application to the human body had not come up to expectations reasonable in the case of so powerful a force, and

[1] Abstract of a paper read before the British Association at Southport, by W. H. Stone, M.A., F.R.C.P.

that it was evidently still in an embryonic state, mentioned some examples of the conflicting and contradictory statements made by different authorities as to its electrical resistance. These varied from 13,000 to 2875 ohms and less. He believed it was enormously overstated, and had for this reason applied himself to make some more accurate determinations. He was at once met by three obstacles:—(1) The difficulty of making good contact through the skin of a living man. (2) The limitation of the amount of current by pain, and by the fact that the rapid opening and closing of strong circuits produced a tetanic state of muscle. (3) The fact that the human body is an easy electrolyte, almost immediately furnishing currents of polarisation.

As regards (1), the axiomatic statement seemed to be that the poles must be infinitely large compared with the current they had to conduct. This condition he had attempted to fulfil in five different ways, two at least of which were successful: either by immersing the feet and hands in baths of brine in contact with an electrode of amalgamated lead or zinc of from fifty to a hundred square inches surface, or by soaking these extremities in brine, and then wrapping a strip of flexible lead two feet long by two inches wide about them, after the fashion of a surgical spiral bandage. The fact that the skin resistance was thus reduced to zero was proved to demonstration by an observation already recorded in NATURE (September 13, p. 463), from which it appeared that the resistance of a corpse, treated with the spiral leaden bandages from foot to foot was 1150 ohms, and with solid silver conductors thrust three inches deep into the plantar muscles was actually 50 ohms more.

Under the heading of contacts it was essential to determine definite anatomical points from which the measurements should start, and which readily admitted of linear verification. Such points existed in the prominence of the ulna at the inner side of the wrist, and the lower edge of the external malleolus at the ankle. The shortest course traversed by the current between these two points had been measured to a quarter of an inch.

There were three principal directions in which determinations had been made:—

1. From hand to hand.
2. From foot to foot.
3. From hand to foot.

No. 1 was much the same as the height of the subject, and was not liable to great variation.

No. 2 varied more, since the difference between very tall and shorter men lies chiefly in the legs.

No. 3 was perhaps the best test of the average conductivity of the body, since looped currents were sure to traverse the whole trunk, and even caused motor disturbance in the extremities not included in the circuit.

Three such observations were given, including one on a man of the exceptional height of nearly 8 feet.

As regards pain, it was noted that the E.M.F. used varied from three to ten bichromate cells of 1·8 volts each. Even the first was occasionally complained of, thus incidentally showing the goodness of the contact obtained. In morbid conditions, such as that termed myxœdema, the E.M.F. of 10 cells or 18 volts through a resistance of only 1260 ohms was easily borne, and indeed hardly felt. The third difficulty, that namely of electrolysis, was the most serious: indeed the particular metal of which the electrodes were made sank into insignificance compared with the rapid and vigorous polarisation of the moist tissues of the body itself. A rotating commutator on Wheatstone's plan, and afterwards a metronomic instrument, by which the periods of alternation could be varied, were first used, but with only partial success. A more delicate mode of discharging was found in the use of an ordinary commutator key worked like a piano with the index and middle fingers of the left hand; a double contact key, putting battery and galvanometer successively in circuit, being beneath the right index finger. The left keys being first depressed alternately, the right key produced a double deflection, while the bridge resistance was too low, which was replaced by an opposite double deflection when it was intentionally made too high. By watching the galvanometer a point was easily found where it ceased to "throw," and then three successive contacts in either direction were taken to determine resistance. In spite of all precautions, the second measurement was sometimes a little in excess of the first, owing to a polarisation-current assisting the battery. This, however, never amounted to more than about five ohms, and was easily allowed for. Between each set of observations a short-circuit key, inserted outside the bridge, was closed for at least a minute, so as to discharge patient, bath, and electrodes.

The measurement was then repeated with inverted current, and the mean taken.

One set of examples out of many was read to the meeting. Three men of very different heights were tested according to the following table:—

	Height.	Weight.	Ulna to malleolus	Foot to foot.	Foot to hand.
	ft. in.	st. lb.	ft. in.		
1. Mr. Todd	5 6 ...	7 13 ...	5 9½ ...	945 ...	1320
2. Mr. Shacket	6 3 ...	13 0 ...	7 0 ...	930 ...	1027
3. Hungarian Giant ...	7 8 ...		... 8 7 ...	930 ...	1032·5

Two of these were students at St. Thomas's Hospital; the third an Austrian now exhibiting at the Aquarium, and kindly lent to the writer for examination. All the three were singularly strong, healthy, well-proportioned men, of active athletic habits. An interesting illustration of physiological laws here incidentally cropped out, showing that, in the normal human body considered as a machine, as is the length of the osseous levers so is the sectional area of the motor muscles. This in the present instance results in an almost complete identity of the electrical resistance, increased length being very fairly balanced by increased sectional area in the conductor. A good test of morbid leanness or fatness might probably be founded on this identity.

A few words only were given to the variations of human resistance in disease and with alteration of temperature. The latter have already appeared in the columns of NATURE (on June 14 and September 13).

As regards the former, six cases of hemiplegia were cited: three on the right and three on the left side of the body, in all of which the paralysed was found less resistant than the healthy side, in amounts varying from 120 to 730 ohms. The only case which differed from this rule was that of a worker in copper, from whose secretions three milligrammes of metallic copper had been extracted, where the cupreous impregnation obviously modified the general resistance of the body, as the writer had found it to do in the case of lead and mercury also.

A confirmation of the view already expressed by the writer of the paper, that the human body follows the law of solid rather than that of fluid conductors under changes of temperature, had occurred in the instance first quoted (June 14, p. 151), where the occurrence of dropsical effusion in the lower extremities permanently reduced the resistance from the values originally given, the lowest of which was 2300, to 750 ohms.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

TEN lectures on the diseases of field and garden crops will be delivered by Mr. Worthington G. Smith, F.L.S., before the Institute of Agriculture, British Museum, South Kensington, during the week November 12-17. The lectures will be illustrated with actual examples, and new drawings of all the diseases from nature, uniformly enlarged to 1000 and 5000 diameters.

UNIVERSITY COLLEGE, ABERYSWYTH.—Mr. J. Brill, B.A., St. John's College, Cambridge, has been appointed lecturer to assist the Professor of Mathematics at this college. Mr. Brill was fourth wrangler in January 1882, and, we understand, had the honour of being one of the selected candidates for the Professorship of Mathematics at the University College, Cardiff.

SCIENTIFIC SERIALS

Revue d'Anthropologie (deuxième et troisième fascicules), Paris, 1883.—In the earlier of these two numbers M. Topinard continues the "Elementary Description of the Cerebral Convolutions in Man, in accordance with the Schematic Brain designed by Paul Broca." This is the second of the series of explanatory instructions begun in the January number. It ends with a description of the occipital fissures, peculiar to man, the simiæ, and lemurs, which Broca termed "scissure occipitale interne" and "scissure occipitale externe." In the simiæ the former of these is generally perpendicular, while in man it is often oblique in direction and irregular in position, rendering its determination difficult.—Under the title "*Transformisme*," a term used by French anthropologists for *Darwinism*, M. Mathias Duval gives the substance of his introductory lecture at the Anthropological School at Paris at the opening of the session of 1881–82. The lecturer, after giving a general idea of "transformism," passes in review the services rendered to the modern science of evolution by Darwin's precursors, Lamarck and Etienne Geoffroy Saint-Hilaire. Next he considers the researches and theories of Darwin, the objections which have been made to some of his deductions, and the evidence and facts which can be brought to support his theory, with reference specially to the importance of the labours of Haeckel and other contemporary naturalists, who have contributed to the development of the Darwinian doctrines, while he lastly draws attention to the various applications of these views beyond the sphere of natural science, strictly so called.—In a paper on the Iroquois Indians Dr. Ten Kate has embodied the most important results of his observations on the physical and social condition of the pure redskins and half-breeds whom he has lately visited in the Indian reservation lands to the west of New York State. He found very few among them of pure Indian descent, but some exhibited a certain degree of prognathism, recalling the same characteristic as seen among the Malayan Liplaps. The average height of the men is 1·75 m., with a greater corresponding length of limb than is usual in whites or mulattoes. They are dolichocephalic. The colour of the eyes is reddish-brown, unlike that of any other race, while the complexion of the children is sometimes as light as that of an Italian. The half-breeds only have beards. Their principal illnesses are of a scrofulous character. The Iroquois dialects, which are gradually dying out, have not hitherto been reduced to writing, owing to the numerous anomalous guttural sounds which belong to them.—M. Bérenger-Féraud contributes an interesting paper on marriage among the negroes of Senagambia. As elsewhere among Africans, the parental tie is slight, divorce is common, women are virtual slaves, and marriages are attended with elaborate ceremonials simply as pretexts for amusements and intemperance.—M. Mondière in a review of the different races of Indo-China, supplies us with many interesting details in regard to the ethnological and anthropometrical characteristics of the Tonquins, Cambodians, and Laos, as well as of the less unfamiliar populations of Siam and Burmah.—In the third number of this year's *Revue*, we have the concluding part of Broca's description of the cerebral convolutions and fissures, which deals specially with the frontal lobes.—M. M. Duval continues his lectures on "*Transformisme*," carrying down his analysis of the most important works on the Darwinian theory of evolution to the sociological and psychological views of Herbert Spencer, and the biological researches of Huxley.—Investigations into the nature of several supernumerary muscles in the antero-internal scapulary region, by Dr. L. Testut. After Cruvilhier, who first drew attention to some of these muscles, Knott and Macalister in Ireland, and Gruber in Germany, among others, have pointed out the not infrequent occurrence of these anomalous structures in man, while in the elephant and bear, and in some of the lower quadrumana, a supernumary caraco humeral and brachial are almost always present.—The so-called "*Maye*," or May Queen of Provence, is described by Dr. Bérenger-Férand, who traces back the festival, by which the return of the month of May is celebrated in Southern France to the ancient cult of Maia, the mother of Mercury, among the founders and Greek colonists of Marseilles. In modern times the worship of the Pagan Maia has been transferred to the Virgin Mary, in whose name alms are solicited for the little girl-child, who, veiled, and nearly buried in flowers, is supposed to represent the much venerated "Notre Dame du Mai" of Provence. These Provençal May festivals are thus closely allied to the so-called "floral games," which still survive in Cornwall, and repeat on each 8th day of May some part of the ancient Roman worship of the goddess Flora.—M. Deniker passes in review the results of the travels of M. Miklouho-Maclay on the east coasts of New Guinea, and summarises the information derived from his careful study of the Papuan races of the island, giving at the same time a number of important anthropometric measurements, together with numerous interesting ethnological and social data.

Zeitschrift für wissenschaftliche Zoologie, Band xxxviii. Heft 3, July, 1883, contains: On the embryology of *Planaria polychroa*, by Dr. E. Metschnikoff (plates 15 to 17).—On the Cœlenterata of the Southern Ocean, part 3. On the Nematophores of Plumularidæ, and on urticating cells in the mesoderm (Schirmgallerte) of *Crambessa mosaika*, by Dr. R. von Lendenfeld (plate 18).—On Karyokinesis in some Protozoa, by Dr. A. Gruber (plate 19) (*Actinosphærium eichhornii* and *Amœba princeps*).—Contributions to a knowledge of the development of the Gastropods, by Dr. F. Blochmann (plates 20, 21).—On the glands of the mantle-edge in Aplysia and kindred forms, by Dr. F. Blochmann (plate 22).—Contributions to a knowledge of the Medusæ, by Dr. Otto Hamann (plate 23).—On the cerebrum of birds, by Dr. A. Bumm (plates 24, 25).—On *Girardinus caudimaculatus*, by Dr. Hermann von Ihering (plate 26). An interesting study of this little limnophagus Cyprinoid found in Rio Grande do Sul.—Contribution to technical histology, by Prof. H. Fol.

Heft 4, August, 1883, contains: On the Cœlenterata of the Southern Ocean, part 4. On *Eucopella campanularia*, a new genus belonging to the Campanularidæ, by Dr. R. von Lendenfeld (plates 27 to 32). This memoir consists of a very elaborate and detailed description of both the hydrosome, gonophore, and ova of this new species.—On the egg-shell (*Eihaut*) of *Python bivittatus*, with remarks on some other reptile eggs, and on the genesis of their outer layers, by W. von Nathusius-Königsborn (plates 33, 34).—Researches on some new Medusæ from the Red Sea, by Dr. C. Keller (plates 35 to 37).—On the manner of propagation in *Proteus anguineus*, by Marie von Chauvin (plate 38).

Archives Italiennes de Biologie, tome iii. fasc. ii. May 20, 1883, contains:—On medical instruction in Italy, by Prof. J. Bizzozero.—On the sanitation of the Roman Campagna, by C. Tommasi-Crudeli.—On the therapeutic effect of prolonged tepid baths in pneumonia and typhoid fever, by C. Bozzolo.—On the structure and affinities of the olfactory lobes in the higher Arthropods and the vertebrata, and on a contribution to the histogenesis of the internal molecular layer of the retina, by G. Bellonci.—On organic particles in the air of high regions, by P. Giacosa.—On the action of cotoïne and paracotoïne, by P. Albertoni.—On lung epithelium and its transformations in disease of that organ, by C. Bozzolo and B. Graziadei.—On the comparative anatomy of the skull of the Terramare pig, by Prof. P. Strobel.—On ptomaines, by J. Guareschi and A. Mosso.

Fasc. iii. July 31, 1883, contains:—On the partial regeneration of the liver, by G. Tizzoni and V. Colucci.—On the presence of cystoliths in some Cucurbitaceæ, by O. Penzig (plate).—On the histology of the nervous centres, by C. Golgi (4 plates).—On the action of iodoform in saccharine diabetes, by C. Bozzolo.—On the normal structure and on alteration caused by experiment in the pacinian corpuscles of birds, by Josephine Cattani.—On negro anatomy, by Prof. C. Giacomini: (1) on the cartilage of the semi-lunar fold in the eye; (2) Graafian follicles.—On the development in Salpa, by Prof. F. Todaro.—On some experimental researches as to a new automatic centre in the bulbo-spinal tract, by Dr. J. Fano.—Anthropometric studies of criminals, by Prof. H. Ferri.—On the anatomical merits of Jerome Fabrizi d'Acquapedente, by Prof. G. Romiti.—On the secretion of bile, by Dr. B. Baldi.—On inoculation of leprosy, by R. Campana.

Proceedings of the Isis Natural History Society, Dresden, January to June, 1883.—Obituary notice of Karl Ch. G. Nagel, by H. Engelhardt.—Perceptive faculty of insects and other lower animals, by Prof. B. Vetter.—Fauna of the Suez Canal, by Dr. C. Keller. Up to the present time eleven Mediterranean species have penetrated for the most part as far as Suez, while the Red Sea yields twenty-five species, which, however, have as a rule scarcely yet reached half way towards the northern entrance.—On a case of albinism observed in the Heidelbeer district, by H. Engelhardt.—A comparative study of the flora of the Erzgebirge and Riesengebirge, by Dr. R. Kell.—On the theory of shifting continental and insular climates, with special reference to the vegetable relations of Norway, by Cl. König.—On the so-called "compass plants," by E. Stahl.—On the exploration of the flora of Lapland made by Linné in 1732, by Dr. O. Drude.—On the presence of Anodonta and Planorbis in the Tertiary lignite beds of Schellenken, by Dr. Deichmüller.—On the source of the nephrite found in North Germany, by H. Credner.—On the river valley formations in the Western Erzgebirge, by J. Jacobi.—On the geological formations of Mittweida, with special reference to its flora, by R. Beck.—On a fossil bird from the Bohemian chalk beds, by H. B. Geinitz.—On the presence of copper in the syenite of the Planenscher Grund, Saxony, by F. Zschau.—On the limits of the Dyas and Trias systems, by A. Dittmarsch.—On the relation of the protoarseniate of iron to the iron oxide in the magnetic iron ore of Berggiesshübel, by H. Vater.—On G. Laube's "Traces of Man in the Quaternary Formations of the Prague District," by Dr. Deichmüller.—On the bronze and iron objects found in the clay beds of the Wendish Circle, Lievland, by A. Engelmann.—On H. Schliemann's "Ilios, City and Land of the Trojans," by H. B. Geinitz.—On a prehistoric find on the Hradischt near Stradonitz, by W. Osborne.—On an ancient burial place at Kunzowo, by F. Raspe.—Find of stone axes at Dippoldiswald, by H. Wiechel.—On some new views respecting the mutual relations of biological and chemical research, by D. W. Hentschel.—On Prof. Lindemann's proof that π is not an algebraic quantity, by Dr. Harnack.—On the preparation and application of perspective models in relief, by Dr. Burmester.—On the general theory of the so-called P.E. system, by Prof. Voss.—On the supposed coprolite deposits of Helmstadt, Büddenstedt, and Schleweke, near Harzburg, by Dr. H. B. Geinitz.—Memoir on the diluvial glaciers of North Europe, with special reference to Saxony, by Dr. H. B. Geinitz.—A Gaulish double grave at La George-Maillet, Marne, by D. von Biedermann.—Monograph on the climate of the Glacial epoch, by Heinrich Vater.—The diamond fields of the Cape, by Thaddeus Schrader.

SOCIETIES AND ACADEMIES

London

Mineralogical Society, October 22.—Anniversary Meeting.—W. H. Hudleston, F.G.S., president, in the chair.—The following were elected officers and Council for the coming session:—President, Rev. Prof. Bonney, F.R.S. Vice-Presidents: Rev. S. Haughton, M.D., F.R.S.; W. H. Hudlestone, M.A., F.G.S. Council: G. S. Boulger, F.G.S.; C. O. Trechmann, Ph.D., F.G.S.; Mr. J. Stuart Thomson, Rev. Prof. Wiltshire, F.G.S. (in place of Messrs. Church, Danby, Merry, and Walker). Treasurer, R. P. Greg, F.G.S. General Secretary, R. H. Scott, M.A., F.R.S. Foreign Secretary, C. Le Neve Foster, D.Sc., F.G.S. The Secretary read the Report, which was adopted. The outgoing President delivered a short address, and the chair was taken by Prof. Bonney, when the following papers were read:—J. Stuart Thomson, on crystals of calamine from Wanlockhead.—A. S. Woodward, on the occurrence of Evansite in East Cheshire.—Mr. S. Henson exhibited a magnificent group of crystals of stibnite from Japan.—A vote of thanks to the outgoing president, Mr. Hudleston, concluded the proceedings.

Sydney

Royal Society of New South Wales, September 5.—C. Moore, F.L.S., vice-president, in the chair.—Five new members were elected, and eighty-nine donations received. The following papers were read:—Notes on the genus Macrozamia, with descriptions of some new species, by C. Moore, F.L.S.—A list of double stars, by H. C. Russell, B.A., F.R.A.S.—Some facts connected with irrigation, by H. C. Russell, B.A., F.M.S., &c.—On models for showing crystallographic axes, by Prof. Liversidge, F.R.S.—On the discolouration of white bricks made from certain clays in the neighbourhood of Sydney, by E. H. Rennie, M.A., D.Sc.—Mr. J. K. Hume exhibited a collection of Carboniferous fossils from Cataract Creek near Mount Wellington, Hobart, Tasmania, which were described by C. S. Wilkinson, F.G.S.—Prof. Liversidge exhibited a fossil specimen of an extinct Chelonian reptile (*Notochelys costata*, Owen) from the Flinders River, Queensland, being the first Chelonian found in Australia.

Paris

Academy of Sciences, October 22.—M. Blanchard, president, in the chair.—River navigation; endless chain towing, by M. Dupuy de Lome. The author describes the recent experiment made on the Rhone of a new system of towage, which appears satisfactorily to solve the problem of the economic transport of goods on this most difficult of navigable rivers, and, *a fortiori*, on all streams with a moderate current. The success of the experiments is due to the employment of two endless lateral chains, worked with independent machinery by a single hand, and serving at the same time to steer the vessel.—Note on a formula of Hansen applicable to the celestial mechanism (continued), by M. F. Tisserand.—Disinfection of ornamental plants intended for exportation, by M. Laugier. The successful experiments made in concert with Dr. Kœnig of Asti at the Agronomic Station of Nice in December, 1882, were renewed during the month of September last with most satisfactory results.—Note on some arithmetical theorems, by M. Stieltjes.—On surfaces whose curve is constant, by M. G. Darboux.—On the law regulating the distribution of tension in an elastic plate of arbitrary primitive form encircling a cylinder of any right section, in cases where the friction is uniform, by M. H. Léauté.—On the movement of a rolling weight along an elastic horizontal rod fixed at both ends in cases where the mass of the rod is much smaller than that of the weight, by M. J. Boussinesq. A wider application is here shown of the problem of rolling masses solved by Willis and Stokes, as described in the paper inserted by Stokes in the *Cambridge Phil. Trans.*, vol. viii. 1849.—Observations on a reply of M. Faye touching diverse phenomena of solar spectroscopy (*Comptes Rendus*, October 8, p. 779), by M. L. Thollon.—On the inductive force due to the variation of intensity in the electric current of a flat spiral multiplication, and on the comparison of this force with that exercised at great distances by a spherical solenoid or a solenoidal fictitious sun, by M. Quet.—Note on the determination of the equivalents of copper and zinc by means of their sulphates, by M. H. Baubigny.—On the transformation of hydrocarburets into corresponding aldehydes by means of chlorochromic acid, by M. A. Etard.—Note on the state of the sensitive nerves during the excitement produced by strychnine, by M. Couty.—On two cases of peripheric nervo tabes (ataxy of the lower members, combined with absolute integrity of the posterior roots, of the spinal ganglia and spinal marrow), by M. J. Dejerine.—On the secreting epithelium of the kidney of Batrachians (triton and axolotl), by M. J. Bouillot.—On the extent and age of the dioritic formations of Corsica, by M. Dieulafait. Instead of occupying a deep continuous vertical range, as hitherto supposed, the author shows that the Corsican diorites belong to three distinct systems—granites at San Luccia di Tollano and Ajaccio, ophiolithic or serpentine rocks of the Triassic and Permian formations at Bastia and elsewhere. With these last are exclusively associated the numerous sulphuretted metalliferous ores occurring in the island.—A discussion of the causes to which is due the movement of glaciers, by Mr. Walter R. Browne. This movement is here attributed rather to atmospheric causes (pressure and temperature) than to gravitation.—Observations on an earthquake felt at Ghadames (Algeria) towards the end of last August, by M. Duveyrier.

CONTENTS

THURSDAY, NOVEMBER 8, 1883

A BUSHEL OF CORN

A Bushel of Corn. By A. Stephen Wilson. (Edinburgh: David Douglas, 1883.)

THIS little book is full of originality and force. It appeals it is true to a class, but a large class. The title is happy and suggestive, and is a sufficient text for every paragraph between the covers. It is true the subject is not exhausted, for much more might doubtless be said concerning "a bushel of corn."

But it is with a *bushel* of corn that Mr. Wilson deals. He introduces us to the bushel as an absolute measure of volume, traces its origin, mentions its varieties, discusses its merits, weighs it in the balances of justice, and dismisses it as inadequate, misleading, and impossible as a corn measure. The interest of the reader is at first excited with regard to the evolution of the bushel from terms of Roman *sextars.* Whether statistician, antiquary, historian, miller, or farmer, he must feel his interest awakened and kept alive. The bushel is seen altogether from a new aspect. Light beams out beneath and around it, and it becomes an object of respect and veneration. It is with regret that we find the fact gradually forcing itself upon us that this archetypal standard of volume, this absolute multiple of the typical wheat grain, this original bond of union between volume and weight in "merrie England," is after all as a gauge of value, and an indication of variations in price with regard to corn, an impostor. This is, however, the conclusion to which we are irresistibly driven, and Mr. Wilson, while he fondles and beams upon his bushel, is in reality dealing it its death wound. Never before has such a blow been levelled against the quarter as a measure of value in wheat.

Let any member of Parliament or of a constituency read this volume and he will rise convinced that the bushel is really doomed, and that the *cental* is the only alternative. Or let any one who is imbued with an idea in favour of the French metric system read it, and he will find that we have in England a much sounder system of quantifying than he imagined, and he will think twice before he gives up his English grain for the French gramme, or the English pint for the French litre.

The work naturally divides itself into two parts. First, an interesting inquiry into the historical origin of the bushel. Secondly, an attack upon the bushel as a means of quantifying corn. We propose to look at both these aspects. First, then, in the language of the author, "What is a bushel of corn?" The chief interest in the answer to this question lies in the fact that the bushel is based upon a unit—namely, an increment of wheat. The French have taken distilled water at 4° C. as the medium for connecting weight and volume. The Romans appear to have taken wheat for a similar purpose. The supposed base of the corn measures was not the money sterling of 24 grains used in weighing gold and silver, but the commercial or tron sterling of 32 grains used for heavy goods. In the book known as "*Fleta*" we are told that "in the English kingdoms the king's measure was made from the penny called the sterling, which is made round; that this sterling should weigh 32 grains of average wheat: that twenty pennies make an ounce, and that twelve ounces make a pound of twenty shillings weight and number; that the weight of eight pounds of wheat makes the measure of one gallon; that eight gallons of wheat make the bushel, eight of which constitute the common quarter." The sextar pint of the Romans held one London pound of twenty shillings or 7680 grains of wheat of the quality giving 64 lbs. to the bushel. A bushel was 64 sextars, and hence a London pound of really good wheat and a sextar pint united the ideas of weight and measure. According to this view a bushel of good wheat ought to weigh 64 lbs. and to hold 64 pints. The latter statement is true at the present day, and in certain cases the weight may be 64 lbs. also. Mr. Wilson, however, considers that the typical bushel of wheat was not considered to be 64 lbs., which is unusual, but 60 lbs. And, still further, that the ideal bushel of 60 lbs. was probably 60 lbs. *avoirdupois* and not London. In working out this very interesting point, Mr. Wilson shows that, according to "*Fleta*," a sack of wool was always considered to be of equal weight with a quarter of wheat. Now wool was quantified by tron weight, and if the assumption is correct that wheat was quantified by avoirdupois we can readily see if we can bring the two into accord. "'*Fleta*' tells us that $12\frac{1}{2}$ merchants' pounds of 15 ounces made a stone of wool, and that 28 stones made a sack of wool equal in weight to a quarter of wheat." The weight of the sack of wool would therefore stand thus:—

Tron oz. =	640 grs.
	15
Tron lb. =	9600 grs.
	$12\frac{1}{2}$
Wool st. =	120,000 grs.
	28
Sack of wool	3,360,000 grs. = 480 lbs. avoirdupois.

The comparison with the weight of a quarter of wheat would stand thus:—One bushel of 60 lbs. avoirdupois = 420,000 grs., and 8 bushels or 1 quarter = 3,360,000 grs. = 480 lbs. avoirdupois. The true solution of this difficulty therefore seems to be arrived at, namely, that the bushel of 2218·192 cub. in. is equal to 64 Roman sextars and to 64 English pints. It holds 8 gallons or 64 pints of wine, and 8 gallons or 64 pounds of really good wheat. It is equal in size to the old Scots or Linlithgow firlot, and holds 80 avoirdupois or Roman pounds of water.

The idea of a system of weights and measures based on a sound unit like a sextar pint of twenty shillings, invests our system with a halo of antiquarian interest derived from the standards of Imperial Rome. "I can see," says Mr. Wilson, with well-timed enthusiasm, "the spirit of the old Scots measures standing in an empty Linlithgow wheat firlot, with a wreath of golden ears around his brows, and looking ineffable scorn upon the statutes which affect to abolish his reign and his dynasty."

Those who want to know more must read the book. We next proceed to take a rapid glance at the objections to the bushel as a corn measure, or as a means of quantifying corn. These objections may be summarised as follows. First, the bushel lends itself easily to misrepresentation. It can be "shaken together, pressed down, running over." However exact as a measure of fluids it is not suitable for a compressible substance. The height from which a bushel is filled affects its amount; a blow upon its side during filling causes evident settlement, and finally we are not certain as to whether a heaped bushel or a struck bushel is always meant. Such is one class of objections. Another arises from the fact that, contrary to general opinion, Mr. Wilson holds, and we think proves, that weight per bushel is not an indication of quality. Samples may be readily "sweated," rubbed, beaten, or dressed, until the weight per bushel is not a fair indication of quality. Again, corn which has been swollen with exposure to rain does not return to its former bulk but remains permanently enlarged. Lacunæ or hollows filled with air remain, and the bushel is rendered lighter, although we cannot hold in such cases that the quality of the flour has been injured. Again, the shape of the grain has its effect in allowing some to pack closer together in the bushel while others lie looser. Lastly, in oats the proportion of kernel to husk varies immensely, and yet this is not indicated at all by weight per bushel. A very strong point is made with reference to moisture. We have generally considered, and with some truth, that the drier a sample of wheat is the heavier will it weigh in the bushel. This it appears is not to be relied upon, and in numerous experiments it was found that after moisture had been artificially driven off the "measure weight" or weight per bushel was less than before! Thus in one case "the measure weight with no moisture in the grain was nearly 4 lbs. less than at first, with 9·35 per cent. of moisture"! This is not by any means contrary to what might be expected. As long as wheat contracts in volume as it dries, so long will it increase in specific gravity. When, however, it reaches a stage at which the moisture evaporated is replaced by air occupying the spaces previously occupied with water—then will the weight per bushel suffer. Hence a very strong case is made out against the bushel and the quarter as standards for quantifying corn.

The question has a retrospective as well as a prospective interest. The bushel weighs differently every year. Thus, according to evidence laid before the Fiers Court in Aberdeenshire, the weight of a bushel of wheat was, in 1856, 57·02 lbs.; in 1857, 60·3 lbs.; in 1858, 61·32 lbs.; in 1860, 55·95 lbs.; and in 1868, 62·29 lbs. A bushel of wheat then between 1856 and 1868 was found to vary in weight by 6·34 lbs., or 50·72 lbs. per quarter of 8 bushels.

If wheat weighs 50·72 lbs. per quarter less one year than another, it will be found that as a standard of value the quarter is misleading. A quarter of 430 lbs. is 10 per cent. in weight less than one of 493 lbs. Now if in a bad year the lighter wheat is quoted at 48*s.* per quarter, while in a succeeding good year the heavier wheat is quoted at 52*s.*, wheat is said to have gone up 4*s.*, whereas according to weight the prices are the same in both years.

Wheat may be dearer per quarter and yet be really selling at less money per cental. Hence the calculations made by statisticians as to the fluctuations in the wheat market have up to now all been made on a false basis. It would take us to undue length if we were next to show from this little volume why the *cental* is a better means of quantifying wheat than the bushel or quarter. That it is so we have no doubt whatever, and therefore consider that the book before us has done much to inaugurate the use of the *cental* and the abolition of the quarter in our corn markets.

JOHN WRIGHTSON

ZOOLOGY OF THE NORTH ATLANTIC EXPEDITION

The Norwegian North Atlantic Expedition, 1876-1878. Zoology: *Holothurioidea*. By D. C. Danielssen and Johan Koren. With Thirteen Plates and One Map. *Annelida*. By G. Armauer Hansen. With Seven Plates and One Map. (Christiania: Printed by Grondahl and Son, 1882.)

THESE two volumes comprise Nos. VI. and VII. of the results of the Norwegian North Atlantic Expedition. The first, which deals with the Holothurians, contains an interesting account of several new genera (5) and species (6). Of the new forms *Kolga hyalina* is perhaps the most interesting; it has been placed in the family Elpididæ, of the order Elasmopoda, instituted by Dr. Théel for some of the Holothurians collected during the *Challenger* Expedition. Kolga is a small Holothurian (the largest specimen dredged measuring 50mm. in length, 15-20mm. in height, and 12-15mm. in width) with the oral disk facing the ventral, and the anal orifice the dorsal, surface, and having a dorsal collar bearing sucker-like contractile papillæ at the anterior extremity. These papillæ, unlike ordinary pedicels, were found to communicate with the perivisceral cavity by means of spaces formed within the collar.

After referring to lateral and terminal conical suckers, the translucency of the skin, and cutaneous cellular glands, the authors give a careful description of the water vascular system, dwelling especially on the sand canal, which is especially interesting, for instead of hanging free in the perivisceral cavity, as in the ordinary Holothurian, it opens directly to the exterior in front of the collar. The larval condition thus persists, the circular vessel retaining its communication with the exterior through a simple membranous tube. In two other Holothurians from this Expedition, constituting the new genera of Trochostoma and Irpa, the sand canal has the outer end attached to the skin but not in communication with the exterior, and in each case there is a madreporic plate developed on the canal within the point of attachment. In Elpidia there is a similar arrangement, but the madreporic plate is rudimentary or wanting, hence the authors think that Elpidia approximates more closely than Trochostoma and Irpa to the larval stage so perfectly maintained by Kolga. With respect to the blood-circulating system, Kolga differs from the general plan in which the dorsal and ventral vessels originate between the stomach and the intestine, for in Kolga they open from a ring encircling the œsophagus, and as this ring has thicker and more muscular walls than the vessels proceeding from it, it is suggested that it may function as a heart.

Of the five nerve trunks which emanate from the oral nerve ring, the two dorsal furnish an offshoot to each of a pair of large vesicles containing otoliths, and the two lateral ventral cords send branches to numerous successive auditory vesicles. Each vesicle contains from 20 to 130 otoliths. Kolga, which is diœcious and in which there is no respiratory tree, may thus be considered to be a very primitive member of the Holothurian group, near which comes Elpidia, the authors disagreeing in this respect with Dr. Théel, who, taking into consideration the bilateral form of Elpidia, gave it a high place amongst Holothurians.

Prof. Steenstrup's and Dr. Lütken's account of *Myriotrochus Rinkii*, St., has been supplemented in the above report from numerous specimens found at Spitzbergen; and *Myriotrochus brevis*, Huxley, is considered to be identical with *Oligotrochus vitreus*, described by Sars in 1865.

In describing the new genus Trochostoma (instituted for *Molpadia boreale*, Sars, *Molpadia oolitica*, Pourtales, *Haplodactyla arcticum*, and a new form, *T. Thomsonii*) the authors discuss at considerable length the function of the respiratory trees, and conclude that they are in all probability secretory organs belonging to the intestines. After dealing with another new genus (Ankyroderma) this very valuable and interesting memoir concludes with a list of the Holothurians collected by the Expedition, and a table showing the depth, temperature, bottom, &c., where each was procured.

The descriptive text is illustrated by thirteen excellent lithographed plates, and a map showing the position of the zoological stations where the various specimens were obtained.

In the memoir on the Annelids collected by the Expedition, Hansen commences by entering a protest against the number of genera instituted in this class by Malmgren, and he especially considers that the distinction on which Malmgren lays so much stress, viz. the difference between the bristles of different members of the class, is not in reality present. The scales, on the other hand, are considered by the author to be much more distinctive specific features, and from the character of the scales accordingly he opposes the wholesale heaping together by Möbius, and after him by Tauber, of proposed genera and species into a single specific group. Of a large number of Annelids procured a description is given only of new species—about 28—and of a few others which are little known. The description of these forms is almost limited to their external characters, especially to the form and structure of the scales.

The Annelids collected are divided into two groups, first, those found in the warm, and next, those from the cold, area. The list containing those from the warm area gives the depth, temperature, &c., at the various stations, but in addition a useful column is added containing their geographical distribution as far as known. A further list appears of the Annelids collected in the cold area arranged under their respective families, from which it appears that most of them are represented in the frigid area, and most of the species occurring there are also found in the fjords and temperate ocean tracts. The author states that there are few indications that the deep bottom-current off the coast of Norway in which the temperature is below zero (C.) should be characterised by a fauna of its own. "Of one Annelid only, *Polynoe globifera*, G. O. Sars, can we infer with comparative certainty that its favourite, if not its sole, habitat is confined to the cold bottom-strata."

From a specimen of Serpula, *Protula arctica*, procured from a depth of 1163 fathoms, temperature $-1^{\circ}\cdot1$ C., bottom biloculina clay, it is inferred that the Serpulidæ do not absolutely require solid matter on which to construct their shells. From a specimen of *Hydroides Norvegica* met with on a muddy bottom with the tube not, as is usually the case, twisted but straight, it is inferred that in such cases the tubes penetrate the mud like those of many other tube-forming Annelids.

In referring to colour and sense organs, the author says that an *Onuphis hyperborea* brought up from 299 and 412 fathoms, "a greater depth than that to which light and vegetable life are supposed to penetrate," was nevertheless vividly coloured and provided with eyes.

This volume also is illustrated by several plates and a map. The letterpress of both volumes is printed in English and Norwegian in parallel columns. They together form a solid contribution to our knowledge of two groups which are becoming more and more interesting to the zoologist.

OUR BOOK SHELF

Catalogue ana Handbook of the Archæological Collections in the Indian Museum. Part I. Asoka and Indo-Scythian Galleries. By John Anderson. (Calcutta, 1883.)

THIS is a model of what a guidebook to a museum should be. The antiquities described by Prof. Anderson are of the highest interest, and the fullness and clearness of his description is worthy of them. The Indian Museum, though only founded in 1866, now contains a mine of wealth for the Indian archæologist. The collections of the Asiatic Society deposited in it have been enriched by the sculptures from Bharhut, the Gândhâra bas-reliefs, the Buddha Gayâ discoveries of the Archæological Survey, and the casts from the early temples of Orissa. A flood of light has been thrown on the history of ancient Buddhist art and belief, as well as upon the relations of Buddhist India with Greece and the west. The dome-shaped Stupa of Bharhut belongs to the second century B.C., and is adorned with sculptures representing scenes from the legendary life of Buddha; the ruins of Buddha Gayâ have been excavated near the site of the famous Bodhi tree under which Buddha sat, and which was visited by the Chinese pilgrim Hiouen Thsang in 637 A.D., while the rock-cut temples of Orissa carry us back to a period still earlier in the life of Buddhism than that of Bharhut. In the Indo-Scythian Gallery the most interesting remains are those from Mathura (or Matra) and Gândhâra. Here, too, the sculptures are partly Buddhist, though also partly Jain—Jainism itself being but an older form of Buddhism, if we are to believe Mr. Thomas. The chief interest attaching to them is due to the fact that many of them owe their inspiration to Græco-Roman—if not even Byzantine—art. The dress of several of the figures represented in them is also interesting as pointing to a northern climate. The same may be said of a group of figures at Sanchi, which have bandages round the legs like those still worn in Afghanistan.

In looking through this catalogue we cannot fail to be struck by the contrast between the care now taken by the Indian Government of the antiquities of the country, and the official neglect to which the ancient monuments of our own islands are exposed. To say nothing of the Archæological Survey, which has already done so much to bring to light the hidden treasures of early Indian art, no pains seem to be spared to protect the memorials of the past which are scattered over the surface of the soil. It is a pity that some little of the intelligent interest taken by the Indian Government in the historical monuments of India cannot be reflected on our rulers here. It is true that, fortunately for archæology, India is still governed by a small body of educated men, while an extended franchise implies a majority which cares nothing for science and much "for the rights of property" and the prospect of increased dividends; nevertheless even the majority is willing to follow the leaders it has chosen, and the leaders will lose nothing if they remember that we have duties to perform towards the past as well as towards the present.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Green Sun

THE appearance of a bright green sun for several days in succession seems to be a phenomenon sufficiently rare to deserve notice in your columns, so I send you the following notes on the subject :—

On Sunday evening, September 9, the sun for some time before setting appeared perfectly rayless and of a bright silvery-white colour, quite different from anything that I have ever seen before. On the following morning I did not observe it particularly, but in the evening I watched it carefully from about five o'clock till sunset. At first it had the same silvery-white appearance as on the previous day, and this continued till 5.30, when it was lost behind a bank of cloud; on its partial reappearance, however, at 5.43, the part visible between the clouds was of a bright pea-green colour. On Tuesday morning it was rather cloudy, but the appearance, when seen at all, was the same as on the preceding night. In the evening, however, it was a magnificent spectacle, and attracted the notice of every one. The silvery sheen was visible early in the afternoon, and the brightness of the sun rapidly faded, till by about five o'clock one could look at it directly without any difficulty. At this time there was a distinct tinge of green in the light when received on a sheet of white paper, while shadows were very prettily tinted with the complementary pink. As the sun sank towards the horizon the green became more and more strongly marked, and by 5.30 it appeared as a bright green disk, with a sharply-defined outline. In fact the definition was so good that a large spot (about 1' long) was a conspicuous object to the naked eye. On this occasion the sun was lost in a bank of clouds near the horizon, but on another occasion, when I was able to see it actually set, the colour got yellow rather than green close to the horizon. Similar, but less marked, were the appearances both at sunset and sunrise for several days, and before sunrise and after sunset the cloud effects were such as I have never before witnessed here. These cloud effects were chiefly remarkable for the brilliancy of the colouring and for the length of time that they were visible, being seen for nearly an hour after sunset. The moon and stars, when near the horizon, showed the same green colours as the sun.

On the 22nd the green sunrises and sunsets began again and continued for three days. I carefully examined the spectrum on every possible occasion with my zodiacal light spectroscope, as well as with a small direct-vision one. The spectrum showed clearly that aqueous vapour played a large part in the phenomena, for all the atmospheric lines usually ascribed to that substance were very strongly developed. But in addition to this there was a very marked general absorption in the red. Even an hour before sunset, and often longer, the absorption was complete as far as B, and the dark shade gradually crept up till it reached C, and at times even that line was invisible, while the absorption was clearly marked up to W.L. 621. At the blue end nothing could be seen beyond W.L. 428, and even that only with a very wide slit, but a photograph showed the lines clearly *nearly* as far into the ultra violet as on ordinary occasions. The phenomenon was visible over a large area of country, from Ceylon to Vizagapatam, and as far west as Aden. It was not, however, observed at all at the Bombay Observatory.

I am at present collecting information from various sources, and so do not care to enter into many details at present.

Most people ascribe the phenomena to the recent great eruption in Java, but there are difficulties in the way of accepting this view, which I have not yet been able to get over, and the similar appearance of a blue sun over Europe and America in 1831 seems to make this explanation unnecessary, besides it is well known that the sun appears green under certain circumstances when seen through steam or even in a mist (Lockyer). On the other hand, observations referred to in NATURE, vol. xviii. p. 155, tend to show that very fine dust might produce the observed effects.

Can any of your readers refer me to Dr. Schuster's original papers?

It may not be without interest to add that on both occasions the green appearance was preceded by abnormal electrical conditions of the atmosphere. The potential of the air was strongly negative for a number of days in succession from about 9.30 a.m. to 2.30 p.m., with a clear sky and no rain within 100 miles.

C. MICHIE SMITH

Madras, October 10

I INCLOSE a letter giving an account of the green sun, which may be of interest to your readers. My correspondent is the wife of General Tremenheere, formerly in the Indian army.

WARREN DE LA RUE

73, Portland Place, W., November 3

Spring Grove, Isleworth, November 2

IT may interest you to hear that my daughter, writing from Bellary, tells me that a gentleman who was at Ootacamund, in the Neilgherries, was on one of the higher peaks when the phenomenon of the sun took place in September, and he first distinctly saw a *green, cloud-like mist* pass across the sun, and *then one of a reddish colour*, and the sun took the colour of each of these clouds or mists. People at Ceylon were terribly alarmed at the unusual appearance of the sun.

S. S. T.

MR. GREAVES has the pleasure to forward to the Editor an extract from a letter just received from Mr. Beardmore at Madras, referring to the phenomenon of the green sun now being discussed in NATURE.

Sunhill, Clevedon, November 2

Harbour Works, Madras, October 10

WE have had the sun here for some weeks past in the mornings and evenings a most curious greenish blue colour, and generally casting a bluish beam of a most pretty tint. Mr. Pogson thinks it due to volcanic dust and sulphurous gases from the great eruption in Java. Another astronomer, Mr. H. Smith, thinks it due to a great amount of aqueous vapour.

NATHL. BERNARD BEARDMORE

The Division of the Circle

ALLOW me to point out an oversight in NATURE (vol. xxviii. p. 598), where, in explaining the divisions of a circle the following passage occurs: "In quite recent times it has been suggested that 400 parts should be taken in place of 360, but that is a suggestion which up to the present time has not been acted upon."

We probably owe our degrees either to the earlier supposed year of 360 days, or to the fact that this number has many divisors, although such divisors afford no practical advantage. When trigonometrical functions were subsequently discovered, it was found that the natural unit is not the circle, but the quadrant or right angle. Our system of numeration being decimal, it was then most convenient to divide the quadrant decimally, and the circle is thus considered as composed of 4, 40, 400, &c., parts according to the degree of exactness required. This was proposed by Briggs when preparing his logarithms, which are based on decimals, but unfortunately it was then set aside. Revived a long time after by Lagrange, it was acted upon by Laplace in his "Mécanique Celeste," being thus much more than a mere suggestion. Nowadays decimal divisions of the quadrant are the only ones used by French geodesists.

Facts are the grand supporters of argument. Will you kindly quote the following? After grumbling on the necessity of using the only circle at his disposal because it was divided decimally, a French civil engineer would afterwards employ no other: he found the decimal circle much more convenient. A special experiment had been already made in Italy, where two geodesists, carefully interchanged and inspected, had been instructed to observe and calculate in both systems the same large lot of angles. It was then found that the use of decimals gave a saving of two-sevenths of time either in observation or in calculation. This result was unknown to Sir George Airy, the ablest astronomer of our time, but he judged rightly that the conversion of all sexagesimal angles into decimal ones would materially lighten his labours, and he actually did so when calculating all the lunar observations previously made at Greenwich. This was the largest quantity of reductions ever made by one astronomer, and they were abridged by the use of decimals. The real supporter of sexagesimal divisions is routine, that sly enemy of progress.

Abbadia, November 2 ANTOINE D'ABBADIE

Christian Conrad Sprengel

IT has now become a standing topic that C. C. Sprengel's treatise on the structure and fertilisation of flowers "after well nigh a century of oblivion has come to be recognised as one of the most interesting books, and his theory of the adaptation of flowers to fertilisation by insects is one that will ever be associated with his name" (NATURE, vol. xxviii. p. 513). Some writers go so far as to speak of a rediscovery of Sprengel's treatise by Darwin. But it should be acknowledged that Darwin himself says only ("Cross Fertilisation," p. 5): "His discoveries were for a long time neglected." So it seems to be true that Sprengel's and Koelreuter's works were unknown to English naturalists, though Kirby and Spence, at the end of Letter IX., published 1815, and in all subsequent editions till 1867, have given a very fair report in their masterly manner. Not only the facts, but also the importance of these discoveries, are fairly expounded.

In Germany these discoveries were well known to every naturalist during the whole century. In 1829, when a mere boy, my father began to instruct me in entomology. Many times he took Sprengel's work from the shelves in his study, and explained to me the discovery of fertilisation of plants by insects with the help of the plates in Sprengel's book. I have never forgotten the interest and the scientific enthusiasm of his exposition. I was told that we are indebted to a mere chance for this discovery. A rather dangerous irritation of Sprengel's eyes had the result that he was entirely forbidden indoor study by his physician, and was therefore obliged to spend his days in the field, where he was gradually led to the observation of plants, followed by his remarkable discoveries. Certainly between 1830 to 1840 at every university in Prussia the same facts were taught as well known facts of the highest importance, and of course known by every student. Prof. C. F. Burdach has related them in his large "Physiology," vol. i. p. 322, 1826, and given his conclusions. H. Burmeister, "Handb. d. Entomologie," vol. i. p. 303, 1832, speaks about them at some length also as well known and of the highest importance. Not only scientific publications, but merely popular works have the same statements. Pierer's "Universal Lexicon" (first edit. 1836, fourth, 1851, vol. ix. p. 942) gives a fair report. H. A. HAGEN

Cambridge, Mass., October 23

"Challenger" Zoological Reports

IT seems to me that the reviewer of my Report on the Pelagic Hemiptera collected during the voyage of the *Challenger* (NATURE, vol. xxix. p. 3) is too hypercritical.

I refer, of course, to the paragraph in which he blames me for alluding to species under their trivial names only; and as the paragraph in question is calculated to convey a wrong impression, I should be obliged if you will kindly allow me to say a word on the subject.

It is true that some writers upon insects (or rather upon Lepidoptera only) have the very bad habit of alluding to species (of different genera) by their specific names only, and the law that forbids the practice is a good one; but it may be applied too stringently, and not altogether in the sense that its framers intended.

In my Report I had to deal with two genera, and a reader of the review who had not seen the Report itself would be justified in concluding from the words of the reviewer that I have used the specific names indiscriminately, without indicating the genus to which the species belonged. In point of fact this is not the case. The two genera are treated of separately, and where I have mentioned the trivial without the generic name, it has only been when the generic name governed the paragraph, and, when, consequently, no doubt could possibly exist as to the genus. In doing so I may have broken the *letter* of the law, but not, I think, the *spirit*; and were the work to be done over again, I think I would be inclined to follow the same course.

F. BUCHANAN WHITE

[The idea of a generic term governing a paragraph did not strike me. I had no wish to be over-critical, and I am glad to find that in all essentials Dr. Buchanan White agrees with the views expressed.—THE WRITER OF THE NOTICE.]

Barytes from Chirbury

A NUMBER of crystals of barytes have lately been acquired by Mr. Henson from Chirbury, Salop, which seem to deserve some description. The crystals vary from one to four inches in length and from one-half to two inches in breadth; they are very bright and clear, and are elongated in the direction of the brachydiagonal, resembling in appearance the barytes from Dufton; they are mostly doubly terminated, and some contain included crystals of copper pyrites. They were at once detected by Mr. T. Davies as being peculiar in form; and the reflecting goniometer revealed the existence upon them of four very well-defined forms which have not been hitherto found upon barytes, besides two more doubtful planes to which it is difficult to assign definite symbols.

The crystals are almost all a combination of the forms—

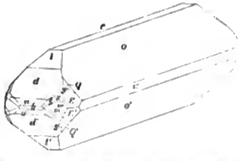
o {101} $\bar{P}\infty$	E {412} $2\bar{P}4$
d {012} $\frac{1}{2}\breve{P}\infty$	*y* {212} $\bar{P}2$
m {110} ∞P	*z* {111} P
l {014} $\frac{1}{4}\breve{P}\infty$	*ξ* {232} $\frac{3}{2}\breve{P}\frac{3}{2}$
u {011} $\breve{P}\infty$	*ω* {432} $2\bar{P}\frac{4}{3}$
a {100} $\infty\bar{P}\infty$	
b {010} $\infty\breve{P}\infty$	
c {001} $0P$	

On some crystals were also observed—

μ (214) $\frac{1}{4}\bar{P}2$ between *d* and *o*
r (112) $\frac{1}{2}P$ between *d* and *y*
Z (034) $\frac{3}{4}\breve{P}\infty$ between *u* and *d*.

The general appearance of the crystals is shown in the annexed figure.

Of the above faces *ξ*, *ω*, E, and Z are new. *ξ* lies with parallel



edges between the faces *d m* and *z b*, and is very dull: *ω* lies between *y m* and *z o'*; E between *y a* and *o z'*.

Several of these crystals have also a small dull face Q lying with parallel edges between *o* and *y*, and on one this is accompanied by another small dull face Y between *o* and *m*. By oiling these faces it was possible to determine approximately their inclination to *o*. The measurements lead to the complicated symbols (15.1.15) for Q and (19.1.18) for Y.

The new faces, and especially E, are very characteristic of these specimens, and it is somewhat curious that faces with the simple symbols of *ξ*, *ω*, E, Z, have not hitherto been noticed among the sixty-six recorded forms of barytes.

H. A. MIERS

Mineral Department, British Museum, October 25

"Anatomy for Artists"

I THINK perhaps if it were known to Dr. Marshall that his "Anatomy for Artists" is not used in cases where it otherwise would be, because of his decision to omit letters of reference in the illustrations of the bones, he might think it better to alter this in a new edition.

Dr. Marshall admits that his plan may be a strain, but perhaps he does not know how great a strain it is when students are not studying leisurely but in the limited time given in schools of art to an anatomy course. Even if he disapprove of any haste in study, he would surely be sorry to hinder rather than help those who have to be quick.

I heard recently a lecturer on anatomy refer his pupils to books inferior to Dr. Marshall's, regretting, he said, to set aside the best book they could have, but adding that, from the want of reference letters, many of the students would simply be puzzled, discouraged, and confused.

I have only Dr. Marshall's book, and although the illustrations are too good to allow of any great difficulty arising, still I have found the use of it a strain. I doubt, too, if the plan secures a "more accurate knowledge of the forms," as Dr. Marshall hopes it may. Perhaps so, after a little knowledge has been gained, but in the first struggle the student has an uncomfortable haziness as to whether he has found the right groove or prominence upon a bone, which prevents his forming a definite picture of it in his mind.

Certainly letters spoil the illustrations, but might there not be small key drawings beside the larger more finished ones.

AN ART STUDENT

Meteor

I WAS just now startled by what appeared to be a vivid flash of lightning out of a perfectly cloudless sky, a fluttering flash that lit up everything brilliantly. On turning to the south-east I was just in time to see the broad path of fire that a splendid meteor had left behind it; the meteor was falling behind some trees, and I saw it very imperfectly, but it seemed very large, and indeed *must* have been from its light. I had been looking out from time to time for shooting stars all the evening, and had seen three fine ones and four or five small ones, all in the east, and appearing to come from the neighbourhood of the Bull. The sky is covered with the lovely light that always appears with shooting stars, and which I think is sometimes called homogeneous aurora.

J. M. HAYWARD

Sidmouth, November 4

THE JAVA ERUPTION AND EARTHQUAKE WAVES

FOR the following facts the writer is indebted to the kindness of Herr Emil Metzger, formerly Director of Surveys in the Dutch Government service in Java. His original account, written before September 12, has just appeared in the *Globus*. The present paper is based upon that, but it contains several small additions and corrections which have been received directly from the author. Most of the geographical details here given are based on the Trigonometrical Survey of the coast of Java, which was carried out under Herr Metzger's immediate direction in 1868-69.

A line drawn eastwards from Flat Point (Vlakke Hoek, Tandjong Blimbing, or Rata), the south-western extremity of Sumatra, would touch the south coast of that island only in two points,—Tandjong Tikūs and Tandjong Tūwa, or Varkens Hoek. Between these promontories are the bays of Semangka and Lampong.[1] The opposite coast of Java follows generally a north-easterly direction almost to Anjer. Along this stretch it deflects, however, more than once towards the south and the east, and forms Seagull, Welcome, and Pepper Bays. Midway in the channel of the Straits, and on a straight line drawn from Tandjong Tikūs (the western side of Lampong Bay), to the western head of Pepper Bay, lies the Island of Krakatoa (called also Krakatau, Rakata), with several smaller islands near it. Sebuku and Sebisi are two islands situated between Krakatoa and the south-eastern extremity of Sumatra. About half way between Anjer and Point St. Nicholas, and only separated from the mainland by a narrow belt of water, is the Island of Merak (Pulu Merak). On the opposite mainland were the extensive quarries of Merak, which have now totally disappeared. Further, in the narrowest part of the navigable channel, lay a group of islands, of which the largest, Thwart-Way or Sunghian (Dwars in den Weg), has been rent into five pieces.[1]

From the manner in which Sebisi (the peak 2818 feet high) and Krakatoa (peak 2700 feet) rose immediately from the waves, and from the great depth of the sea around them, Junghuhn was led to conclude that Sumatra and Java, in spite of the corresponding configuration of their approximating coast-lines, and the fact that they are both volcanic, do not belong to one continuous formation. The Island of Krakatoa, considered by Junghuhn to be a continuation of the mountain system on the adjoining coast of Java, was about five miles long by about three broad; and close at its foot were the two small islands Verlaten and Long, on the west and east respectively. The Trigonometrical Survey of 1868-69 fixed the position of the cone of Krakatoa as 105° 26′ E. long, and 6° 8′ S. lat. Like most of the islands in the Sunda Straits, Krakatoa was clothed from base to summit with a luxuriant growth of forest and of tropical vegetation. When in the course of the survey the northern face of the mountain was visited in the latter year, several warm springs were found—a common enough thing, however, in these islands. Moreover, Krakatoa, as well as Sebisi, was at that time totally uninhabited, being only visited occasionally by the inhabitants of the neighbouring coasts for the sake of the products yielded by the woods.

On May 20 in the present year several shocks, accompanied by loud explosions and hollow, reverberating sounds, were observed at Batavia and Buitenzorg, each about 100 miles distant from Krakatoa. That these phenomena were not seismical was recognised at once; the magnetic needle of the magneto-meteorological observatory showed no deviation, only a trembling motion in a perpendicular direction. A few days later came the news that a volcanic eruption had taken place on the Island of Krakatoa, where nobody had once thought of looking for the seat of the phenomena. The captain of a mail steamer, however, which passed the island at about 6 p.m., has since reported that the needle on his ship was violently agitated, being spun round repeatedly.[2]

From the deck of another vessel which was passing about eight o'clock on the evening of the 22nd, a dome-shaped mass of vapour, mingled with smoke of a dark gray colour, was seen to rise from the lower part of the island. The first thing noticed was from ten to fifteen dark red "sheaves" of fire flashing up in rapid succession from the base of the column. These were followed by explosions, more or less loud, resembling discharges from artillery, so that the ship, which was sailing at no great distance, distinctly felt their influence. In the upper part of the volume of smoke appeared an uninterrupted series of flashes, differing in no respect from ordinary lightning flashes, except that they were discharged concentrically upon the column from the atmospheric clouds surrounding it. The heat emanating from the locality of the eruption was sensibly felt on the hands and face at a distance of nearly two miles away; the presence of a powerful marsh-gas was also easily detected. Several nautical miles past Krakatoa a thick shower of fine dark-gray sand continued to fall upon the ship for the space of

[1] See the map of the Sunda Straits in this journal, September 6, 1883, p. 444. With this compare the map given in *Globus* (vol. xliv. No. 15, p. 233), where also fuller geographical descriptions may be found than could be given here.

[1] The earliest telegrams spoke of a volcano Sungepan, which had been split into five craters. This appears to have been a mistake: there never was a volcano of this name in this place, nor is there now. It is only an island.

[2] See the Dutch *Natuur*, September 15, 1883, p. 262.

half an hour. An apparently illimitable cloud of drifting pumice was encountered at a distance of ten miles from the island, and twenty miles farther a second cloud of pumice, which was so thick that a bucket let down into the sea was filled with it before it reached the surface of the water, while the ship, although going at the rate of 10½ knots an hour, cut through the pumice with a noise like that made by a vessel breaking way through thin ice.

A short time afterwards a visit was made to the scene of the eruption by a party from Batavia, and as the account of this visit contains perhaps the latest description of the condition of Krakatoa before the great convulsion of August 26, a few words from it may be perhaps not devoid of interest.

The spectacle as seen from the north of Krakatoa was one calculated to have inspired the pencil of a Doré. From the devastated island a huge, broad pillar of smoke towered upwards as high as the clouds; and while Verlaten Island gladdened the eye with its profuse display of the glories of tropical vegetation, Long Island was completely withered up,—the leafless trees, bent, twisted, and torn, but not scorched, were left standing like naked spectres, as colourless as the soil, or rather enveloped in the same neutral tint of gray, from the pumice dust, as all the rest of the island. Between these two, and only separated from each by a narrow channel, rose, somewhat in the background, the lofty cone of Krakatoa, still covered with green foliage, and without any signs of activity. But in front of the volcano all was wrecked, covered, nay, completely buried, under pumice dust, which, when the sun shone upon it, became of a yellowish-gray colour, while thick masses of condensed vapour, accompanied by incessant fulminations, boiled up from behind the bare and gently sloping dunes. These masses of vapour were for the most part snowy white, others gray, and were closely intertwined, afterwards spreading out in continually widening circles. It was as if a gigantic spectral cauliflower were with incredible rapidity evolving its successive stages of growth before the spectator's eyes. The volumes of vapour were shot out with terrific force in a strictly vertical direction; the atmospheric pressure in the middle of them must have been something fearful. And from time to time immense funnels became visible, leading outwards, and into these many of the incessantly changing ravelled wreaths of smoke were sucked. The rest maintained their original form to a height of several thousand feet; then they slowly drifted eastwards, and, spreading out into mist, discharged their ashes downwards in black streaks like the dark fringes of rain-clouds seen on the horizon. Occasionally the bellowings became louder, and a thicker and larger volume of smoke was vomited forth. Soon afterwards it was noticed that the sky in the west, which was there as bright and clear as it was dark and heavy in the opposite quarter, was being thronged with small, dark bodies,—they were pieces of pumice, of no great gravity, hovering in the air as if upheld by the power of the fiery breath that was streaming upwards. On landing, the party found that they sank up to the ankles in ashes, and accordingly it was necessary to proceed with great caution. As they slowly ascended, the ground and the air both became warmer, the evidences of destruction amongst the trees more conspicuous, and pieces of pumice lay scattered more thickly on the ground. Arrived at a height of about 200 feet above sea level, they found themselves on the edge of a "caldron" of about 700 yards in diameter, probably a former crater. Thence they saw to the north-east the seat of the recent outbreak of May 20, the maximum length of which was about 100 to 110 yards. Here, besides the volumes of vapour and smoke and pumice dust, they also observed sulphur troughs, out of which the mud boiled up in enormous bubbles, which at length burst; and sulphur springs and new but smaller columns of smoke showed themselves in other places. The noise was terrible; the sound made by the discharge of a rifle was like the snapping of a bonbon in the midst of the hilarity of a banqueting hall. Some of the party ventured to descend a little way into the crater, a few even to step tentatively upon its hot and burning floor. They brought back with them pieces of pumice and lava[1]—a kind of black glass—or a piece of sulphur as a memento of the visit. By the time they reached the steamer again darkness had come on, and the spectacle was then one of extraordinary beauty and grandeur. The great column of smoke was still tolerably visible, but the lower part had become a mass of glowing red, from which tongues of yellow flame continued to dart incessantly. At intervals a shower of fine sparks broke out from the cloud, and red-hot stones clove fiery furrows in the air, and fell back at an acute angle to the earth, where they were shattered into a thousand pieces.

That the activity of the mountain was continued during the months of June and July is certain from the report of the Comptroller of Katimbang (on the easternmost promontory of Sumatra), who observed several violent detonations. Also from other places in Sumatra, and particularly from Mexapi (100° 28′ E. long., 0° 20′ S. lat.), came tidings of volcanic movements; and similar reports arrived from Java.

Then came the outbreak of August 26, surprising, inconceivable, in its terrible effects. Although full and detailed reports are not yet to hand, as indeed from the nature of the circumstances they cannot well be expected to be, for communications are in great measure interrupted, destroyed, and rendered impossible, or those who should have made the reports have either fallen victims to the catastrophe, or have fled—who knows where?—yet sufficient intelligence has reached us to justify an estimate of the number of the victims who have perished at tens of thousands; and as for the amount and extent of the material damage done, it is so great that an approximate calculation even cannot be attempted.

The plain simple facts to which all this is due were the eruption of August 26, and particularly the ocean wave which succeeded it on the following day.[2] This destructive wave appears to have started from Krakatoa, or its neighbourhood, as a centre, to have dashed with terrific force upon the contiguous coasts of Java and Sumatra, to have proceeded down the Sunda Straits eastwards with a height that reached from 40 to 100 feet in the narrow throat of the pass opposite Anjer, and 17 feet at Batavia, and even to have extended to the western and eastern shores of America, where it was observed on the 27th and 29th respectively. Not to repeat what has been already stated in this journal (vol. xxviii. p. 443), it will be sufficient to add that a few days after the occurrence we learnt in Europe from official telegrams that Tjiringin, Anjer, and the quarries of Merak, as well as the cone of Krakatoa, had disappeared from sight. But further intelligence from Java, of August 28, states that Krakatoa has not entirely disappeared.

Although information respecting the extent of damage and destruction caused on the south coast of Sumatra is still very meagre, it appears that the two bays of Lampong and Semangka have been rendered totally unfit for navigation owing to the immense masses of floating pumice with which they are covered. In Lampong Bay, notwithstanding that it was protected by certain islands, the momentum was so great that at Telok Betong a Government steamer was carried three miles inland. Telok Betong itself, the chief town of the Royal Lampong District, is, with the exception of the resident's house, the fort, and the prison, completely destroyed.

[1] This deserves particular notice. Herr Metzger ascended several of the volcanoes of Java, and often stayed days and weeks together upon them and in their immediate vicinity without ever once finding what was, strictly speaking, lava.

[2] It is now stated that waves, but of no extraordinary height, were observed at 6 p.m. on August 26.

Fortunately the district as a whole was not very populous. According to the *Royal Almanac* for 1883 there was on an area of nearly 10,100 English square miles a population of 70 Europeans (excluding the military force), 128,939 natives, 255 Chinese, and 154 Arabian and other foreign races. No exact estimate of the loss amongst these has yet reached Europe; all we know is that it has been very great, and the destruction to property not less so. Except the three parallel chains of volcanic origin which stretch from north-west to south-east in the three promontories already mentioned, the country is flat and monotonous, and covered with thick woods. In these are the scattered villages and fields of the native population.

On the opposite coast of Java it is the Residency of Bantam which has borne the full brunt of the wave. We learn that at Tjiringin and Anjer it reached a height of nearly 100 feet. Accordingly all along the coast from Java's First Point to Anjer everything must have perished. And although no accurate or detailed returns of the number of lives lost in this district have yet come in, it may perhaps help us to form some conception of what it will probably amount to if we state that Bantam, on an area of about 3200 square miles, had a population of 350 Europeans, 565,438 natives, 1479 Chinese, and 21 Arabs and others. Between Java's First Point and the country to the south of Tjiringin a range of low hills, by alternately advancing and receding from the coast, formed several small bays and coves, the shores of which were more or less thickly studded with native villages and flourishing tracts of cultivated soil. But these were less frequent in the western part on account of the tigers. On the eastern margin of Pepper Bay, south of Tjiringin, the country was more flat and level, and, preserving this character, extended farther inland. But from Tjiringin to Anjer the mountains approached close to the sea. Along their base ran the chief highway to Anjer, thickly set with prosperous villages, while several others hung on the slopes. Here the full force of the great wave was expended; being broken against the rocky walls, it seems to have swept round them on the north and south and to have completely covered the lower-lying districts about Anjer and Tjiringin. South of Anjer was a bay and small valley running eastwards into the land and bordered by ranges of hills called Kramat Watu, which form the connecting link between the mountain systems to the north and south of this point. The sea is now said to wash the foot of these hills, the invasion having come from the west. It has been already stated that Tjiringin, Anjer, and Merak have disappeared; and all the ground which the inundations have not swept away is now covered with ashes. Tjiringin had six European households, while in Anjer and Merak together there were twenty-two.

Further reports, necessarily imperfect, have come in of the ruin caused by the inundations along the whole extent of the north coast of Java right away to Batavia, and even still farther. Bridges have been swept away, dams broken down, villages swamped, and the cultivated land washed bare by the floods, causing, as everywhere else where they appeared, great losses of life and still greater losses in property. In Tanara alone 700 corpses have been already found. Notwithstanding the facts that the ocean wave, when once it had emerged into the Indian Ocean southwards and into the Java Sea northwards, had more room for expansion, that the Javan coast then formed a kind of angle running back into the land, and that several small islands to the north of Batavia acted as a sort of breakwater, the great wave still possessed such strength that it drove a man-of-war ashore on one of these islands and tore away its floating deck. At Tandjong Priok the sea was observed (unfortunately the time is not given) to rise to a height of more than seven feet above the normal level, and then immediately afterwards to sink ten feet below that point, thus giving a difference of seventeen feet, while the average difference between ebb and flow is not quite three feet. The water poured in through the narrow opening (410 feet wide) between the inner and outer harbours like a waterfall, and, having filled the basins, flowed out again in the same manner.

According to the accounts received up to the present time, everything to beyond Pandeglang (south of Serang) is covered with ashes, and everything that was in the fields has perished. Very considerable damage has also been done to the lightly constructed bamboo houses by the shower of ashes, so that more than half the population (the north-east portion of the district is by far the most populous) are without means of sustenance, and, what is of far graver consequence, without fodder for their cattle. Appalled by the eruption, and dreading the famine that would soon stare them in the face, they have, it is said, taken to flight, carrying off with them what they could, and leaving their territorial possessions in the lurch. It is probable, however, that this has only been in the first moments of terror, for the native is wont to cling tenaciously to his hereditary soil. It is to be hoped that the Government Commissioner will succeed in furnishing assistance, and that speedily and in no stinted measure, to these especially unfortunate people. For years they have been visited by epidemics, and have suffered great losses from murrains amongst their cattle. Indeed, during the last year alone, the population has fallen off 10 per cent. in numbers; and what makes the case so much the worse is that the Government itself has experienced from this disaster losses in public works and in its extensive coffee plantations which may safely be reckoned in millions.

What, however, was the immediate cause of this ocean wave, whether occasioned by the rising of sixteen new islands (active volcanoes?) between Krakatoa and Sebisi, or by the falling in of the cone of the former island (or whatever be the part of it which has disappeared), or whether both causes have co-operated together, must remain more or less matter for conjecture until we have more authoritative details, based on scientific examination of the scene of the disaster. J. T. BEALBY

Mr. Meldrum contributes to the Mauritius *Mercantile Record* fresh information on the tidal phenomenon of August 27 last, a condensed statement of which may be given here in connection with the above:—

At Cassis, during the whole day, the water was coming and going, but the movement was not taken much notice of till about 1.30 p.m. The tide on that day did not rise as usual. The water came with a swirl round the point of the sea wall, and in about a couple of minutes returned with the same speed. This took place several times. Similar phenomena occurred on the 28th, but to a much smaller extent.

At the St. Brandon Islands on August 27, Capt. Rault's vessel was anchored on the west-north-west side of Avocaire Island in 3¾ fathoms, a cable's length off shore, when at 3 p.m. the water began to rise 20 feet above the highest point attained by high water. It was then ebb tide. Quickly the water receded with a very rapid motion, leaving everything dry, showing out the shoal patches quite dry, to a very long distance from the island. Before fifteen minutes had elapsed the water rose again with the same velocity for the second time, coming up to the first mark. It was not a wave, nor a billow, nor a high sea; the water was smooth, except where there were heads of coral, and there a few wavelets only were produced. This motion of the water backwards and forwards lasted up to 7 o'clock p.m., the intervals between low water and high water being greater towards the evening; at first the intervals were about ten minutes, and towards six o'clock twenty minutes. The current was setting towards east-north-east of the compass, and the velocity was ten miles an hour. At sunset the sky in the western horizon had a peculiar smoky appearance, which extended nearly to the zenith in an east-south-east direction. On the 28th, at 4 a.m., the same tidal phenomenon took place and lasted up to 7 a.m., but it was less intense, the alternate motions of the sea having only been observed four times. When day dawned on the 28th there was a peculiar crimson colouration from east by north to south-east by east, and the sun after rising showed as if seen through the red shade of a sextant.

At the Seychelles, at 4 p.m. on August 27, the tide came rushing in at the rate of about four miles an hour, and rose two feet. In about half an hour it receded; it returned and receded.

This continued all night and all next day, but the action was quicker and the rise lower. The observations were taken in a channel about twenty-three feet wide, and walled in on both sides. The action continued all day and part of the next day (29th), but not so frequently. At 5 p.m. on the 28th the sun was clear and bright. At sunset there was a lurid glare all over the sky; at 6.30 it was much brighter, and at 6.45 it disappeared. On the 27th the sky was slightly hazy all day. On the morning of the 29th the sun at 7 a.m. was more like a full moon than anything else, and appeared about 70° above the horizon, instead of as usual about 30°. At sunset on the 28th the sun looked as it does through a fog on a frosty day in England.

At Rodrigues, about 1.30 p.m. on the 27th, the sea was all disturbed, resembling water boiling heavily in a pot, swinging the boats which were floating about in all directions. It was then low tide, and most of the boats were aground. This disturbance in the water made its appearance quite suddenly, lasted for about half an hour, and ceased as suddenly as it had commenced. At 2.30 p.m. a similar disturbance commenced again in the inner harbour, and the tide all of a sudden rose to a height of 5 feet 11 inches, with a current of about ten knots an hour to the westward, floating all the boats which were aground, and tearing them from their moorings. All this happened in a very few minutes, and then the tide turned with equal force to the eastward, leaving the boats which were close inshore suddenly dry on the beach, and dragging the Government boat (a large decked pinnace) from heavy moorings, and leaving her dry on the reef. At noon on the 29th the tide was about its usual height and appeared to be settled. The water was very muddy, and not nearly so salt as sea water usually is; it was little more than brackish. Since this singular occurrence took place the sky at north-west has had in the evenings, to as late as 7.15 p.m., a very threatening and strange appearance of a deep purplish red colour.

Tidal disturbances were also observed on the west coast of Réunion, and especially at St. Pierre, on the south-west coast. The maximum amplitude (in height) of this tide was about a metre and a half. The flow took scarcely five minutes to rise, after which the water remained about a minute at rest, and then receded with the same rapidity, to rise again a minute after.

At East London (South Africa) it was not low water on August 27 till 6.29 p.m. At 5.30 p.m. on that day the tide-gauge showed 2 feet 3 inches, and the tide was running in fast. The gauge showed 3 feet 3 inches at 5.38; 1 foot 8 inches at 5.45; 1 foot 3 inches at 5.49; and 2 feet 3 inches at 6.10. Thus, although it was a falling tide, the water suddenly rose 1 foot in 8 minutes, then fell 1 foot 7 inches in 7 minutes, and 5 inches in the next 4 minutes, and then rose 1 foot in 21 minutes. The wind was moderate from east-south-east, and the barometer was 30·40, with dull cloudy weather to south-east. It had been observed during the early part of the afternoon that the tide was oscillating very considerably, and ebbing very fast for neap tides.

On Sunday, August 26, while coming through the Straits of Banca, Capt Strachan, of the s.s. *Anerley*, thought he heard in the forenoon a noise like that of distant cannonading; about noon the noise was more distinct, and it soon attracted the attention of all on board; flashes of light were seen to the south-westward. In the evening an arch of light rose in a short time from the horizon to the zenith. Three aneroid barometers on board rose and fell to the extent of nearly an inch at short intervals. During a part of Monday, the 27th, there was total darkness. Showers of pumice-stone lasted till midnight. The *Anerley* ran back and anchored under the North Watcher Island. While afterwards passing Anjer Point, it was seen that the lighthouse had disappeared, and that great damage had been done.

Capt. Perrot, of the French brig *Brani*, reports that on August 26 to 27, in 1° 39′ to 2° 59′ S. and 89° 56′ to 89° 50′ E. of P., constant peals of thunder were heard in the direction of Sumatra, but without any appearance of lightning in that direction. From midnight of the 27th to 11 a.m. of the 28th showers of "very white and very fine sand fell all over the vessel." More sand fell later on in the day and on the 29th. This sand obscured the atmosphere. On August 28, in 8° 20′ S., and 92° 04′ E., "a great quantity of dust, supposed to be coral dust," fell on board of the *County of Flint*, and a specimen of the dust has been kindly presented by Capt. Rowland, the master of that vessel. On September 9, in 4° 57′ S. and 79° 46′ E. of P., the French bark *Gipsy*, Capt. Martin, "encountered during the whole day a great bank of floating pumice-stone." On Sunday, August 26, in 0° 32′ S., and 105° 57′ E., Capt. Knight, of the brig *Airlie* heard, about 3 p.m., explosions, like the sound of heavy artillery, which continued at intervals till about 10 p.m., the last report making the ship tremble all over. Next morning the rigging and deck were covered with fine gray sand like dust.

Mr. Meldrum remarks that there is no doubt that the tidal disturbances observed at Mauritius and elsewhere in the Indian Ocean were due to earthquakes. The origin of the seismic waves was apparently in the Straits of Sunda, and at a very considerable depth below the surface. There were earth-waves, forced sea-waves, and aërial waves. The destruction in Java was caused, apparently, by an immense wave of translation. The extraordinary sunrises and sunsets observed at Mauritius, Rodrigues, and the Seychelles, were probably due to the sun's light passing obliquely through fine volcanic dust floating in the air. It is not improbable that the disturbances of the magnets on August 27 were due to electric currents produced by the action of subterranean forces.

THE LITERATURE OF THE FISHERIES EXHIBITION

FROM the moment of its inauguration, the present Exhibition has been the centre of a ceaseless activity, and we doubt if its streaming thousands of visitors have realised the amount of real work which has gone on in their presence. The results of this, embodied in an extensive literature, are now before the public, and add another testimony to the faultless management of the governing body. The enormity of the fishing interest and the need of reform in certain of its branches, are obvious; and now that the press is speculating upon the "outcome" of this great enterprise, all eyes are turned upon the executive. The extent to which the Exhibition is under State control is in itself a guarantee of success, and we hail with pleasure that same system of descriptive labelling of the exhibits, and the publication of authentic treatises upon or cognate to them, so long characteristic of the adjacent National Museum. By this system the public nets a tangible result—a knowledge of that which is at stake—becoming thus prepared to form a rational estimate of the final issue.

Of these treatises or "Handbooks"—also introductory to the more important "Conference Papers" to be spoken of hereafter—twelve have been already published, and it is to be regretted that they were not ready upon the opening day. Foremost among them is a powerful treatise on "The British Fish Trade," by His Excellency Spencer Walpole, whose authority in these matters no one will venture to doubt. Here at the outset, we encounter, in the deplored absence of reliable statistics, one of the most formidable difficulties of the whole question, and the labour under which the author has collected those upon which he so ably generalises, speaks for itself. It is shown that the East Coaster, Manxman, and Cornishman are—for obvious reasons—gradually monopolising the "take," and in the discussion upon and ultimate denunciation of the "brand" question, every thoughtful reader will agree. That a legal reform is pending no one will doubt, and such statements as those on p. 3 regarding the registration of boats, and on pp. 17 and 19 concerning the regulation of lights, suffice to show how the follies of this world can confound its administrative wisdom. This admirable work is a masterly analysis of the "catch and distribution," and should be read by all who would grasp the question in hand.

Dealing with the purely legal aspect, Mr. F. Pollock produces an authoritative work on "The Fishery Laws." The freshwater fisheries are seen to be, of necessity, more protected by law than those of the sea, territorial waters excepted; and it is important to note the extent to which conservators and other local authorities are empowered. The present aspect of the question is ably summed up in the author's "conclusion" to this a concise and well-arranged work.

The educational side of the matter has not been overlooked. In the production of a valuable little work on the zoology of food-fishes, Mr. G. B. Howes has successfully solved the very difficult problem of so diluting a large store of special knowledge, as to present it in a form well adapted to the assimilation of the class of readers for which it was avowedly written; and at the same time has contrived to invest it with an earnestness of tone and a dignity of conception which cannot fail to be productive of good to the most casual student. We cannot expect a composition of this kind to assume the accurate character of a text-book, and hence a few omissions, which more mature reflection would have remedied, constitute faults which should readily be overlooked. Altogether the author may fairly be congratulated on having scored a genuine success. Mr. W. S. Kent has done good service by bringing into one volume a synopsis of the distinctive characters of *every species* of British fish. His work, welcome for this reason alone, also embodies observations upon fishes in captivity, made during his career as naturalist to various existing aquaria. Many of them are interesting, but those upon the feeding of fishes must not be taken as necessarily indicative of their natural habits. The strange, guarded mode of progression of the Boar-fish, John Dory, and others described, can also be seen in the Pike in his native run. Much of the controversial matter in this book, befitting a conference paper, would, so treated, have entailed a desirable curtailing of this, a popular work of reference.

Man's all-prevailing imagination is wisely checked in "Sea Monsters Unmasked," in which Mr. H. Lee collects the scattered literature of this subject, and puts in a strong plea for the "cuttle theory," of which he is a well-known champion. An able defence of Pontoppidan is maintained, and one novel record set forth in this work is the dissipation of superstition—the kraken of our childhood—by a bishop—a Norwegian however, and in the eighteenth century. The two last-named manuals are illustrated, and all concerned merit congratulation upon the production of such examples of xylographic art as cover pp. 18 and 21 of the latter work.

The four following volumes are devoted to the more practical side of the industry. Mr. E. W. Holdsworth gives an exceedingly clear and systematic account of "The Apparatus for Fishing," and by the use of well-chosen similes succeeds in making plain his descriptions of the most intricate apparatus. The advances dependent upon the introduction of the "ketch-rigged" boats must, as here set forth, impress the reader with the need and value of improved apparatus. From the manner in which the various topics are treated by so competent an author, the reader can form some definite notion of the real practical difficulties which our fishermen encounter. These and other like matters are also fully dealt with in the two following works, by Messrs. J. G. Bertram and W. M. Adams respectively. The former is a plea for "The Unappreciated Fisherfolk," and the latter deals with the "Fisheries and Fishermen of all Countries." Much fresh testimony to the antiquity of the industry and the remarkable community of its followers—wherever they are found—is brought forward in these two volumes. Their hard-worked lives are shown, as generally acknowledged, to bring in but a scanty remuneration, accompanied by ceaseless anxiety and danger: how far the former is not at times due to their inherited conservatism—especially as regards the bait question—remains uncertain. The moral attributes of their lives, often untainted by "civilisation," are fully attested, and any one who has witnessed the operations incident upon, say, a Scotch herring take, will know that reform in this respect is more needed among the "gutters" and others accessory to the work than among the fishermen proper. The evidence adduced here and elsewhere points to a need of immediate reform in the apprenticeship question, much that is bad in it being due to existing regulations. The sketch given of the decay of the Irish fisheries is to be deplored, but of their restoration a hope still lingers. It is certain that if our fisherfolk "know nothing whatever about fish, except the way to catch them," they know this at least thoroughly. Mr. Adams claims for Oppian the dignity of an ichthyologist, and gives Ælian perhaps more than his due on p. 16 of his book. An incident, bearing upon the foundation of "Holland's Maritime Ascendancy" (p. 37), will not fail to interest our readers at the present time, and we note that neither Mr. Adams' researches nor those of any one else, have yet satisfactorily cleared up the origin of trawling.

It is not reassuring to compare the state of affairs in India, as detailed in Dr. Day's Manual, according to which, matters in that land stand as much in need of reform as at home. The author attributes the existing deplorable condition of the Indian fishermen largely to misrule, but more especially to the weight of the salt-tax imposed by the British; indeed, this topic is the refrain of the whole book, and the author's own investigations go far to support the belief. As might be expected, there are some curious customs and forms of apparatus described, in use among men so interesting as these from an ethnological point of view. Some speculations on p. 37 as to the behaviour of ova in mud are at least suggestive as our knowledge stands, and it is sincerely to be regretted that we have no British representative of the air-breathing Ophiocephalidæ described on p. 31, for if so, we venture to say that reform in the matter of our freshwater-fisheries would be less slow. Dr. Day also furnishes a work on "Fish Culture," in which he gives a historical review of the different aspects of this subject, not altogether favourable to our own possessions. Bewailing the need of Governmental action, and deploring the lack of statistical evidence upon which to generalise, the writer has either collected or furnished a mass of information which will both enlighten the public and prove of service to the practical man. The style of this book is somewhat heavy, and might be improved by a little judicious thinning. Both Dr. Day's books are illustrated—in the case of the former somewhat unintelligibly. No one interested in fishing will regret the failure of an attempt (made, we believe, by the late F. Buckland) to acclimatise the Sheat-fish (Silurus).

Mr. C. E. Fryer, in his work on "Salmon Fisheries," throws some doubts upon the necessity of elaborate artificial breeding, in a weighty argument, having for its key-stone the restoration of our waters by the removal of pollution. The intricacies of the vexed question in hand are admirably put before the reader, and the author shows that, in some cases, existing obstacles could be removed, or that at least considerate action could, if exercised at the right time, beneficially modify the present state of affairs. In a comparison of the "pass" and "dam" systems, the success of Cooper's pass, on the Ballisodare River, Ireland, is adduced as a strong argument for the salmon-ladder. The reported death, after spawning, of the kelts of British Columbia opens up a new field for inquiry; and those interested in animal intelligence, so much discussed in these pages, will find here some interesting additional testimony to the capacity of the salmon. The author's description of the dawn of life on pp. 13 and 14 might be advantageously improved.

The only remaining volume, one by Mr. J. P. Wheeldon, treats of "Angling Clubs and Preservation Societies"; and in tracing the growth of many of these it is shown that they have done good work, as, for example, the abolition of "snatching" and "night-lining." The opening remarks, however, are not favourable to the majority of those in London, whose members unfortunately constitute more than ninety per cent. of our Thames angling-community. In tracing the changes wrought in our local waters, the village poacher of old is compared with the modern steam launch as a destroyer, and one more protest against the latter is lodged by the writer, a champion in the cause. It is important to note that the best regulated waters are those in which the management is vested in the hands of resident local bodies.

Such are these "Handbooks," the main portion of a series which will doubtless form a complete, but none too hopeful, epitome of the subject-matter. We now turn to the "Conference Papers."

The meetings at which these were read and discussed were all thrown open to the public, and, what is of greater importance, there were to be found present influentials of all grades and nationalities from royalty down to the very fishermen and dealers whose immediate interests were under discussion. The chair was invariably occupied by some one of authority—in one case by a sole living "Minister of Fisheries."

Of the masterly inaugural address delivered by Prof. Huxley, and of the paper by H.R.H. the Duke of Edinburgh, which formed the subject of the first sitting, the public have already been fully informed, and no one who was present at either of those meetings could fail to observe that the surroundings augured at least an active future. Concerning the address, suffice it to say that the truth of the only statement upon which dissension has been raised —by a carping minority who have entirely misunderstood the real meaning implied—has been more fully verified at each subsequent sitting (we refer to the inexhaustibility of the herring-fisheries). The very fact that in the latter admirable paper an attempt has been made to estimate *for the first time* our national take of fish—615,000 tons per annum—to say nothing of other statistics, gathered with immense labour, is in itself sufficient to justify immediate action, striking as it does at the very root of the evil at present existing—at the same time forming a good starting point for future investigation.

Beyond the formal passing of a vote of thanks, these were both dismissed without discussion, that upon the latter being adjourned *sine die;* but the subject-matters of the twenty-six papers which follow on were all freely discussed, both the length of the paper itself and of each speaker's remarks being under control, such as favoured a thorough sifting and all-round investigation of the topic under consideration—the object being to get at facts rather than to frame schemes. The Exhibition itself shows the far-reaching interests of the fishing industry, but in the account which follows we have attempted to roughly classify the work done in conference.

The gravity of the important question of "supply" will be seriously increased should the ingenious argument advanced by Sir H. Thompson on pp. 14 and 15 of his "Fish as Food" be substantiated. This paper is of great value, embodying as it does the most recent analyses in the question, of which it must be admitted that very little is known, and dissipating certain cherished but fallacious notions, in matters dietetic. Deploring our national indifference to these, the author formulates them for all conditions ofmen, on the supposition that fish shall be eaten, giving some valuable hints for practical treatment. It is well known that the West Highlander would probably rather starve than eat the eel which abounds in his waters, and which, the experienced author of this paper shows, supplies the very requisites of which he most stands in need.

Of first importance among a series of papers dealing with our home sea-fisheries is that on "The Herring Fisheries of Scotland," by Mr. Duff, M.P. Certain aspects of this question have been before the public for some time past, but the conclusions drawn by the writer all point to the introduction of improved apparatus and harbour accommodation, and to the repeal of any restrictive legislation which may exist in this—a matter in which the current official report shows that we do not know sufficient of the habits of the fish themselves to even account for their movements, still less to legislate upon their capture. This paper will be of great value to the practical fisherman, and furnishes a good survey of all sides of the industry. No greater argument for improved tackle can be adduced than that of the change wrought in our herring-fisheries by the substitution of cotton for hemp netting. The closely allied "Mackerel and Pilchard Fisheries" form the subject of a thoroughly practical paper by Mr. T. Cornish, himself a worker. In the absence of statistics to prove otherwise, reform points in the same direction as for the herring-fisheries. Fuller information on the question and probable cause of the fluctuations in the "boat-side" price of mackerel (p. 10) would be acceptable. Although the habits of the pilchard baffle us, the author shows that where these fishes do occur they are most productive, and giving some interesting statistics concerning them, he advocates the establishment of a cheap market for their sale. In the discussion which follows, Prof. Brown Goode gives a short but interesting account of the American mackerel-fisheries. Two short papers on "Trawling" and "Line Fishing," respectively by Messrs. A. W. Ansell and C. M. Mundahl, embrace all the information upon our sea-fisheries other than that given above. Our readers are doubtless aware that a Commission is now inquiring into the disputes between the advocates of these two great systems, and much of the matter contained in these papers is naturally devoted to them. An amount of useful statistical information is collected, and certain subsidiary questions are discussed in their bearing upon the industry, notably those connected with transport. The old belief that the beam-trawl displaced and destroyed the ova of our deep-sea fishes has been but recently shattered by Sars, but Mr. Ansell adduces evidence to show that the question of shore-trawling demands investigation. There can be no reasonable doubt but that trawling will be the fishing of the future; it gives constant employment for the whole year, all objections raised against it are dissipated, and its advance must be sought in the application of steam power. It will be generally admitted that our existing home-difficulties are in no way due to defective apparatus.

Capt. Temple, in writing on "Seal Fisheries," adopts the wise course of holding himself responsible only for those of which he has had actual experience, leaving a hiatus, filled in during discussion by Mr. Martin and others. Devoting but little attention to the legal aspect of the industry, which we venture to say stands, with us, sorely in need of reform, the author seems more hopeful than the world at large of the chances of the chase. The body of the paper sets forth the *modus operandi* of the unenviable life of the sealer, whose lot entails great hardship, often rendered none the less buoyant for an excess of oil, nor the less happy under a "truck system." More might have been said with regard to this industry.

Turning now to other countries, we have most prominent a highly important paper on "The Fishery Industries of the United States," by Prof. Brown Goode. Some idea of its contents will be formed when we say that it fully bears out the impression made by the magnificent exhibits of that country, to study which delegates have even been sent over from other lands. The paper is a mine of useful information, and the refreshing speeches which have fallen from its author during the Conference meetings have shown how much remains untapped. The accounts given of refrigerator-cars, special oyster-trains, of the utilisation of waste, and the well-known potting system on the economic side; of floating hatcheries, of the artificial propagation of fish (twenty-seven species), and other practical topics; and on the administrative side, of the amount of liberty allowed in matters where a more jealous State might interfere, surely point to a common moral. The history of the Menhaden fishery cannot fail to strike all readers as an example of what can be done by persevering in a "new departure," and it is important to note that the system of management and insurance of the boats composing the American fishing fleets is such as to give every impetus to the work by arousing the best interests of the men, at the same time insuring those of the capitalist. The statements advanced in both this and a paper on the Canadian fisheries, by Mr. L. Z. Joneas, are based upon deductions from a most perfect system of registration. The status of the latter country—jealous of its reputation—in fishing matters is everywhere recognised, but even it has to record the failure of attempts to artificially cure the cod—the staple fish of its trade—and the writer deplores, for good reasons, the want of export traders in this the leading enterprise of its fishing population. The herring and mackerel fisheries are also dealt with, and it is reassuring to us to read that for the regulation of its lobster fisheries, of ten years' standing, Government measures are still being taken. The written account of the seal fishery conveys a good notion of its importance and a far better one of its technique than do certain sanguinary models exhibited in the Newfoundland section. The method of working a steam service on a wage system (in connection with their Great Lake fisheries) is worthy of attention.

Coming nearer home, Prof. Hubrecht, on behalf of the Dutch Government, tenders some very valuable observations upon the "Oyster Culture and Fisheries in the Netherlands." Upon the present state of *our* oyster-beds no comment is needed, any more than upon the fruitless efforts on the part of private individuals to establish new fisheries in our own waters. The experimental evidence—the result of observations still going on—brought forward by the author is of the highest importance; statistics favourable to artificial culture are given, the period of sexual maturation has been determined, and these and other similar facts ascertained all point to the conclusion drawn, viz. that "a close time *may* be of service, but that the great thing appears to be to leave a fair portion of the oysters on or around a natural bed wholly undisturbed for a series of consecutive years." This fact, discovered by chance in the Netherlands, embodies the sense of a statement made by Prof. Huxley in the matter in his opening address. It is noteworthy that the purely scientific biological and physico-chemical aspects of this question have received their full share of attention.

The main question bearing upon Mr. C. Harding's paper on "Mollusks" is that of bait. As the matter stands, action would be premature, until it can be shown that other forms of bait than those now in use are of no avail. It is well known that, on the one hand, fishermen are often compelled to stay on shore for want of bait, and on the other, it must be remembered that they are as conservative in this matter as in any which concerns them; but the fact that under *like circumstances* the Lofoden Islanders carry on a brisk catch by aid of the "gill-net," must not be overlooked.

(*To be continued.*)

THE PARIS OBSERVATORY EQUATORIAL[1]

THE accompanying illustration represents the remarkable apparatus recently set up in the Observatory of Paris, to which we have before called attention, the ingenious construction of which is due to M. Lœwy, sub-director of that establishment. Begun under the administration of M. Delaunay, interrupted during the war, thanks to a new act of munificence on the part of M. Bischoffsheim, it has now been finished.

To answer the requirements of modern astronomy equatorials are necessarily gigantic. Like the guns of modern warfare, each new apparatus is constructed on a larger scale than that of its predecessors, though it is not for purposes of destruction that they are aimed at the celestial bodies.

The advantages of the new equatorial are (1) that it measures great angular distances; (2) that it enables observations to be made with comparative ease and rapidity. Seated on a fixed chair apart from the support of the instrument, the astronomer is as if placed before his writing-table. The instrument obeys him, not he the instrument.

The new telescope is bent at right angles, one part directed in a line with the axis of the earth, and capable of turning round itself; the other perpendicular to it, and therefore moving in the plane of the equator. At the extremity of the latter is a mirror, and at the elbow of the telescope, in the interior, another mirror, both forming with the axis an angle of 45°. These mirrors are intended to reflect to each other, and finally to the observer seated with his eye at the eyepiece, the image of the star which is the object of observation.

The loss of light from successive reflections is hardly perceptible. The deformation which the images might suffer from the use of mirrors of insufficient thickness has been guarded against. In its optical qualities, too, the new equatorial is not surpassed by any telescope in the Observatory. Two advantages have thus been secured—the power of measuring great angular distances, and that of exploring the entire heavens, the observer regulating the apparatus himself, and not needing to shift his position.

Another benefit resulting from these happy arrangements must also be mentioned—the abolition of the Observatory with a heavy, ungainly, and expensive dome, and the substitution of one of much smaller compass and of much simpler construction. It consists of a movable part covering the object-glass end, and of a fixed part appropriated to the observer. When proceeding to make observations the

[1] From *La Nature*.

The New Bent Equatorial at the Paris Observatory.

observer draws away the movable part, which readily rolls on a railway. The extremity of the telescope bearing the mirror of the objective is thus left uncovered, while the astronomer, ensconced in his fixed part as in his own room, and sheltered from all inclemencies of weather, studies the infinitely great in conditions as comfortable as those of the naturalist who examines under his microscope the infinitely little.

Seeing it is but just that those who bear the burden should also enjoy the honour, we again state that the optical part of this instrument has been executed by the Brothers Henry, and the mechanical part by MM. Eichens and Gauthier.

THE INSTITUTION OF MECHANICAL ENGINEERS

THE Institution of Mechanical Engineers have held their autumn meeting this year in Birmingham—a town which for many years was the headquarters of the Society. The returning to their former seat was specially opportune, because the first paper on the list related to one of the greatest of Birmingham worthies, viz. James Watt. The title of the paper was "On the Inventions of James Watt, and his Models preserved at South Kensing- and Handsworth." The author is Mr. Edward A. Cowper, who, from his long connection with engineering both personally and through his father and uncle, is perhaps as well fitted as any man in England to trace out the course of Watt's inventions. This he has endeavoured to do, using as his main guide the numerous models preserved partly at the South Kensington Museum, partly at the Patent Office Museum, and partly at James Watt's house at Handsworth in Birmingham. Some of the models at South Kensington were in danger of falling altogether to pieces from dry rot and decay, but owing to the exertions of Mr. Sandham, the curator of this department, they have, as far as possible, been repaired; whilst, in addition, a complete set of photographs has been taken, which, even if the models themselves should cease to exist, would preserve their appearance and construction to future ages.

The sequence of James Watt's inventions with regard to the steam engine is stated at the end of Mr. Cowper's paper as follows:—

Firstly, in 1769 he made an invention (the separate condenser) which was practically an improvement on the Newcomen engine, the effect of which was to work pumping engines more economically and quickly.

Secondly, in 1781 he produced rotative power for driving factories, obtaining it in a manner by having a heavy balance weight to act one way whilst the steam acted the other way; however, the obtaining rotative motion by steam was an enormous advantage, far greater in its effect, in the author's opinion, than the improvement in the pumping engine.

Thirdly, the crowning invention of 1782 made the steam engine the one useful motive power, by making it double-acting and fit to drive cotton mills, flour mills, and all other machinery requiring regular rotative motion.

These various stages are illustrated by the models above mentioned. It is indeed doubtful whether there exists at present any model embodying the first idea of the separate condenser; but there is a most interesting model at South Kensington showing the condensation of steam in a separate surface condenser, composed of a large number of vertical tubes and provided with an air pump. This form of condenser, which in many cases, such as marine engines, has superseded all others, is thus proved to have been invented by James Watt, and not only invented, but brought to a high degree of perfection. The arrangements in this model, according to Mr. Cowper (than whom there can be no better authority), are in points equal to the best modern examples of surface condensation.

The only model actually exhibited was an engine of the character of Watt's patent of 1771. It is single acting, and has an open-topped cylinder, air pump, and condenser. There is a heavy bob on the connecting rod, which is used to help the piston up, while the vacuum formed below it causes it to descend on the return stroke, thus obtaining rotative motion. This engine, however, has a crank, and it is known that for many years Watt was afraid to use the crank in his engines, as it was supposed to be barred by another patent: it is true that his patent of 1771 shows a crank composed of a pin in a disk, but this is carefully termed "the point of attachment of the connecting rod." In practice, however, he used other methods, chiefly the well known sun and planet motion. Of this there are several different forms, which are illustrated by models at South Kensington. There is also a device consisting of a long rack or ladder fixed to the end of the connecting rod and digging into the teeth of a spur wheel on the engine shaft; the rod being guided by means of rollers running in a guide plate, so as to keep it in gear throughout the revolution.

Turning now to the 1782 patent, we find what Watt describes as "the new improved engine, the piston of which is pressed forcibly both upwards and downwards by the power of steam," that is to say, the engine is no longer single-acting, but double-acting. Here the chain hitherto used between the piston-rod and beam is replaced by a parallel motion, and the engine takes very much the form which was still common for shop engines within recent years. A good model of such an engine exists in the South Kensington Museum.

Some variations of this engine, probably made subsequently, are also illustrated by models, such as the Bull engine, in which the piston-rod passes out through the bottom of the cylinder, and takes hold of a beam placed lower down.

Still more interesting are Watt's proposals to make use of the expansion of steam for the saving of fuel; a diagram in one of his specifications shows that he fully understood this action, and he gives several methods by which the load upon the piston may be varied so that when the pressure is least it shall have least work to do. One of these is to mount a weight high up above the beam, which would be lifted when starting from either end of the stroke, and fall after passing the centre; this has been used even in recent times with good results. Several miscellaneous inventions of high interest are also described; one of these is the well-known invention of the steam indicator in probably its earliest and rudest form. Another is a counter for telling the revolutions of an engine, of which an actual specimen in good preservation remains in the Patent Office Museum.

There is also an arrangement for obtaining rotary motion in opposite directions out of the same engine by means of two connecting rods starting from a cross-head at one end of the beam, but working opposite ways. Another model shows two hammers worked by a single engine, the one lifted from the belly like an ordinary forge hammer, and the other by depressing the tail like a tilt hammer. A yet more curious device is a semi-rotary engine, of which an unfinished model remains in the Watt Room at Heathfield Hall. Here there is a piston fixed in a radial line to the shaft, within a large disk or cylinder. Inside this cylinder, at one part, is a fixed support, against which the steam presses each way as it acts against the piston, in either one direction or the other. The reciprocating shaft was made to act by a spur wheel on two racks attached to the pump rods. Watt also invented a very simple form of rotary engine, which, as Mr. Cowper states, has probably been reinvented at least fifty times since 1782, the year of his patent.

This leads us to notice the Watt Room, or attic workshop of James Watt, which still remains at Heathfield Hall precisely as he left it—his lathe and bench standing at the window, his tools lying about, and his old leather apron hung on the vice. There are numerous shelves with drugs and parcels on them, chiefly relating to his invention of copying-ink, and nests of small drawers full of tools; but the principal objects which strike the attention are two large machines for copying sculpture, whether in marble, alabaster, or wood. One of them copies to the exact size of the original, but the other is a reducing machine, taking a copy on a very reduced scale. The construction of both machines is described in the paper, and bears testimony to the inventive and mechanical genius of James Watt. The principle in each case consists in using a bar or slide, having at one end a blunt point to feel over the surface of the model, and at the other end a quick-running drill to cut away the surface of the material operated on. This drill is worked by a light cord attached to an ordinary foot lathe, whilst the bar, by means of a skilful arrangement of trussed frames, is made movable in any direction as the feeler passes over the model. The model and work can also be rotated, so as to be set at an angle for handcutting, &c. The drills and cutters, of which a large number are preserved, are excellent in their design and workmanship. These machines were apparently the amusement of Watt's late years, and are frequently referred to in his correspondence. They were never protected in any way, and partly perhaps for that reason have never been followed up and brought to perfection.

The second paper read was a report by the Research Committee on Friction. The Institution experiments on friction, which have been long delayed, have at length been carried so far as to admit of the publication of an interim report, prepared by Mr. Beauchamp Tower, which proves to be of great interest. They are, properly speaking, experiments on *lubrication*, being conducted on a 6-inch steel shaft or journal, which could be run at any given velocity, and on which rested a brass bearing carrying a loaded frame. By altering the load on this frame the pressure per square inch on the brass could be altered; and the temperature could also be altered by means of gas jets under the journal. As a standard of comparison experiments were first tried with the underside of the journal running in a bath of oil, so as to give the maximum of lubrication. The results of these experiments were to show that the friction of bearings under such circumstances follows the laws of liquid rather than (as usually assumed) of solid friction. These laws are very different. Solid friction varies directly as the pressure per unit of area, is independent of velocity at low speeds (Morin), but decreases with increasing velocity at high speeds (Galton, &c.). Liquid friction, on the other hand, is independent of the pressure per unit of surface, is directly dependent on the extent of surface, and increases as the square of the velocity. In fact it is not friction at all, but the shearing of one part of a more or less viscous fluid across another, as the above law plainly indicate. Now the Institution experiments show that, in the case of oil-bath lubrication, there is really a film of liquid oil surrounding the journal and keeping it away from the brass; and that what is called journal friction is really the shearing of one part of this film over the other. In such cases the friction may be exceedingly small: in some of these experiments it actually was as low as 1/1000th, and 1/500th is easily attained. This is much below what is generally supposed to obtain. The limit of pressure appeared to be about 600 lbs. per square inch. Beyond this the oil is squeezed out, and the metal "seizes." This is of course with high speed and constant pressure; with low speeds and intermittent pressure (as was pointed out in the discussion) very much higher pressures are admissible.

So far the experiments were satisfactory; but when the oil-bath was replaced by ordinary modes of lubrication, great difficulties were experienced. When the oil was introduced from above through grooves in the brass, it was found that, however these were cut, and at whatever part of the brass then opened, the bearing seized at a comparatively low pressure. The fact that such methods do as a matter of fact answer with ordinary railway vehicles is accounted for, it is supposed, by the end play of such bearings, and probably also by the general vibration. When, however, a pad fed with oil by capillary attraction from a bath below, was placed below the journal, so as to press lightly against it, satisfactory results were obtained, although the lubrication was so slight as only to appear to the touch as a slight greasiness. The laws here, however, approximated to those of solid friction, and probably the oil merely acts to fill up the little inequalities of the metal, and so practically render it smoother.

A curious subsidiary result should be noticed. When the oil-bath experiments were in progress, advantage was taken of the brass being removed to drill a hole in it for the subsequent tests with ordinary lubrication. On resuming the running, however, the oil was found in the hole, and on a pressure-gauge being attached, the finger rose to above 200 lbs. per square inch, which was the limit of its indications. This pressure was above the *average* pressure on the brass, and shows clearly that the surfaces are separated by a continuous film of oil, having at each point an actual hydrostatic pressure due to the external pressure which obtains at that point.

On the whole, these experiments, while to a great extent confirming the well-known researches of Prof. Thurston in America, throw a good deal more light on the curious phenomena and laws of journal friction. Their results (including some on temperature, which was found to have a marked influence in diminishing friction) are contained in a series of tables, which our space forbids us to publish, but which can no doubt be obtained, by any one interested, from the offices of the Institution, at 16, Victoria Chambers, Westminster.

NORDENSKJÖLD'S GREENLAND EXPEDITION[1]

II.

IN my report of the expedition of 1870 I drew attention to a clayey mud which is found in circular cavities, from one to three feet in depth, on the surface of the inland ice, not only near the shore, but even as far inland as we reached on that occasion. My companion on that occasion, Prof. Berggren, discovered that this substance formed the substratum of a peculiar[2] ice-flora, consisting of a quantity of different microscopical plants (algæ), of which some are even distributed beyond the clay on the ice itself, and which, in spite of their insignificance, play beyond doubt a very important part in nature's economy, from the fact that their dark colour far more readily absorbs the sun's heat than the bluish-white ice, and thereby they contribute to the destruction of the ice-sheet, and prevent its extension. Undoubtedly we have, in no small degree, to thank these organisms for the melting away of the layer of ice which once covered the Scandinavian peninsula. I examined the appearance of this substance in its relation to geology, and demonstrated:—

1. That it cannot have been washed down from the mountain ridges at the sides of the glaciers, as it was found evenly distributed at a far higher elevation than

[1] Continued from p. 13.

[2] Lately described by Prof. V. Wittrock. "Om Snöns och Isens Flora, Särskildt i Arktiska Trakterna." Ur "A. E. Nordenskjöld, Studier och Forskningar föranledda af mina resor i höga Norden." (Stockholm, 1883.) See NATURE, vol. xxviii. p. 304.

that of the ridges on the border of the glaciers, as well as in equal quantity on the top of the ice-knolls as on their sides or in the hollows between them.

2. That neither had it been distributed over the surface of the ice by running water, nor been pressed up from the hypothetical bottom "ground" moraine.

3. That the clay must therefore be a sediment from the air, the chief constituent of which is probably terrestrial dust spread by the wind over the surface of the ice.

4. That cosmic elements exist in this substance, as it contained molecules of metallic iron which could be drawn out by the magnet, and which under the blowpipe gave a reaction of cobalt and nickel.

Under these circumstances the remarkable dust which I have named "kryokonite," *i.e.* ice dust, obtained a great scientific interest, particularly as the cosmic element, viz. the matter deposited from space, was very considerable. Even later students who have visited the inland ice have observed this dust, but in places surrounded by mountains from which it might with more probability have been washed down. They have, therefore, and without having examined Prof. Berggren's and my own researches of 1870, paid little attention to the same, while the samples brought home by Dr. N. O. Holst from South Greenland in 1880 were not very extensive.

But now Dr. Berlin brings home from a great variety of places ice algæ, which, I feel convinced, will contribute fresh materials to our knowledge of the flora of the ice and snow. For my own part I have re-examined my first researches of the kryokonite, and they are fully corroborated. Everywhere where the snow from last winter has melted away, a fine dust, gray in colour, and, when wet, black or dark brown, is distributed over the inland ice in a layer which I should estimate at from 0·1 to 1 mm. in thickness if it was evenly distributed over the entire surface of the ice. It appears in the same quantity in the vicinity of the ice border surrounded by mountains as a hundred kilometres inland, but in the former locality it is mixed with a very fine sand, gray in colour, which may be separated from the kryokonite. Further inland this disappears, however, completely. Gravel or real sand I have never, in spite of searching for them, discovered in the kryokonite. The kryokonite always contains very fine granular atoms, which are attracted by the magnet, and which, as may be demonstrated by grating in an agate mortar and by analysis under the blowpipe, consist of a gray, metallic element, viz. nickel iron In general the dust is spread equally over the entire surface of the ice; thus it was found everywhere where the snow from the previous year had melted away, while, to judge by appearances, there seemed to be little difference between the quantity found near the coast and in the interior. The dust does not, however, form a continuous layer of clay, but has, by the melting of the ice, collected in cavities filled with water, which are found all over the surface. These are round, sometimes semicircular, one to three feet in depth, with a diameter of from a couple of millimetres to one metre or more. At the bottom a layer of kryokonite one to four millimetres in thickness is deposited, which has often, by organisms and by the wind, been formed into little balls, and everywhere where the original surface of the ice has not been changed by water-currents the cavities are found so close to each other that it would be very difficult to find a spot on the ice as large as the crown of a hat free from them. In the night, at a few degrees below freezing point, new ice forms on these hollows, but they do not freeze to the bottom even under the severest frost, and the sheet which covers them is never strong enough to support a man, more particularly if the hole is, as was the case during half our journey, covered with a few inches of newly-fallen snow.

The kryokonite cavities were perhaps more dangerous to our expedition than anything else we were exposed to. We passed, of course, a number of crevasses without bottom as far as the eye could penetrate, and wide enough to swallow up a man, but they were "open," *i.e.* free from a cover of snow, and could with proper caution be avoided, and the danger of these could further be minimised by the sending of the two-men sledges in front, and if one of the men fell into the crevasse he was supported by the runners and the alpenstock, which always enabled him to get up on the ice again. But this was far from being the case with the kryokonite hollows. These lie, with a diameter just large enough to hold the foot, as close to one another as the stumps of the trees in a felled forest, and it was therefore impossible not to stumble into them at every moment, which was the more annoying as it happened just when the foot was stretched for a step forward, and the traveller was precipitated to the ground, with his foot fastened in a hole three feet in depth. The worst part of our journey was four days outward and three days of the return, and it is not too much to say that each one of us during these seven days fell a hundred times into these cavities, viz. for all of us 7000 times. I am only surprised that no bones were broken, an accident which would not only have brought my exploration to an abrupt close, but might have had the most disastrous consequences, as it would have been utterly impossible to have carried a man in that state back to the coast. One advantage the kryokonite cavities had, however, viz. of offering us the purest drinking-water imaginable, of which we fully availed ourselves without the least bad consequences, in spite of our perspiring state.

On July 16 we covered thirteen, on the 17th eighteen and a half, and on the 18th seventeen and a half kilometres. The country, or more correctly the ice, now gradually rose from 965 to 1213 metres. The distances enumerated show that the ice became more smooth; but the road was still impeded by the kryokonite cavities, whereas the rivers, which even here were rich in water, became shallower, but stronger, thus easier of crossing. Our road was, besides, often cut off by immense snow-covered crevasses, which, however, did not cause much trouble.

On the night of the 18th, when arrived at camp No. 14, the Lapp Anders came to me and asked if he might be permitted to "have a run," viz. to make a reconnaissance on "skidor,"[1] to see if there was no "land" to the east. This granted, he started off without awaiting supper. He came back after six hours' absence, and reported that he had reached 27 kilometres further east, that the ice became smoother, but was still rising, but there was no sign of "land." If his statement was true, he had, after a laborious day's journey, in six hours covered about sixty kilometres! At first I considered his estimate exaggerated, but it proved to be perfectly correct. It took us thus *two whole* days to reach as far as he had got, as shown by the track in the snow. I particularly mention this occurrence in order to show that the Lapps really did cover the estimated distance of their journey eastward, of which more below.

During these days we passed several lakes, some of which had the appearance of not flowing away in the winter, as we found here large ice blocks several feet in diameter, screwed up on the shore, which circumstance I could only explain by assuming that a large quantity of water still remained here when the pools about became covered with new ice. The lakes are mostly circular, and their shores formed a snow "bog" which was almost impassable with the heavy sledges.

On July 19 we covered seventeen and a half, on the 20th sixteen and a half, on the 21st, seven, and on the 22nd seven and a half kilometres (15th to 18th camp). The ice rose between them from 1213 to 1492

[1] [The Swedish "skidor" and Norwegian "Ski," are long strips of pine-wood slightly bent at the top, polished and as elastic as if they were of the finest steel, with a strap for the feet in the centre, on which the Lapps and Scandinavians run on the snow with remarkable agility at a tremendous pace.—ED.]

metres. The distances enumerated fully show the nature of the ice. It was at first excellent, particularly in the morning, when the new snow was covered with a layer of hard ice; but on the latter days we had great difficulty in proceeding, as a sleet fell with a south-east wind in the night between the 20th and the 21st. The new snow, as well as that lying from the previous year, became a perfect snow bog in which the sledges constantly stuck so that it required at times four men to get them out. We all got wet, and had great difficulty in finding a spot on the ice dry enough to pitch the tent. On the 22nd we had to pitch it in the wet snow, where the feet immediately became saturated on putting them outside the indiarubber mattresses. A little later on in the year, when the surface of the snow is again covered with ice, or earlier, before the thaw sets in, the surface would no doubt be excellent to journey on.

When we, therefore, on July 21, were compelled to pitch the tent in wet snow, as no dry spot could be discovered, and it was impossible to drag the sledges further, I sent the Lapp Lars Tuorda forward on "skidor" to find a dry road. He came back and stated that the ice everywhere was covered with water and snow. For the first time in his life he was at a loss what to suggest. It being utterly impossible to get the sledges further, I had no choice. I decided to turn back.

I wished, however, to let the Lapps go forward some distance to the east to see the country as far as possible. At first I considered it advisable to let their journey only last twenty-four hours, but as both Anders and Lars insisted that they were most eager to find the "Promised Land," and said they could do nothing towards discovering it in that short period, I granted them leave to run eastwards for four days and nights, and then return.

On leaving I gave them the following written orders:—

"Instructions for Lars and Anders's 'skid' run on the inland ice of Greenland, viz.:—

"Lars and Anders have orders to proceed on skidor eastwards, but are allowed to alter the course, if they may deem it advisable, to north or south.

"At the end of every third mile the barometer shall be read and the direction run noted.

"The absence is to be four days, but we will wait for six days. After that, viz. on the morning of July 28, we return. If not returned, we leave behind in a sledge provisions, brandy, mattresses, &c.

"Lars is warned not to be too bold. Should land be reached, you are to collect as much as you may gather of blossoms and grass, if possible several kinds (specimens) of each.

"Given on the inland ice in Greenland, July 21, 1883,
"A. E. NORDENSKJÖLD"

They were allowed to select what provisions, &c., they desired, and were furnished with two compasses, aneroid barometers, and a watch.

At 2.30 a.m. on July 22 they started. The days we waited for them were generally spent in the tent, as water surrounded us everywhere. The sky was covered with a thin veil of clouds, through which the sun shone warmly, at times even scorchingly. From time to time this veil of clouds, or haze, descended to the surface of the ice and hid the view over the expanse, but it was, remarkably enough, not wet but *dry*, yes, so dry that our wet clothes absolutely dried in it. We have therefore, I consider, witnessed a phenomenon on the inland ice of Greenland which is related to the "sun-smoke" phenomenon of Scandinavia, viz. what Arago has described under the name "brouillard sec."

On the 24th, after an absence of fifty-seven hours, the Lapps returned. It was the want of drinking-water and fuel which compelled them to return. The surface had been excellent for their journey, and they had covered a distance out and back of 230 kilometres, an estimate which I consider perfectly reliable. During the march forward the barometer was read every third hour. It gave the point of return a height of 2000 metres.[1]

As to the run, Lars rendered the following report: When they had reached thirty miles from the camp no more water could be found. Further on the ice became perfectly smooth. The thermometer registered $-5°$ C. It was very easy to proceed on the "skidor." At the point of return the snow was level and packed by the wind. There was no trace of land. They only saw before them a smooth ice covered by fine and hard snow. The composition of the surface was this—first four feet of loose snow, then granular ice, and at last an open space large enough to hold an outstretched hand. It was surrounded by angular bits of ice (crystals). The inland ice was formed in terraces—thus, first a hill, then a level, again another hill, and so on. The Lapps had slept for four hours, from twelve midnight on July 23, in a hollow dug in the snow while a terrific storm blew. They had till then been awake for fifty-three hours. On the first day there was no wind, but next day it came from the south, and lasted thus until twenty-four miles on the return journey, when it changed to west. On the return journey, when forty miles from our camp, two ravens were seen. They came from the north and returned in the same direction. The Lapps had for a moment lost the track of the "skidor" in the snow. The ravens flew at first, they found, parallel with the track, and then turned to the north.

On July 25 we began the return journey. It was high time, as the weather now became very bad, and it was with great difficulty we proceeded in the hazy air between the number of crevasses. The cold, after the sun sunk below the horizon at night, also became very great; and on the morning of July 27 the glass fell to $-11°$ C.

As to the return journey I may be very brief. The rivers now impeded us but little, as they were to a great extent dried up. The ice-knolls had decreased considerably in size too, and lay more apart, but the glacial crevasses had greatly expanded, and were more dangerous, being covered with snow. Even the cavities and the glacial wells, of which many undoubtedly leave a veritable testimony of their existence behind them in the shape of corresponding hollows in the rock beneath, had expanded and increased in number. On a few occasions, on the return journey, we saw flocks of birds, most probably water-fowl, which were returning from the north.

On July 31 we again sighted land, which was reached on the afternoon of August 4, and proceeded to "Sophia Harbour," where Esquimaux were, as arranged, waiting for us. For convenience sake I now divided our party into two, one of which sailed in the lifeboat of the *Sophia* to Egedesminde, where the steamer was to take us on board, and the other, in which was myself, marched to that place across the low but broad promontory which separates Tessiusarsoak and South-East Bay, and then in two Esquimaux "Kone" boats to Ikamiut and Egedesminde.

On August 16 the *Sophia* arrived from the north, embarked us, and made for Ivigtut, where we arrived on the 19th.

Of the expedition carried out under Dr. Nathorst during my absence he will himself make a report,[2] and I have no doubt that the results of the same will prove very important. Particularly will the very rich collections of fossil plants, which he has made with the greatest regard to the geological condition of the strata, be of great value to science, as they will furnish us with many new materials and detailed illustrations of the flora of the Far North during the epoch when forests of fig-trees, cycadi, ginko, magnolia, and tulip-trees covered these regions. Dr. Forsstrand and Herr

[1] I have as yet been unable to verify the barometer calculations, and the figures stated here may suffer some modification.

[2] NATURE, vol. xxviii. p. 541.

Kolthoff's collections and studies of the fauna of Greenland will also contribute to extend our knowledge of the naturalistic conditions of the Arctic regions, while the careful researches made by Herr Hamberg of the saltness, composition, and temperature of the sea will, I am sure, greatly benefit hydrography. His researches have been effected in Davis Strait and Baffin's Bay too, the hydrographical conditions of which are but little known.

With regard to the results of my exploration of the inland ice, I may be permitted to say a few words. That we found no ice free land in the interior, or, that it does not exist between 68° and 69° lat. in Greenland, is due directly to the orographical conditions which exist in this part of the country, as referred to in my programme of the expedition.[1] The land has here the form of a round loaf of bread, with sides which gradually and symmetrically slope down to the sea, *i.e.* exactly the shape which I then pointed out was a necessary condition if the entire country should be covered with a continuous sheet of ice.

But, thanks to the Lapps, my expedition is the first which has penetrated into the very heart of the enormous Greenland continent, and which has thus solved a problem of the greatest geographical and scientific importance. It is the first exploration of the hitherto unknown interior of Greenland, the only continent in the world into which man had not penetrated.

A new means of locomotion, the "skidor," seems also to have been acquired for the Arctic explorer of the future, which may greatly assist him in his work, and enable him to reach places hitherto deemed impossible of approach, but of the use of which the Lapp seems to possess, so to speak, the monopoly.

A. E. NORDENSKJÖLD

We are enabled to supplement Baron Nordenskjöld's report by the following account, furnished to us by another member of the expedition, of the visit paid to the remarkable Igaliko ruins:—

On August 24 the *Sophia* steamed to Igaliko, at the bottom of the fjord of the same name. The object of this visit was to examine the ancient Norse ruins which are found here. Those who thus believe that the "Österbygd" of Greenland was situated in this part assert that the ruins of Igaliko are nothing more nor less than those of Erik Röde's own mansion "Brattelid." However that may be, the Norseman who selected this spot for his residence acted very wisely. The ruins are situated at the very bottom of the fjord, where the absence or presence of the ocean ice on the coast affects the climate but little. The vegetation in this spot is, in consequence, quite luxuriant. Thus a vaginal plant, *Lathyrus maritimus*, grows here in such abundance that it reminds one of a field of peas, while *Ranunculus acris* attains a height of two feet, and *Campanula rotundifolia*, the bluebell, along with various grasses, flourish in great profusion. In the pools Menyanthes and Potamogeton thrive, while copses of birch-trees and willows offer excellent fuel. There are also plenty of wild berries. The ruins, the walls of which were formed of enormous blocks of sandstone, lie just below a table-shaped ridge of sandstone by the side of a crystal brook, copiously encircled by *Alchemilla vulgaris* and watercress. The spot is, in fact, one which would fully justify the name given to the country. At the time of our visit about a dozen cows were fed here, whose excellent milk we tasted, while in the beds around the huts of the natives swedes and potatoes grew luxuriantly, the former having attained the size of large apples. It certainly was strange to view this spot, and we naturally asked each other, what has become of the old Norsemen who once peopled it? It is impossible to believe that they were extirpated or conquered by the Esquimaux. It seems far more probable that both races have commingled, an assumption further corroborated by the strange circumstance that Esquimaux are found in this tract who have never been in contact with the Danes, but who nevertheless possess features of pure Norse character.

[1] NATURE, vol. xxviii. p. 37.

THE VIENNA INTERNATIONAL ELECTRIC EXHIBITION

(FROM OUR VIENNA CORRESPONDENT.)

THE Scientific Commission having for its purpose the taking of electrical measurements and conducting scientific researches at the Exhibition commenced its work on September 17. By the assembled Austrian and foreign delegates Prof. Stefan (Vienna) was elected president, while as vice-presidents were elected Prof. Galilei Ferraris (Turin), Col. J. Florensoff (St. Petersburg), Prof. Hauffe (Vienna), Prof. Kittler (Darmstadt), Major A. Obermayer (Vienna), Sir William Siemens (London), Prof. Mascart (Paris), Emil Effendi Lacoine (Constantinople), Prof. E. Gerard (Liége). The Commission is subdivided into the following eight sections according to the matters to be dealt with:—1. Scientific instruments. 2. Motors and general mechanics. 3. Dynamo-electric machines, electric lighting, and transmission of power. 4. Electro-chemistry. 5. Telegraphy, telephony, electric bells and clocks. 6. Signalling for railways and military purposes. 7. Electro-therapeutics. 8. Application of electricity relating to arts, industry, and technology. At the third section the measurements are carried out according to the plans devised for electric measurements by the president of the section, Prof. Kittler, and for photometric measurements by Prof. Voit (Munich). A control calibration of the instruments used in this section showed their accuracy and precision, as well as the correctness of the hypothesis that the variations of the earth's magnetism during the daily periods of measuring could not exert any important influence on the results of the measurements. When the first trials were made, some disturbances of the delicate instruments arose, the cause being that the iron building of the Rotunda was charged with electricity by the return currents of the dynamo-electric machines. But this difficulty was soon overcome by modifying the arrangements of the conducting wires, and the Commission is now hard at work trying the various electric lamps and machines. The results of these trials when finished will be published by the Commission. The series of lectures delivered at the theatre of the Exhibition is still continued, and we had occasion to hear, among others, Mr. Preece (who spoke in English), on the recent progress of telegraphy in England, and the Austrian professors Mach, Zenger, Pfaundler, Waltenhofen. The attendance on the part of the public is as large as it was at the Universal Exhibition in the year 1873, the average number of visitors being 17,000 daily.

While in the Bernstein lamps described in our last letter a relatively thick carbon is used, in the Cruto lamps brought to the Exhibition a few days ago a very fine but hollow carbon loop is employed; it is prepared by a process similar to that already devised by Mr. Sawyer in the year 1878 for flashing carbon filaments. A thin platinum wire (1/20 mm. to 1/60 mm. in diameter) is heated, by an electric current passing through it, in a vessel containing the vapour of a hydrocarbon. The hydrocarbon being decomposed in a short time, the platinum wire is covered by a homogeneous layer of deposited pure carbon. The platinum is then removed by volatilising it. The remaining hollow carbon filaments thus obtained are very fine and elastic, and show a metallic polish. The Cruto lamps, as well as a series of Lodiguine incandescent lamps, are fed by Gravier's distributers of electricity, the installation of which has been completed during the past week. The process of preparing the illuminating portions of the new incandescent lamps with high resistance exhibited by Siemens and Halske, and lighting beautifully Witzmann's restaurant and the exhibits of this firm, is still kept secret. The stall of the Société Anonyme d'Électricité is lighted by several Gerard incandescent lamps of high candle-power (300 candles). These lamps have large ovoid glass bulbs pierced at their broad part by a narrow glass tube containing the two terminals of the conducting wires. The five straight and comparatively thick carbon rods forming the illuminating part of the lamp are cemented together at their ends by means of a carbonaceous paste in such a manner that, by the two pairs of longer rods being connected by a short intermediate carbon rod, two long-sided, acute-angled triangles crossing one another are formed, which, if brought to incandescence, make the appearance of a single flame, giving an agreeable and bright light. This chain of carbon rods is fastened to the supporting terminals by two short cylindrical pieces of carbon. An interesting historical collection of incandescent lamps is exhibited in the Prussian Section, showing the lamps made by Florensoff, Buliguine, and Khotinsky in the years 1872 and 1873. The latter had already used exhausted glass bulbs, but the carbon rod used having a diameter of 1·5 mm. to a length of 1½ cm. could not give a good result.

Most of the incandescent lamps exhibited have transparent bulbs, and very disagreeable after images of the glowing carbon filaments are caused if they are looked at only for a moment or two.

An interesting and practical regulator for single incandescent lamps has been exhibited by the International Electric Company. By turning a handle the intensity of incandescence can be raised or lowered. This regulating apparatus consists of a hollow perforated brass bulb mounted below the lamp, containing a number of carbon disks, which, when the handle is right over in one direction, are highly compressed, a metallic circuit being established at the same time. By turning the handle, the metallic circuit is broken, and the current passes through the carbon disks, while the pressure on them being gradually relaxed causes a steady increase of resistance to the current, thus diminishing its intensity, and in the final position the circuit is broken, and the carbon filament of the lamp ceases to glow.

Vienna, October 16

NOTES

WE have received the following announcement from the Royal Society:—On the last day of the present month the Fellows of the Royal Society will hold their anniversary meeting, and elect Council and officers for the ensuing year. The following list has been nominated:—President: Prof. Thomas Henry Huxley, LL.D.; Treasurer: John Evans, D.C.L., LL.D.; Secretaries: Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., Prof. Michael Foster, M.A., M.D.; Foreign Secretary: Prof. Alexander William Williamson, LL.D.; other Members of the Council: Capt. W. de Wiveleslie Abney, R.E., Prof. W. Grylls Adams, M.A., F.C.P.S., the Duke of Argyll, K.T., D.C.L., John Gilbert Baker, F.L.S., Thomas Lauder Brunton, M.D., Sc.D., William Henry M. Christie, Astronomer-Royal, William De la Rue, M.A., D.C.L., Sir Frederick J. O. Evans, K.C.B., Prof. George Carey Foster, B.A., Francis Galton, M.A., F.G.S., James Whitbread Lee Glaisher, M.A., Sir William Withey Gull, Bart., M.D., Hugo Müller, Ph.D., Prof. Joseph Prestwich, M.A., F.G.S., Prof. Osborne Reynolds, M.A., Osbert Salvin, M.A., F.L.S. It will be a subject of congratulation to the scientific world at large to learn from the above announcement that Prof. Huxley has consented to allow himself to be nominated for President.

A NOTICE of some importance has just been issued by St. John's College, Cambridge. Inasmuch as it indicates an advance on the old examination in mathematics and classics only, which has hitherto obtained at this college, we are glad to welcome the change. It will tend to place science candidates still more on an equality with those who pursue the older studies, and it will directly encourage them to undertake "independent" work (the word is better than "original" where Bachelors of Arts are concerned) at the stage when they have most leisure and most plasticity. The notice is as follows:—"Candidates for Fellowships at the next annual election are invited to submit to the electors dissertations or other writings as evidence of their independent work, in accordance with the following directions:—(*a*) The matter and form of the writings to be left to the discretion of the candidates; (*b*) the writings may be prepared especially with a view to the election, or may consist wholly or partly of work already published; (*c*) the candidates to state clearly what parts of their writings they claim to be original; (*d*) the candidates to inform the Master not later than June 1 of the subjects of the writings they propose to submit; (*e*) the writings to be sent to the Master not later than September 1. The electors wish it to be understood that at the next election their decision will be influenced by consideration of the following points:—(1) The performance of the candidates in the University and other public examinations. (2) The quality and promise of the writings submitted by the candidates. Candidates may be examined by papers or *vivâ voce* on questions arising out of their writings, and on other matters also if the electors desire it. (3) The proficiency in some special subject of candidates who do not submit any writings. Such candidates may at their own request be examined in their special subject, provided they give full and precise information in regard to it by letter addressed to the Master not later than June 1. (4) The candidates' power of expression as shown in the composition of an extempore English essay. Candidates will be offered a certain number of subjects to choose from; and in judging of the essays account will be taken of method and style. (5) Such other evidence as may be forthcoming to attest the candidates' qualifications. The next annual election will take place on Monday, November 3, 1884. Candidates will be required to present themselves for examination on Tuesday, October 21, at 9 a.m."

THE success which attended the course of lectures delivered this year has induced the Council of the Institution of Civil Engineers to make arrangements for a similar series next session. Electricity was then dealt with. Another most important subject will now be treated, namely, "Heat in its Mechanical Applications." The lectures will be delivered on Thursday evenings at 8 p.m., in the months from November to April, as under:—1883: November 15, "The General Theory of Thermodynamics," by Prof. Osborne Reynolds, F.R.S.; December 6, "The Generation of Steam, and the Thermodynamic Problems Involved," by Mr. W. Anderson, M.Inst.C.E.; 1884: January 17, "The Steam-Engine," by Mr. E. A. Cowper, M.Inst.C.E.; February 21, "Gas- and Caloric-Engines," by Prof. Fleeming Jenkin, F.R.SS.L. and E., M.Inst.C.E.; March 20, "Compressed-Air and other Refrigerating Machinery," by Mr. A. C. Kirk, M.Inst.C.E.; April 3, "Heat-Action of Explosives," by Capt. Andrew Noble, F.R.S., M.Inst.C.E.

THE 130th Session of the Society of Arts will commence on the 21st inst., with an opening address from Sir William Siemens, the chairman of the Society's Council. Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting, and for these the following arrangements have been made:—November 28, A. J. R. Trendell, "The International Fisheries Exhibition of 1883;" December 5, Thomas T. P. Bruce Warren, "The Manufacture of Mineral Waters;" December 12, Thomas Fletcher, F.C.S., "Coal Gas as a Labour-saving Agent in Mechanical Trades;" December 19, W. H. Preece, F.R.S., "The Progress of Electric Lighting." There will be six courses of lectures delivered during the session, under the bequest of Dr. Cantor. These will be: (1) "The Scientifie Basis of Cookery," by W. Mattieu Williams, F.C.S.; (2) "Recent Improvements in Photo-mechanical Printing Methods," by Thomas Bolas, F.C.S.; (3) "London Houses," by Robert W. Edis, F.S.A.; (4) "The Alloys used for Coinage," by Prof. W. Chandler Roberts, F.R.S., Chemist of the Royal Mint; (5) "Some New Optical Instruments and Arrangements," by J. Norman Lockyer, F.R.S., F.R.A.S.; and (6) "Fermentation and Distillation," by Prof. W. Noel Hartley, F.C.S. The usual short course of Juvenile Lectures will be delivered during the Christmas holidays. The subject will be "Crystals and Crystallisation," and the lecturer Mr. J. M. Thomson, of King's College, London.

THE death is announced of Prof. Peter T. Riess, whose treatise on frictional electricity—"Die Lehre von Reibungselektricität"—has long been a standard work. Riess was a careful and accurate observer of phenomena. His researches on ring-figures produced by discharges, on the electric air thermometer, and on the phenomena of the return stroke, are well known. His memoirs on electricity were published in a collected form some years ago.

THE sum of 100*l*. has been placed at the disposal of the Council of the Statistical Society by Mr. H. D. Pochin for an essay in memory of the late Mr. Wm. Newmarch, F.R.S., "On the Extent to which Recent Legislation is in accordance with, or Deviates from, the True Principles of Economic Science; and showing the Permanent Effects which may be expected to arise from such Legislation." The Council accordingly invite public competition for the prize above mentioned. Essays must be sent in on or before May 1, 1884.

DR. SOPHUS TROMHOLT has just left for Iceland, where he intends to establish his auroral station during the coming winter.

IN connection with the vote given by the delegates to the congress at Rome for establishing a meridian common to all civilised nations, it may be stated that the first French meridian was not originally that of Paris and special to the French geographers, but Ferro, according to an ordinance of Louis XIII., published in 1632 in compliance with a report drawn up by Cardinal de Richelieu, then superintendent of commerce and navigation. It was transferred to Paris only fifty years afterwards by Dominique Cassini, who obtained the authorisation of Louis XIV. and the French Academy of Sciences, because it was too difficult to ascertain the exact distance of the Ferro meridian.

THE date of admission of foundation members to the International Society of Electricians has been postponed to Nov. 15, when a general meeting to constitute the Society will be held, which at present numbers 900 members, belonging to twenty nationalities. Requests for admission should be addressed to M. Georges Berger, 99, rue de Grenelle, Paris.

M. RAPHAEL PERUITA writing to *La Nature* under date Manilla, September 14, states that the detonations of the Java eruption of August 27 were distinctly heard throughout the Philippine Islands; so distinctly were the sounds heard that gunboats were sent out under the imoression that a fight was going on at Java, or that a ship in distress was firing for help.

OF the expeditions despatched in May last from Denmark to Greenland, the one to North Greenland, under Lieut. Hammers, has just returned, after having succeeded in accomplishing its object, viz. to map out and examine the coast from Ritenbank to Kongatsiok in the Egedesminde district, *viâ* Jacobshavn and Kristiansbank, between 70° and 68° 20′ N. lat. During the journey the finest weather prevailed, which was a necessary condition, as this part of the coast is greatly obstructed by islands and holmes, while there are but few heights along it. By Lieut. Hammers and his companions' labours the exploration of the coast of North Greenland has been completed, Lieuts. Steenstrup and Hammers having—between 1878 and 1880—explored the district between Pröven (Upernivik) and Godhavn, and Lieut. Jensen, in 1879, the coast between Holstensborg and Egedesminde. These expeditions have succeeded in collecting all the materials necessary for a map of the whole coast between Pröven and Holstenborg. Lieut. Hammers has, besides geographical researches, also made collections in natural history, and brought home valuable botanical and mineralogical collections. From the second expedition, under Lieut. Holm, despatched this summer to the district of Julianshaab in order to carry out a two-and-a-half years' exploration of the south coast of Greenland, a short report has been received, stating that it had arrived at Huilek, a small settlement on the east coast, in lat. 61°. Lieut. Holm had established a depot of provisions here, to be brought north next summer to his place of wintering. He intended to return to Nanortalik, on the west coast, between Julianshaab and Cape Farewell, this autumn, where the expedition will carry out meteorological and auroral observations during the winter, which would be a continuation on a small scale of those effected at Godthaab for a year under the international scheme. These observations will be carried on in the buildings erected there by Capt. Hoffmeyer in 1882, and with the instruments of the previous expedition. On returning to the west coast in the autumn, Lieut. Holm's expedition will effect detailed explorations of the coast, fjords, and the ice and sea. He has arranged with several Esquimaux to meet and assist him on his journey northwards next year, when he hopes to reach the sixty-seventh degree of latitude.

MR. CARL BOCK'S new book is now nearly ready for publication. Its title will be "Temples and Elephants," a narrative of a journey of exploration through Upper Siam and Lao. Messrs. Sampson Low and Co. are the publishers.

DURING the last few years the Swedish Government have, as an experiment, retained an entomologist to assist farmers in the destruction of insects, &c., dangerous to the crops. The services of this functionary have, however, been in such request that the appointment is to be made a permanent one.

ON October 26 at about 7 p.m. a splendid meteor was seen in the district of Hernösand, Sweden. A traveller on the road to Ragunda states that he suddenly saw the night lit up as in broad daylight, which was caused by a large meteor appearing with a blinding white lustre in the zenith and travelling very rapidly down to the horizon. When half way, as it appeared to the observer, between zenith and the earth it suddenly burst, throwing a quantity of sparks in every direction.

A UNIVERSAL EXHIBITION on a tolerably large scale will be opened at Nice on December 1 next, and will continue open the whole of the winter. The Algerian *Akhbar* suggests that in 1885 a Pan-Mediterranean exhibition should be opened in Algiers, and in 1887 a Pan-African one.

WE have to announce three new numbers of the "Encyclopædia of Natural Sciences" from the publishing house of Eduard Trewendt, Breslau—No. 35 of Part 1, and Nos. 17 and 18 of Part 2, making up altogether a substantial addition to what had been previously accomplished in the progress of this comprehensive work. No. 35, Part 1, gives a continuation of "Schenk's Manual of Botany," more particularly a paper by Göbel, well and copiously illustrated, on the "Comparative

History of the Development of Vegetable Organs." No. 17 of the second part of the total work concludes the first volume of the "Alphabetical Manual of Chemistry," edited by Ladenburg, and begins the second volume with a series of valuable articles; one by Biedermann, on the "Atmosphere," taking up by itself as much as two and a half printed sheets. No. 18 brings the "Alphabetical Manual of Mineralogy, Geology, and Palæontology" as far as the letter "I," and supplies treatises by Kenngott, Lasaulx, and Rolle. Lasaulx's work on "Glaciers" should, especially, be of interest.

"UNIVERSAL GEOGRAPHIES" are appearing on all hands. There is M. Reclus' magnum opus and Stanford's Compendium; a new edition of Balbi is appearing in Vienna, and we believe of Malte Brun in Paris. Now the first parts of an Italian "Universal Geography" have been sent us, "La Terra," by Signor G. Marinelli, and published by Dr. F. Vallardi of Milan. It begins at the beginning, with the earth as a member of the solar system, and enters into considerable astronomical detail, and into the composition of the sun and the results of recent solar research. It is abundantly illustrated, and seems to us to deserve a large circulation, which we hope it will have in Italy. We have also the first part of a new German work of this class, "Unser Wissen von der Erde, Allgemeine Erdkunde," edited by Drs. Hann, Baron von Hochstetter, and A. Pokorny. These names are a guarantee that this work will be up to a high scientific standard, and it is evident that scientific geography will occupy a large space. The illustrations are good. The publisher is Freytag of Leipzig.

MR. G. K. GILBERT has recently, according to *Science*, given some rather disturbing suggestions to the people of Salt Lake City (*Salt Lake Weekly Tribune*, September 20) concerning the probability of destructive earthquakes there. He describes the slow and still continuing growth of the ranges in the Great Basin by repeated dislocation along great fractures, the earth's crust on one side being elevated and tilted into mountain attitude by an upthrust that produces compression and distortion in the rocky mass, until the strain can no longer be borne, and something must give way. Suddenly and violently there is a slipping of one wall of the fissure on the other, far enough to relieve the strain, and this is felt as an earthquake; then follows a long period of quiet, during which the strain is gradually reimposed. Such a shock occurred in Owen's Valley, along the eastern base of the Sierra Nevada, in 1872, when a fault-scarp five to twenty feet high and forty miles long was produced. A scarp thirty or forty feet high is known along the western foot of the Wahsatch Range, south of Salt Lake, and other scarps of similar origin have been found at the bases of many of the Basin ranges. The date of their formation is not known; but it must be comparatively recent, because they are still so little worn away. Wherever they are fresh, and consequently of modern uplift, there is probable safety from earthquakes for ages to come, because a long time is needed for the accumulation of another strain sufficient to cause a slipping of one wall of the fissure on the other. Conversely, when they are old and worn down, the breaking strain may even now be almost reached, and an earthquake may be expected at any time. This is the case at Salt Lake; for, continuous as are the fault-scarps along the base of the Wahsatch, they are absent near this city. From the Warm Springs to Emigration Cañon they have not been found, and the rational explanation of their absence is that a very long time has elapsed since their last renewal. In this period the earth-strain has been slowly increasing. Some day it will overcome the friction, lift the mountains a few feet, and re-enact on a fearful scale the catastrophe of Owen's Valley.

THE Aristotelian Society is exerting itself, we hear, to widen its sphere of action, so that it may be to philosophy what the scientific societies are to science. Very encouraging support has already been obtained from those interested in philosophy and the relations between philosophy and science.

WE have received the first number of *The Science Monthly* (Bogue), neatly got up and well printed.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, presented by Mr. Thomas L. M. Rose; a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, presented by Mr. S. Sandbach Parker; a Globose Curassow (*Crax globicera* ♀) from Central America, presented by Miss Beale; a Red-throated Diver (*Colymbus septentrionalis*), British, presented by Mr. T. E. Gunn; a Dwarf Chameleon (*Chamæleon pumilus*) from South Africa, presented by Capt. J. C. Robinson; a Common Heron (*Ardea cinerea*), European, a Common Cormorant (*Phalacrocorax carbo*), a Gannet (*Sula bassana*), British, deposited; a Common Otter (*Lutra vulgaris*), British, two Crested Screamers (*Chauna chavaria*) from Buenos Ayres, purchased.

OUR ASTRONOMICAL COLUMN

PONS' COMET.—We continue our ephemeris of this comet from the provisionally-corrected orbit of MM. Schulhof and Bossert :—

At Greenwich Midnight

1883.		R.A. h. m. s.	Decl. ° ′	Log. distance from Earth.	Log. distance from Sun.
Nov.	21	17 57 16	+48 49·1	0·1079	0·1445
	23	18 4 12	48 23·6		
	25	18 11 30	47 56·8	0·0839	0·1276
	27	18 19 11	47 28·4		
	29	18 27 18	46 57·9	0·0583	0·1102
Dec.	1	18 35 51	46 25·0		
	3	18 44 51	45 49·0	0·0311	0·0923
	5	18 54 20	45 9·4		
	7	19 4 19	44 25·5	0·0023	0·0738
	9	19 14 48	43 36·5		
	11	19 25 47	42 41·5	9·9721	0·0549
	13	19 37 17	41 39·5		
	15	19 49 17	40 29·3	9·9409	0·0356
	17	20 1 47	39 9·8		
	19	20 14 45	37 39·8	9·9093	0·0161
	21	20 28 9	35 57·8		
	23	20 41 54	34 2·8	9·8784	9·9965
	25	20 55 57	31 53·6		
	27	21 10 13	29 29·3	9·8500	9·9772
	29	21 24 37	26 49·5		
	31	21 39 4	+23 54·9	9·8263	9·9585

On the evening of November 4 the comet as viewed in one of the larger-sized comet-seekers of Martins of Berlin, was conspicuous enough, with traces of a tail. On October 29 Mr. Talmage, observing with Mr. Barclay's 10-inch refractor at Leyton, considered it made about the same impression upon the eye as the annular nebula in Lyra.

TEMPEL'S COMET, 1873 II.—According to the calculations of M. L. Schulhof, of Paris, this comet will arrive at perihelion on the 20th of the present month. Its position on the evening of the previous day will be approximately in R.A. 18h. 33m., N.P.D. 114° 0′, distant from the earth 1·93, and from the sun 1·34, so that the theoretical intensity of light expressed in the usual way will be 0·15, under which condition it will be of the last degree of faintness, judging from the experience of 1878. Still as the comet sets more than 2h. 20m. after the sun, it would be well worth while to search for it where there is a clear sky near the horizon, especially in the South of Europe.

A NEW STAR CATALOGUE.—Prof. van de Sande Bakhuyzen states that the catalogue of positions of stars contained in the first sixty-six volumes of the *Astronomische Nachrichten*, commenced by the late Prof. Hoek and continued by Dr. Kam, formerly of the Observatory at Leyden, has been completed and is ready for the press. It contains the places of nearly 5000 stars reduced to 1855·0, with their annual precessions, and the secular variations, the epoch of observation, &c. It is not mentioned in what way the publication of the catalogue is to be effected.

THE OBAN PENNATULIDA[1]

THIS report is a very thorough piece of work. It consists of a detailed and finished description of specimens dredged during an excursion of the Birmingham Natural History Society in July, 1881. The specimens all belonged to the three species *Funiculina quadrangularis*, *Pennatula phosphorea*, and *Virgularia mirabilis*. The language in which they are described is very distinct and lucid, though perhaps some criticism may be allowed as to the scale of measurement used and as to a certain point in the nomenclature. Measurements are given in the decimal divisions of an inch, instead of the metrical system, which is so much more satisfactory. The axial portion of a Pennatulid is described as consisting of two parts—the stalk and the rachis, the latter being the polyp-bearing portion; and the word "stem" is used for the calcareous rod running through the axis of both rachis and stalk. "Stem" would naturally mean both the stalk and rachis together as opposed to the polyp-leaves. "Core" might be suggested as a better term for the axial skeleton. The example of Kölliker has been followed in the use of the terms "polyps" and "zooids" for the two kinds of individuals. In describing the "stomach," its inner lining membrane is called ectoderm, but no reference is made to he fact that the evidence for its being ectodermic is embryological.

The description and figures given of *Funiculina* are the first published in English which deal with the internal structure; and they are in some respects more complete and perfect than those of Kölliker in his monograph on the Pennatulida. The examination of the largest of the specimens, which was thirty-nine inches long, has finally disproved the validity of the distinction maintained by Verrill and Gray to exist between the Scotch *Funiculina*, and that of the Mediterranean and Scandinavia. The supposed species, *F. Forbesii*, is simply the younger form, the largest of the Oban specimens being in all respects a typical *F. quadrangularis*.

A very interesting part of the work is that which refers to the reproductive organs of *Pennatula phosphorea*; the male and female elements are here fully described and figured for the first time. The fact of the sexes being distinct was ascertained by Lacaze Duthiers, but neither he nor Kölliker give figures or satisfactory descriptions of the sexual organs. The male elements are shown here to be produced in spherical capsules, which at first sight resemble ova.

In the account of *Virgularia* the process of the origin of new polyps is described. The stomachs arise as invaginations of the surface of the rachis into the cavity of large canals lined by endoderm.

An ingenious discussion of the reason why specimens of *Virgularia* when dredged are almost always truncated at the upper end leads to the conclusion that the loss is due to the attacks of fish.

The descriptions are followed by a complete critical list of the literature, and an account of the geographical distribution both in the sea and in museums. The figures are very clear, and at the same time artistic. It is much to be regretted that the condition of the specimens did not allow the histology to be completely made out. No doubt the Birmingham Society will pay greater attention to the preservation of material for this purpose on future occasions. J. T. CUNNINGHAM

[1] Report by Prof. A. Milnes Marshall, M.D., D.Sc., and William P. Marshall. Birmingham, 1882.

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

III.—*On some Embryos of "Callorhynchus antarcticus"*

SOME weeks since I obtained from a fisherman a number of eggs of *Callorhynchus antarcticus* from Wickliffe Bay, Otago Peninsula. As I believe this is the first time any observations have been made on the development of the *Holocephali*, the following report of remarks made at a meeting of the Otago Institute on May 7 may be of some interest to morphologists:—

"The eggs were found buried in the sand a little below low-water mark, a position which would seem to cast some doubt on the generally accepted theory which accounts for the peculiar form of the egg-shell by supposing it to have acquired a protective resemblance to kelp. The cavity for the embryo has an elongated pyriform shape, the broad end being anterior, and the narrower or posterior end produced into a long canal. On what may be described as the 'hairy' in contradistinction to the smooth side of the egg-shell, there is on each side of the middle line at the anterior end a longitudinal slit in the wall of the cavity, which serves to allow of currents to and from the latter for respiratory purposes. The anterior ends of these slits are united by a weak place in the wall of the egg-shell; very slight pressure from within causes rupture along this line and produces a valve, the lateral boundaries of which are formed by the respiratory slits, its anterior boundary by the line of rupture. This valve readily opens outwards by pressure on its inner face, and serves for the exit of the fœtus; pressure upon its outer face only forces it against the opposite wall of the cavity.

"The advanced embryo lies in the cavity in such a position that its head lies at about the level of the base or hinge of the valve, and therefore some distance from the anterior end of the cavity, its tail lies in the narrow posterior prolongation of the cavity, which fits it accurately; its right side lies almost invariably against the smooth, its left against the hairy side of the egg-shell.

"Unfortunately the embryos in all the four dozen eggs examined were in a tolerably advanced stage of development, so that there will be little chance of getting younger stages until next autumn. The youngest obtained are about four inches long; they have large yolk-sacs (1·75 inch in length), and very long external gills projecting from the opercular aperture; the snout has acquired the characteristic form, but the tail shows as yet no trace of heterocercality, nor the skin of the silvery character it has in the adult, being in the fresh state translucent and highly vascular. The yolk-sac is remarkable; it is longitudinally elongated, and produced into numerous blunt paired projections, which are tolerably constant in position; one pair of these always lies to the anterior end of the dorsal surface of the yolk-sac, and between them the snout of the embryo is invariably situated. The umbilical or somatic stalk is practically obsolete, the fœtus being sessile upon the yolk-sac.

"As in Elasmobranchs the yolk-sac is gradually drawn into the cœlome, and so consists in advanced stages of an internal and an external portion, the former continually increasing at the expense of the latter. As the external portion diminishes in size, it loses its blood-vessels, and its projections gradually disappear. In the latest stage obtained, the external portion is not more than 0·5 inch long, the internal portion being fully 1·25 inch in length, and causing a great distension of the abdominal walls. In this stage also, the external gills are absorbed, and the adult characters of the integument attained."

The foregoing description appeared in the *New Zealand Journal of Science* for this month. T. JEFFERY PARKER

Dunedin, N.Z., July 13

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The delegates of the Common University Fund have agreed to appoint a Reader in Anthropology, so as to utilise the presence of Dr. Tylor for University instruction. In a Convocation to be held on November 15, a decree will be submitted to the House, fixing the Reader's stipend at 200*l.* a year, on condition that he lecture at least once a week in each of the three terms, and receive students for informal instruction and assistance.

A Scholarship in Natural Science is offered this term by Wadham College. Candidates may offer either Animal Morphology, Botanical Morphology, or Physiology. They will also be examined in Elementary Chemistry and Physics. Weight will also be given to a knowledge of French or German. Candidates must send in their names to the Warden on or before November 15.

CAMBRIDGE.—Dr. H. Sidgwick has been elected Knightbridge Professor of Moral Philosophy. Prof. Bonney, F.R.S., has been approved for the degree of Sc.D. Dr. Routh has been elected Hon. Fellow of Peterhouse; and Professors Dewar and M. J. M. Hill have been elected Ordinary Fellows. Messrs. A. G. Greenhill and R. R. Webb will be the Examiners in the Mathematical Tripos of 1874. The honorary degree of M.A. has been conferred on Prof. Macalister, F.R.S. Messrs. J. A. Fleming and S. L. Hart, both distinguished Natural Science graduates, have been elected Fellows of St. John's.

Dr. Gaskell, F.R.S., is to be approved as a Teacher of Physiology, Dr. F. Darwin as a Teacher of Biology, and Mr. G. B.

Atkinson as a Teacher of Physics, for the purposes of medical education.

The honorary degree of M.A. is proposed to be conferred on Mr. A. Graham, First Assistant at the Observatory, in recognition of his astronomical services.

Mr. M. C. Potter of Peterhouse has been appointed Assistant Curator of the Herbarium.

Mr. W. H. Caldwell, Fellow of Caius College, has been appointed the first Balfour student.

At St. John's College, in December, there will be open for competition among students who have not commenced residence in the University—The Foundation Scholarships then vacant, two of which may, after residence is commenced, be increased in value to 100*l.* a year on condition of regular residence, satisfactory progress, and good conduct; four Minor Scholarships, two being of the value of 75*l.* a year and two of 50*l.* a year; three Exhibitions of 50*l.* a year for two years; one Exhibition of 40*l.* a year for four years; one Exhibition of 32*l.* a year for four years; together with two Exhibitions of 30*l.* a year for four years; one Exhibition of 33*l.* 6*s.* 8*d.* a year for three years. The number of Exhibitions may be increased if candidates of sufficient merit present themselves. The Foundation Scholarships and Minor Scholarships are open to candidates under nineteen years of age. The Minor Scholarships are tenable for two years, or until the Minor Scholar is elected to a Foundation Scholarship. The Exhibitions are open to all candidates irrespective of age, and are not vacated by the election of the Exhibitioner to a Foundation Scholarship. The number of Foundation Scholarships is sixty. Candidates may present themselves for examination in any of the following subjects, namely, Classics, Mathematics, Natural Science, Hebrew, and Sanskrit. A candidate may be elected on the ground of proficiency in any one of these taken singly. The Examination in Natural Science will include papers and practical work in Physics, Chemistry, General Biology, Botany, Zoology and Comparative Anatomy, Human Anatomy, Physiology, and Geology. Every candidate must show a competent knowledge of two at least of the following subjects, namely: (1) Elementary Physics, (2) Elementary Chemistry, (3) Elementary Biology [the range of the examination in Elementary Biology may be taken as defined by the contents of Huxley and Martin's "Course of Practical Instruction in Elementary Biology" (Macmillan)]. A candidate may be elected on the ground of special proficiency in any one of the foregoing sciences. Each candidate's name should be sent not later than November 27, 1883, to the tutor under whom it is proposed to place him.

SCIENTIFIC SERIALS

THE *Journal of Physiology*, vol. iv. Nos. 2 and 3, August, 1883, contains: W. H. Gaskell, on the innervation of the heart, with special reference to the heart of the tortoise (plates 2 to 5).—I. Th. Cash, description of a double cardiograph for the frog's heart.—Wesley T. Mills, an examination of some controverted points of the physiology of the voice, especially the registers of the singing voice and the falsetto.—F. Warner, a method and apparatus for obtaining graphic records of various kinds of movements of the hand and its parts, and of enumerating such movements and their combinations (plate 6).—H. H. Donaldson and L. T. Stevens, the influence of digitaline on the work of the heart and on the flow through the blood-vessels.—G. F. Yeo and Th. Cash, on the relation between the active phases of contraction and the latent period of skeletal muscle.—S. Ringer, a third contribution regarding the influence of the inorganic constituents of the blood on the ventricular contraction.—L. C. Wooldridge, further observations on the coagulation of the blood.—Also Supplement Part to vol. iv. Physiological papers of 1882.

THE *Journal of the Royal Microscopical Society*, October, 1883, contains: On *Asplanchna ebbesbornii*, nov. sp., by E. T. Hudson, LL.D. (plates 9 and 10), with the usual bimonthly summary of current researches relating to zoology and botany (principally Invertebrata and Cryptogamia), microscopy, &c.

THE *American Naturalist* for October, 1883, contains: Man's place in nature, by W. N. Lockington.—The Naturalist Brazilian Expedition (No. 2, continued), the Lower Jacuhy and São Jeronymo, by H. H. Smith.—On the shells of the Colorado desert and the region further east, by R. E. Stearns (woodcuts).—Review of Report C_4 second geological survey of Pennsylvania, by Dr. P. Frazer.—Means of plant dispersion, by E. J. Hill.—Is the group Arthropoda a valid one? by J. S. Kingsley.—On the Serpentine of Staten Island, New York, and on a classification of the natural sciences, by T. Sterry Hunt.

Proceedings of the Linnean Society of New South Wales, vol. vii. part 4, 1883, contains:—E. P. Ramsay, on new species of Solea; contributions to Australian Oology, part 2; notes on birds from Solomon Islands.—E. Meyrick, Australian Microlepidoptera, Oecophoridæ.—Prof. Stephens, geology of the Western coalfields, parts 1 and 2.—Dr. J. C. Cox, edible Australian oysters.—C. W. de Vis, new birds of Queensland; description of a new Belideus from Northern Queensland; on two new Queensland fishes.—Rev. C. Kalchbrenner, *Fungi aliquot Australiæ Orientalis*, and on new species of Agaricus.—Rev. J. E. Tenison-Woods, botanical notes on Queensland; on a species of Brachyphyllum from mesozoic coal beds, Ipswich, Queensland.—Wm. Macleay, new fishes of New Guinea, No. 3.—Wm. A. Haswell, on *Phoronis australis*, n.sp.; an instance of symbiosis (an Actinia lodging in the pits of a species of Cellepora); segmental organs of Aphroditea.—On some new species of Australian tubicolous annelids (plate).—E. Haviland, plants indigenous to Sydney.—Rev. Dr. Woolls, Eucalypts first known in Europe.—J. J. Fletcher, comparative anatomy of the female urogenital system in kangaroos, part 1.—Dr. H. B. Guppy, habits of the Birgus of the Solomon Islands.

Vol. viii. part 1, June 19, 1883, contains:—William Macleay, a new form of mullet from New Guinea.—J. J. Fletcher, anatomy of the urogenital system of the kangaroos, part 2.—C. W. de Vis, extinct marsupial remains.—C. P. Ramsay, contributions to the zoology of New Guinea (plate, *Hapalotes papuanus*).—Some new Australian fishes.—H. R. Whittell, habits of *Pelopæus lætus*, and *Larrada australis*; on the voracity of a species of Heterostema.—Rev. J. E. Tenison-Woods, on the coal flora of Australia (eleven plates, heliotypes); gives a history of the subject and descriptive list of fossils (pp. 36-167).—Rev. B. Scortechini, contributions to the flora of Queensland.—Rev. C. Kalchbrenner, two new fungi.—Jas. Norton, fructification of the Bunya (*Araucaria bidwellii*) in Queensland.

Vol. viii. part 2, July 17, 1883, contains:—E. Haviland, plants indigenous to Sydney, Nos. 3 and 4.—C. W. de Vis, tooth-marked bones of extinct marsupials; on *Brachalletes palmeri*, an extinct marsupial; on a lower jaw of *Palorchestes azael*; on some new genera and species of Australian fishes.—H. K. Bennett, habits of *Leipoa ocellata*; on water from Eucalypti roots.—Wm. Macleay, fishes from the Burdekin and Mary Rivers; New Guinea fishes, No. 4.—J. J. Fletcher, on a viviparous lizard (*Hinulia elegans*).—John Brazier, synonymy of Australian and Polynesian land and marine mollusca; localities of some species of recent Polynesian mollusca.—Rev. J. E. Tenison-Woods, mesozoic fossils from Central Australia (two plates).—Rev. B. Scortechini, second half century of plants new to South Queensland.

Revue Internationale des Sciences Biologiques for July, 1883, contains:—Elie Reclus, studies on indigenous people: the Khonds.—Prof. Huxley, living organisms and the way to study them (translated).—Proceedings of the Academy of Sciences, Paris.

August.—Leon Metchnikov, essay on the Christian communion: the God of Nyssa and the God of Nazareth.—Prof. Huxley, living organisms and the way to study them (translated).—Proceedings of the Academy of Sciences, Amsterdam, and of the Academy of Sciences, Paris.

September.—Prof. Huxley, living organisms and the way to study them (translated).—Prof. Williamson, the primitive ancestors of living plants and their relation to the doctrine of evolution.—Proceedings of the Academy of Sciences, Paris.

Atti of the Royal Academy dei Lincei, June 17.—Remarks on Schiff's memoir on changes of volume during fusion, by Sig. Camizzaro.—On De Stefani's upper crest of the Apennines, by S. Capellini and Taramelli.—On the temperature corresponding with the glacial period, by S. Pietro Blaserna.—On the measurement of altitudes by means of the barometer, by S. Paolo Busin.—On the isobarometric types of Italy, by the same author.—On the first phenomena in the development of the embryo of the Böops (*Salpa maxima*), by S. Francesco Todaro.—On the caloric developed in liquids by the discharge of electric condensers, by S. Emilio Villari.—Report on the antiquities recently discovered in Val della Torre, Adria, Forli, Orvieto, and other parts of Italy, by S. Fiorelli.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, October 29.—M. Blanchard, president, in the chair.—Allusion was made by the President to the loss sustained by the Academy in the person of M. Louis Breguet, the mechanician, who died suddenly on the night of October 26.—Observations on the geometrical deformations produced by pressure on a rectangular parallelopipedon with prolongation in a single direction (two illustrations), by M. Tresca.—Fossil and savage man; anthropological stndies, by M. de Quatrefages. In presenting this important work to the Academy, the author remarked that since the discoveries of Boucher de Perthes and the jawbone of Moulin-Quignon some twenty years ago, not only has the existence of Quaternary man been universally recognised, but a certain number of distinct Quaternary races has already been determined. The existence of Tertiary man also, without being yet fully demonstrated, has been rendered highly probable, especially by the researches of M. Capellini. A detailed account is given of all the known Quaternary races of Western Europe, based mainly on the fossil remains collected by M. de Baye in the artificial caves explored by him in the department of La Marne.—Note on the freezing point of alcoholic solutions, by M. F. M. Raoult. In accordance with the general law established by the anthor, the soluble bases are shown to belong to two distinct groups, one presenting a molecular lowering of the freezing point comprised between 33° and 48°, with a mean of 39°; the other lying between 16° and 20°, with a mean of 19°.—Report on the results of the treatment of the vines attacked by phylloxera in the Maritime Alps, by M. Laugier. The report speaks favourably of the experiments made dnring the years 1881-83 with sulphnret of carbon and sulphocarbonate of potassium.—On certain equations connected with surfaces of constant curvature, by M. G. Darboux.—Determination of the equivalent of nickel by means of its sulphate, by M. H. Daubigny.—On a process for detecting by chemical analysis the traces of blood in clothes that have been washed, by M. C. Husson.—A comparative study of the excitability of the surface and deeper parts of the brain, by M. Couty.—On the spermatogenesis of podophthalmous crustaceans, and especially of the decapods, by M. G. Herrmann.—Note on the anatomy and physiology of the Sacculine and the allied genera Peltogaster and Lernæodiscus, by M. Yves Delage.

Berlin

Physical Society, October 19.—Dr. Frölich made a report on measurements of solar heat executed by him in continuation of observations he had made at an earlier date, according to the method he was still pursuing, on the temperature of celestial space. Observations on the temperature of the earth's surface had led him to the conviction that solar heat, the principal source of the temperature of the earth, must pass through very rapid oscillations, which were in all probability connected with the quick movements on the solar surface that had been brought to light by the new methods of investigation. To establish these variations beyond all doubt required long-continued observations of the sun's heat by means of trustworthy instruments remaining invariable for years. Thermoelectric piles provided with due protective apparatus could alone be deemed instruments of this description. Mr. Langley's bolometer was not adequate for any length of time, the electric resistance of thin metal plates being liable to very rapid variations. The thermoelectrie pile he had made use of was inclosed in a wide, double-walled pipe, opening in front in the shape of a funnel, in which circulated a constant stream of water of atmospheric temperature. The exposed front end of the thermopile was closed by a plate of rock salt, and the whole was set up in such a manner that it could turn in a frame, which itself might be turned in all directions and closed by means of a Venetian shutter. The whole apparatns was capable of revolving in all directions. The thermopile and the galvanometer of Siemens and Halske's recent construction were perfectly trustworthy instruments, as Dr. Frölich had repeatedly convinced himself. There now remained the task of finding a standard for the solar heat. For this purpose preparatory experiments were instituted with luminous heat generators—a glowing platina sheet and an electrical glow-lamp of older construction. These experiments, however, came to nothing. At last recourse was had to dark heat, such as was produced from a hollow screen filled with steam, one side of which is blackened with smoke, and the other whitened with chalk. With these apparatus measurements of solar heat were taken on perfectly clear days under a bright sun at very different points of the sun's altitude, and were represented by curves, the abscissæ of which showed the thickness of the transmitted atmosphere; the ordinates, the observed warmth of the sun. Under favourable conditions the curve formed a straight line, which, when extended to zero of the abscissa, furnished the measurement of the solar heat without atmospheric absorption. The measurements were at first attempted to be taken at the Berlin Observatory, but were found to present so many irregularities and oscillations in consequence of the situation of the Observatory in the midst of the city and the constantly vaporous and dusty state of the atmosphere surrounding it that they had to be discontinued there. Better and more regular results were obtained from observations made at a house in the western suburbs. The best and most conclusive measurements, however, in which the errors of observation were reduced to 1 per cent., were obtained from a tower in the West End near Berlin, where, throughout six days of the past summer, curves were registered approximating very closely to a straight line. One single measurement executed on the Faulhorn at a height of 9000 feet yielded a perfectly straight curve. The six measurements distributed over the months of June, July, August, September, and October, showed considerably different results in the different months. Dr. Fröhlich caused Dr. Lohse, who had been taking daily photographs of the sun at the Potsdam Observatory, to supply him with data regarding the presence of sunspots in the last months. From these data Dr. Fröhlich found that the lower degrees of solar heat corresponded with numerous formations of spots, while the higher gradations of heat were attended with fewer sunspots. In this coincidence Dr. Frölich was disposed to see a sequence of cause and effect. It would be necessary, however, to accumulate a large number of observations, and in particular to take them at elevated stations before any definitive judgment could be passed respecting the influence of sunspots on solar heat.

CONTENTS

THURSDAY, NOVEMBER 15, 1883

THE "AUSTRAL" JUDGMENT

THE inquiry into the sinking of the mail-steamer *Austral* in Sydney Harbour has probably attracted more attention than any other case which has come before the Wreck Commissioner's Court since it was established. Not merely those specially interested in or connected with shipping but the public generally were desirous of knowing how it happened that a magnificent steamship of the most recent construction should have foundered at anchor in smooth water and in a dead calm. It is satisfactory, therefore, to find that the causes of the accident have been discovered, and that they do not affect the reputation of the ship, nor the credit of her designers. The circumstances of the accident are briefly these :—The *Austral* had completed her second outward voyage, had discharged nearly all her cargo, and had partially refilled her coal-bunkers. A collier came alongside to continue the coaling, and the work was proceeded with during the night. In order to facilitate coaling, and to keep the interior of the ship clean, coal-ports had been formed in the sides, the height of these ports above water when the ship was upright being about five feet. The coaling was rapidly done, and no proper supervision was exercised by any of the officers of the ship; consequently a considerable weight of coal was introduced on the starboard side without any corresponding weight being placed on the port side, and the ship was gradually heeled over. At length such an inclination was reached that the sills of the after coaling-ports were brought to the sea-level; water began to enter the ports and to pass freely into the interior of the ship, and in fifteen to twenty minutes from the time the alarm was given she sank. No one appears to have observed the dangerous proximity of the coal-ports to the water until it was too late to save the vessel. Had there been ordinary care and watchfulness the accident would not have occurred.

This last statement can be made with certainty in view of the scientific evidence respecting the stability of the *Austral* given in the course of the inquiry. After the vessel had been raised and brought home the owners commissioned a competent naval architect, Mr. Elgar, to thoroughly investigate her conditions of stability at the time of the accident, and under various circumstances. As a basis for this investigation an inclining experiment was made on the vessel, and the vertical position of her centre of gravity was ascertained. Simple calculations enabled the investigator to pass from the experimental condition of the ship to all other conditions brought under review, and to place before the Court ample materials for answering the question—Was she a stable vessel? This answer was distinctly in the affirmative; indeed there is no room for doubting that with proper management, and the occasional use of the water-ballast with which she was provided, the *Austral* possessed sufficient stability. It is unnecessary to enter into details as to her "stiffness" and range of stability in various conditions of lading; but it may be worth stating that, according to the evidence, had the coal-ports been closed and all weights on board secured, she would have been practically *uncapsizable* at the time of the accident.

It would be out of place here to discuss the finding of the Court as regards the responsibility or blameworthiness of the owners, officers, and other persons connected with the management of the ship. One broad general principle laid down by the Commissioner in his judgment may be considered with propriety, since it affects not merely the owners of the *Austral*, but shipowners as a body. Mr. Rothery is strongly of opinion that shipowners should cause investigations to be made of the stability of their ships, and should furnish captains with the results of these investigations for information and guidance. In the case of the *Austral* no such investigations were made until after the accident, and what happened with her is the common case with ships of the mercantile marine. There has been a remarkable advance in the applications of scientific methods to merchant-ship construction of late years, and the consideration of problems of stability has been forced upon the attention of shipbuilders and shipowners in many cases. But the adoption of the Commissioner's opinion would involve a much greater extension of scientific method and exact calculation than has yet taken place.

Shipbuilders necessarily have no control over the loading of the ships they build; and in most merchant ships the stability is practically determined by the nature and distribution of the cargoes carried. Up to the present time exceedingly little information is on record as to the actual stability of laden merchant ships; and their loading usually has to be done under very hurried and difficult conditions by men possessed of great practical experience, but having little or no acquaintance with the principles of stability. Owners have hitherto been content to depend almost exclusively on experience with previous vessels in determining the dimensions of new ships, and have not set much store on the result of scientific calculation. Builders, on the other hand, recognising their want of control over the working of the vessels, have refrained, for the most part, from making detailed calculations of stability. Even the leading firms have chiefly confined attention to experimental and other investigations which would be useful in preparing subsequent designs; and in most cases the owners have not had communicated to them any facts which may have been ascertained respecting the stability of ships. Mr. Rothery maintains that all this should be changed: that fuller investigations should be universally made, and the results furnished by the owners to the captains.

The great, if not paramount, importance of due consideration being given to the stability of merchant ships, and particularly of cargo-carrying steamers, is recognised by the most eminent authorities. Mr. Rothery in his recommendation indorses what has been said and written repeatedly of late years. But while there is a very general assent to the proposition that something should be done to secure a due amount of stability and to prevent improper or excessive loading, there is not a similar agreement respecting the means to be employed. For example some of the professional witnesses at the *Austral* inquiry expressed doubts as to the wisdom of placing in the hands of merchant-ship captains the results of calculations for stability expressed in the forms of "metacentric diagrams" or "curves of stability." These gentlemen feared that to the average ship-captain such curves and diagrams would be unintelligible, and therefore of no practical value. It must be admitted that there is some force in this contention; but on the other hand it is obvious that a very moderate amount of instruction ought to suffice to make information of the kind intelligible and useful to an educated seaman.

It may be worth while to mention what is the established practice in the Royal Navy in this matter. Each of Her Majesty's ships is provided with a "Statement of Stability," in which appears a record of the "metacentric heights," corresponding respectively to the "fully laden" and the "extreme light" conditions of the vessel. There is also a record of the calculations of stability at various angles of heel; the angle at which the stability attains its maximum and that at which it vanishes being noted. In cases where special precautions are needed special standing orders are given. For instance, in some low freeboard ships it is stringently ordered that a certain maximum load draught shall not be exceeded, because any diminution of the corresponding freeboard would cause an objectionable decrease in the range and area of the curve of stability. Again, in some vessels, as coals and stores are consumed, the stability is considerably diminished, and then orders are given that the ship shall not be lightened beyond a certain minimum draught, that draught being maintained if necessary by the admission of water-ballast. All these regulations are based upon careful experiment and detailed calculations. In the original design of the ships close attention is bestowed upon the question of their sufficient stability; and when the vessels are completed, an experimental check is put upon the intentions of the design, any necessary corrections being made in the original calculations. But it is right to remark that war ships are much more easily dealt with than merchant ships, because definite positions are assigned in them by the designer for all the weights carried—whether they be armour, or guns, or coals, or ammunition, or outfit. Hence it is possible to state distinctly what is the stability in the fully laden condition, and what are the extremes of possible variations in stability as coals, stores, &c., are consumed. In merchant ships, as was remarked above, the designer and builder have no corresponding control over stowage, and in practice very considerable variations in stowage necessarily occur. Leaving this difference aside for an instant, it may be stated that in the Royal Navy the information given on "Statements of Stability" is highly valued and well understood by naval officers. This result is, no doubt, attributable in a large degree to the fact that at the Royal Naval College for many years past classes have been arranged wherein naval officers receive instruction in the elements of naval architecture, and especially in the methods of interpreting the various statements and drawings issued by the Admiralty to the ships of the fleet. Similar instruction could not fail to be of service to officers of the mercantile marine, and the Admiralty have made provision in the Regulations for the admission of a certain number of such officers annually; but as yet no advantage has been taken of the permission. Either in this way or in some other, instruction must be obtained by merchant captains if they are to exercise an intelligent control over the loading of their vessels, and to insure the provision of sufficient stability.

It seems very probable that one result of recent occurrences and discussions will be the grant of greater freedom to shipbuilders in choosing the dimensions for new ships than has been customary hitherto. And it may be anticipated that increasing attention will be bestowed upon investigations of stability in connection with new designs. But whatever improvements may be made in the general practice of shipbuilders, the responsibility for management and loading must always remain with the owners and commanding officers of merchant ships. Ill-advised action on their part might render futile all the precautions of the designer. He may have secured what seems a good margin of stability, on the basis of some hypothetical arrangement of a certain dead weight which was supposed to be the maximum a ship would carry; and yet in practice some more critical condition of loading may arise which must be dealt with by those in charge of the vessel.

Having regard to the very considerable variations in the character of the cargoes carried by the great majority of merchant ships on their several voyages, it appears to be highly important that owners and captains should have placed in their possession full information respecting the stability of their ships; and that they should be able to make intelligent use of this information. One of the most valuable pieces of information which a captain could obtain for a laden ship would be her "metacentric height," and there seems no reason why an intelligent officer who had been furnished with a "metacentric diagram," and understood its use, should not experimentally determine for himself before leaving port what measure of "stiffness" his ship possessed, and at what vertical position the centre of gravity was placed (if the conditions of loading were of an unusual character). He would then have a more certain assurance of the sufficiency or otherwise of the stability of the ship than he could otherwise possess; and this assurance might easily be made to extend not merely to the initial stability but to the stability at large angles of inclination. It may be urged that it is too much to hope for any such experiments, or for such an advance in knowledge; and that in the stress of business time cannot be found for such elaborate inquiries. Possibly one may be too sanguine to indulge this hope; but inclining experiments of the kind indicated are neither lengthy nor costly operations, and their value as indications of the probable safety or danger of laden ships cannot well be over-estimated.

The necessity for carefully considering the stability of merchant ships is not a matter of dispute. All concerned may be assumed to desire some practical solution of the problems involved in securing sufficient stability. And on a review of the whole subject it will probably be admitted that all three classes interested—the shipowner, shipbuilder, and ship-captain—must accept their several responsibilities while working towards a common end. The shipowner may be presumed to know best the special requirements to be fulfilled in any new design. It is the duty of the designer to make sure that appropriate dimensions and proportions are secured in association with the fulfilment of these requirements, or to point out the impossibilty of such an association. And, finally, upon the skilful and intelligent conduct of the captain must necessarily depend in a great degree the safety and success of the vessel during her career. In order that the best results may be obtained in face of the difficulties incidental to the design and management of many modern types of ships, the standard of knowledge must be raised in all three classes.

W. H. WHITE

THE "ENCYCLOPÆDIA BRITANNICA"

Encyclopædia Britannica. Ninth Edition. Vol. xv. Loo-Mem. Vol. xvi. Men-Mos. (Edinburgh: A. and C. Black, 1883.)

AMONG the most important scientific articles in vol. xv. of the new edition of the "Britannica" are those on Medicine, Mechanics, and Mammalia.

The concise but comprehensive epitome of the history of medicine which Dr. Payne has contributed is the only history of the kind in the language. In Germany there are in this subject, as in almost every other branch of learning, excellent text-books; and the author acknowledges his obligations to Häser's "Lehrbuch der Geschichte der Medicin und der epidemischen Krankheiten." In France, Daremberg's "Histoire des Sciences Médicales" is also well known. But in England there has been no serious attempt to write a history of medicine since the publication of Freind's letters to Mead (1725); even these only dealt with a portion of the subject, and were written or at least begun under the disadvantage of confinement in the Tower. There have been a few valuable contributions to the subject, such as Dr. Greenhill's articles in Smith's "Dictionary of Classical Biography," and Dr. Munk's Roll of the College of Physicians, but nothing more.[1]

Is this neglect justifiable? In other branches of natural history and natural philosophy an acquaintance with the successive steps by which modern knowledge has been won is almost necessary for clearly comprehending the result. A history of astronomy, of electricity, or of physiology would be not only of interest but of practical value to the student of each of these subjects. But a history of medicine, however important as a chapter in the development of human intellect and the progress of civilisation, is scarcely any help towards understanding either the principles or the practice of the art of healing. A modern physician finds some knowledge of chemistry and of physics indispensable; botany and zoology are not without important bearing on his professional studies; a knowledge of German is of great practical use; but he may be ignorant of all medical literature above fifty years old without any loss, except the loss of the intellectual pleasure which every educated man should take in the past history of his profession.

That this is the case seems evident from the utter neglect of the older medical classics in medical education, notwithstanding occasional murmurs from the few who have earned the right to murmur by having read them, and from others—a neglect which exists not only in practical England and America, but no less in the learned German and the conservative French schools. This neglect is only confirmed by occasional glimpses of the said classics, and it is illustrated by the fact that we owe even the sketch of the labours of two thousand years which forms the subject of this review to the demands of an encyclopædia.

Nor is the reason far to seek. Modern medicine has scarcely anything but its aim in common with the art of the ancients. The attempt of the older physicians was to find some comprehensive explanation which would account for all the diseases of mankind, and their practical method was the application of certain remedies, recommended by the crudest experience, or more often by some such dogmatic criterion as that of "signatures." The authority of the ancients was regarded as independent of proof. In like manner naturalists used to study the worthless gossip of Pliny, and Milton recommended Columella as a school-book because of the practical importance of husbandry; indeed in England we still teach geometry from an ancient Greek text-book, and Euclid will be the last to follow Aristotle and Galen, Dioscorides and Celsus, into learned oblivion. But the object of modern medicine is not to explain but to investigate, to ascertain what is amiss, and to deal with it as directly as possible, on the principles of physics and of chemistry, guided by experiment and checked by skilled statistics. Homœopathy is only the last of the "systems" of medicine; not more arbitrary than many others, and, like the rest, not so much a wrong solution of a scientific problem as an answer to a question which cannot reasonably be put.

The art of rational medicine must therefore depend upon a knowledge of the body and its functions, on the power of discovering its physical conditions, and on acquaintance with the physico-chemical laws to which it is subject; just as the art of navigation depends on a knowledge of astronomy and of meteorology. But even the rough outlines of anatomy were only made out during the sixteenth and seventeenth centuries, and the discovery of its minuter details, so well begun between 1650 and 1700, was only resumed and carried to its present degree of completion by the achromatic microscopes of the last fifty years. Morbid anatomy dates from Morgagni. Physiology had no true existence before Harvey's discovery of the muscular contraction of the heart and the circulation of the blood in 1628. It was retarded rather than helped by premature application of mechanical laws, and did not make important progress again until the birth of chemistry in the last thirty years of the eighteenth century. If anatomy may be dated from the dissections of Vesalius, physiology from the vivisections of Harvey, and chemistry from the laboratory of Lavoisier, we cannot fix the beginning of modern medicine earlier than the introduction of mediate auscultation by Laennec in 1819.

Interest, however, will always belong to the history of medicine, apart from the practical value of the older medical literature. The study of the dreary succession of the Greek "sects," of the Galenical and Arabian "schools," and of the subsequent iatro-chemical, iatro-mechanical, Brunonian, and other "systems," is of service to warn too eager speculation from the errors of

[1] Dr Edward Meryon's "History of Medicine" was never finished. Dr. Adams's editions of Hippocrates and of Paulus Ægineta, Croke's of the "Regimen Sanitatis Salernitanum," and Payne's of Linacre's translation, "De Temperamentis," are scholarly works. "Lives of British Physicians" and "The Gold-headed Cane" are not ungracefully written. "The History and Heroes of the Art of Medicine" is a very poor compilation. A brilliant essay on the subject will be found at the end of "Poems" and other remains of the late Dr. Frank Smith (Smith and Elder, 1879).

past ages. Here and there, "apparent rari, nantes in gurgite vasto," records of real observation: the aphorisms of Hippocrates, or the clinical pictures of Sydenham. Occasionally a good style commends an almost valueless treatise, as in the case of Celsus and Fracastori. More often we are attracted by some amusing gossip, some shrewd remark, or some interesting historical allusion, to epidemics or to wars, to the deaths of kings and conquerors, or to the daily accidents of contemporary life. Such are Caius's account of the sweating sickness, Ambrose Paré's description of his treatment of gunshot wounds in Savoy and at Rouen, and the "cases" recorded by Dutch surgeons of the seventeenth century. Nay, apart from utility and from such chance rewards as these, there will always be those who take the genuine delight of a book-worm in old authors because they are old, those who have the respectable appetite for information which is omnivorous, and students of the human mind for whom acquaintance with its dullest wanderings is fruitful.

It is therefore well that English readers should have at least an outline of medicine in the past, and this want has been admirably supplied by Dr. Payne. Wisely abandoning all endeavours to include the biographical part of his subject, tempting as the excursion must often have seemed, and leaving on one side the curious history of medicine as a profession, its connection with the Church, the differentiation of its several branches, its varied social position, and the growth and decay of the great colleges and schools of medicine, he has aimed only at presenting within the narrow limits allowed (about thirty-seven columns quarto) a view of the changes of medical theories, and of the slow progress and frequent retrogression of the medical art. Beginning with an appreciative sketch of Hippocratic medicine, the important work of the Alexandrine physicians is next indicated, the scientific scope and character of Galen is described, and the obscure line of tradition of classical medicine is traced down to the mediæval school of Salerno. The vast, but thankless and little explored, field of Arabian medicine is then rapidly surveyed, and its dominion in Western Europe explained as being really little more than that of a corrupt Galenism. The revival of learning at the beginning of the sixteenth century was probably a misfortune to medicine, for when the Italian scholars, and our own Linacre and Caius translated the works of Galen into good Latin, these medical "classics" shared in the glory which surrounded the language of the New Testament and of Plato. The first steps of anatomy were in contradiction of statements by Galen, the first discovery of physiology was a refutation of his whole system. Yet the baneful influence of his great name, like that of the still greater name of Aristotle, lasted long after his claim to implicit credence had been disproved. As the ancient system was worn away, its place was eagerly striven for by the feebler systems of Paracelsus, Van Helmont, Borelli, Sylvius, Stahl, Hoffmann, John Brown, and Hahnemann in a long succession of three hundred years.

With the morbid anatomy of Morgagni, Baillie, and Laennec, and the physical diagnosis introduced by the latter great physician, the modern era of rational medicine began, in which sects and systems are mere survivals —superstitions—of an unduly prolonged middle age. At this point Dr. Payne's heart and paper seem to fail together. He ends, much as Gray's bard ended his prophetic outline of English history, in a fine confused view of a period of light and splendour, illustrated by the names of Rokitansky and Virchow, Czermak and Helmholtz, Bright, Graves, Addison, Stokes, and Trousseau. It was no doubt wise not to attempt an account of the triumphs of the new era, but we hope that the learned author of this article may make it the foundation of a complete history of medicine, fuller and more exact than Daremberg's, lighter and brighter than those of Sprengel and Häser. We also venture to suggest to the editor of the "Encyclopædia Britannica" that an article dealing with the curious and interesting history of medicine as a profession should be obtained from the same pen, under the heading, say, of "Physic, History of the Practitioners of."

We have scarcely left room for finding fault, and little room is needed. But to redeem our encomium from the charge of blindness, we may ask why the history of the school of Salerno is given after that of Arabian medicine; what evidence there is apart from his name that Bernard Gordon of Montpellier (1307) was a Scot; and what possible aptitude there is in a comparison between two such different persons as the impudent, drunken vagabond who called himself Paracelsus and the great German reformer who lived at the same time.

Lastly, while we fully admit the justice of connecting the introduction of auscultation and of chemical and microscopical examination of morbid fluids with the introduction of a knowledge of morbid anatomy—for this connection was, in fact, the *novum organum* of medicine from 1820 onwards—yet we think that there should also have been indicated, however briefly, the still newer method which has characterised the history of yet more recent medicine, namely, the method of number and measurement, by which to the stethoscope and the test tube have been added the clinical thermometer, the compte-globule and the sphygmograph. Perhaps future historians of medicine (particularly if they should write "primers" or "outlines" "for examination purposes") will divide the nineteenth century into four periods: the first (1800-1820) introductory, the second (1820-1850) the period of morbid anatomy and of physical diagnosis, the third (1850-1880) the period of morbid histology and of quantitative investigation; while the last, we may hope, will be called the period of experimental medicine, in which laboratories shall do the same service for pathology and therapeutics which they have already done for physiology.

There appears, under the head of "Mechanics," another of those mathematical dissertations which, each complete in itself, are to be found at such frequent intervals in the volumes of the new edition of the "Britannica." The author of the part of this article which treats of theoretical mechanics is Prof. Tait, and those who are familiar with his writings will be able to form an estimate of the way in which the treatment of the subject is conceived and carried out.

The science of mechanics in its widest range rests on Newton's Three Laws of Motion, and on that other passage in the "Principia" dealing with the activity of an agent, the full significance of which, when interpreted by the light of modern discoveries, was first made clear by Professors Thomson and Tait. An examination of Newton's original statement shows that in his view "equilibrium is not a balancing of forces, but a balancing of the effects of forces. When a mass rests on a table, gravity produces in it a vertically downward velocity which is continually neutralised by the equal upward velocity produced by the reaction of the table, and these forces . . . are equal because they produce in equal times equal and opposite quantities of motion."

As regards our knowledge of force as distinguished from its mechanical measure as change of momentum, we are reminded that our idea of force, originally derived from the muscular sense, "may be a mere suggestion of sense corresponding (no doubt) to some process going on outside us, but quite as different from the sensation which suggests it, as is a periodic shearing of the ether from brightness, or a periodic change of density of air from noise."

In discussing still further the nature of force, Prof. Tait points out that our belief in matter, the most certain of all objective realities, is largely based on the property of the unchangeability of its aggregate amount. "The only other thing in the universe which is conserved as matter is conserved is energy. Hence we conclude that energy is the true physical reality, and force, which is merely the space-rate at which energy is transformed, must be regarded like other expressions, such as rate of interest, death-rate, gradient of heat, as an expression introduced for convenience, and not necessarily because of an objective reality attached to it."

Remembering the dual nature of all force as being exerted between two bodies, we have, as another reading of the Third Law, "Every action between two bodies is a stress."

With regard to potential energy, which must depend in some hitherto unexplained way, like kinetic energy, on motion, Prof. Tait says: "The conclusion which appears inevitable is that, whatever matter may be, the other physical reality in the universe which is never found unassociated with matter, depends, in all its widely varied forms, upon motion of matter."

After explaining Newton's Laws, the author deals with the principles of kinematics, and then with statics and kinematics of various material systems, with different degrees of freedom, inserting amongst the analytical proofs several of those elegant geometrical constructions for which he is so well known. Whilst the nature of the article precludes a thorough exposition of the higher and more involved parts of the subject, he has succeeded in presenting illustrative problems of all the great divisions in mechanics, which afford some insight into the nature of the special parts of the subject to which they refer.

This most useful article, which exhibits the state of knowledge in theoretical mechanics at the present time, concludes with a list of the principal works on mechanics.

Following Prof. Tait's article, and under the heading of "Applied Mechanics," we have the reprint of an article by the late Prof. Rankine, contributed by him to the volume of the "Encyclopædia Britannica" which was published in 1857.

In this article Prof. Rankine has dealt with the principles of the subject very much on the same lines as in his larger published work on "Applied Mechanics." It is needless to say that nothing that Rankine wrote on the theory of mechanics can ever become antiquated or obsolete. He possessed such a firm grasp of the foundations of the subject, that it seems impossible to believe that on these points he could commit an error. But since that time many new discoveries have been made in mechanics, as in other sciences, to which we find no reference in the present articles. Of these perhaps the most important are the later developments of graphical statics, and the kinematical analysis of Prof. Reuleaux. The former subject, which really dates its origin from the time of the discoveries by Rankine of the Theory of the Extension of the Funicular Polygon, and by Clerk Maxwell of the Theory of Reciprocal Figures, has received at the hands of Culmann and others developments which are now proving themselves of the greatest importance in engineering design. Of the higher parts of these more modern methods no information is given, either in the article before us, or in the extremely clear and simple theory of Frames, which appears in Prof. Jenkin's article on "Bridges," in the fourth volume of this "Encyclopædia," or in any other place in the work, and having regard to the importance of the subject, we cannot but regret its absence.

We believe that had the work of Reuleaux been published earlier, Rankine would have been one of the first to recognise its beauty and value.

The whole article displays the power of logical arrangement and method, as well as the condensed style which is so characteristic of all Rankine's writings, and makes them such difficult reading for beginners. These will probably prefer his "Applied Mechanics," for purposes of study, to the article before us. But as an exposition, in small compass, of the leading principles of that science, it is altogether admirable as far as it goes, whilst its value is increased by the numerous articles in this "Encyclopædia" on special, more technical parts of the subject, such as that of Prof. Jenkin, already quoted, and that of Prof. Unwin on "Hydraulics," and others which are promised in forthcoming volumes.

The article on "Mammalia," by Prof. Flower, is an extremely well condensed and intelligibly written essay on the highest class of vertebrate beings, for which, as the author notes, there has never been a generally accepted vernacular designation. Still the class known to zoologists as Mammals is one rigidly defined, and one that obeys the strictest rules of logic in its definition, despite Kant's remarks on the impossibility of defining strictly natural objects. It is easy to imagine the mammary glands reduced to a state of extreme simplicity, but among living mammals this never occurs, nor is there any gland to be confounded with them in any other vertebrate form. The article opens with a chapter on the general anatomical characters of the class, in which an immense amount of accurate information is compressed into a small space. Many of the figures illustrating the details of the osteology are taken from Prof. Flower's well-known work on this subject. In the chapter on classification, the recent arguments of Prof. Huxley in favour of passing over all known forms of birds and reptiles and going straight to the amphibia for the progenitors of the mammalia are quoted with approval; and that author's subdivision of the class into three sub-branches—Prototheria, Metatheria, and Eutheria—is adopted. The history of the distribution of the mammals in time and space follows; and then we have the characters of the different orders and families, and of the principal forms of the class. In this section of the memoir the illustrations, taken from the best sources, are especially to be praised, and in many instances the information as to rare or new species is brought well up to date. This seems to us especially so in the interesting group of the bats and insectivora, for which Prof. Flower acknowledges his indebtedness to Dr. G. E. Dobson, but in the portion devoted to the order Primates, an order which Prof. Flower makes to include the lemurs, the monkeys, and man, we read the little that is written under the impression that it was but introductory to a good deal that was to follow, and when we turned over to p. 446 we found the essay was finished and that we had arrived at the index; even this bears marks of a forced compression, for while the earlier letters are fairly done, the last in the index have evidently had a lot "squeezed" out.

One other article relating to zoology in this volume is also by Prof. W. H. Flower, on the "Mammoth." He alludes to the derivation of this name as being by some ascribed to a Tartar origin, by others that it is a corruption of the Arabic word *Behemoth*, or great beast, but on the authority of Prof. Sayce it is a corruption of the Biblical Behemoth, Arabic behîmat.

The scientific articles in vol. xvi. are so numerous and important that it is impossible for us to give them satisfactory notice in the space at our disposal; we can do no more than name the more important. From Prof. Dittmar we have Metallurgy and Metals; Prof. Chandler Roberts and Mr. R. A. Hill contribute the article on Mint, in which all aspects of the subject are fully as well as interestingly treated; while Mining, by Dr. Le Neve Foster, is both practical and scientific. Meteorology, of course, has been undertaken by Mr. Buchan and Prof. Balfour Stewart, and forms an admirable exposition of the present condition of a science of great and growing complexity; Mr. Buchan treating of instruments and phenomena, while Prof. Stewart deals with the science that underlies the subject. The article on Micrometer is by Dr. David Gill; while it is natural to find Dr. W. B. Carpenter's name attached to that on Microscope. Prof. Heddle contributes an elaborate and profusely illustrated article on Mineralogy. Molecule has a triple authorship, Rev. H. W. Watson, Mr. S. H. Burbury, and Prof. Crum Brown, both its physical and chemical aspects being thus fully treated. The article on Mollusca in this volume, by Prof. Ray Lankester, is as complete and masterly and richly illustrated as that on Mammalia in the previous volume. Under Moon we have a short article on the lunar theory, by Prof. Simon Newcomb; other aspects of the subject have been dealt with under Astronomy. Mr. P. Geddes has a careful and wonderfully exhaustive article on Morphology: and Mr. R. M'Lachlan finishes off the volume with a somewhat tiny article on Mosquito. There are many other smaller articles in all departments of science,—Prof. A. Newton, for example, doing all birds,—and several important ethnologico-geographical articles, as Mexico, by Mr. E. B. Tylor and Prof. Keane, and Mongols, by Prof. Douglas and Prof. Jülg. We hope in a future number to be able to refer in detail to some of the articles mentioned.

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.*]

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Living Scorpions, Mygale, and Protopterus

WILL you allow me to use your columns in order to ask any of your readers residing in tropical localities, who may be generous enough to wish to help a naturalist in his researches, to send to me *living* specimens of *large* Scorpions (not less than three inches in length), and *living* specimens of large Mygale (birdsnesting spider); also I would beg for *living* Earthworms of large size from African, Indian, American, and Australian localities. Any of these animals can be sent in a small tin box in which a few holes are perforated; the tin box being packed in a much larger wooden box with hay or loose paper. Damp moss should be placed with the Scorpion or Mygale. Each specimen should be inclosed in a separate tin box, since these animals are cannibals. The holes in the tin box containing an Earthworm should be very few, and the amount of damp moss very great. Earthworms would travel best in a Wardian case, should the opportunity offer—not loose, but in the above-mentioned tin box.

I would further take this opportunity to ask for information concerning the best way of keeping the African Lepidosiren, or mud-fish (*Protopterus annectens*), in confinement. I require to ascertain (1) its natural food, (2) the temperature of the waters in which it naturally lives, (3) whether these are stagnant or rapidly running, (4) whether anything is known as to habits in the breeding season, and if this season immediately precedes or succeeds the dry season.

Some of your readers in this country or in Africa may have gained experience on these points, and would greatly help me in an attempt to breed the mud-fish by communicating with me.

E. RAY LANKESTER

11, Wellington Mansions, North Bank, N.W.

Electricity in India.—The Green Sun

[THE following letter has been sent us for publication by Sir William Thomson, to whom it is addressed:—]

For nearly a month the air has been in a state of electrification, which seems to me so interesting that I thought you would probably like to hear of it at once without my waiting to complete my observations. Unfortunately I cannot tell the exact date at which it began, but August 31 showed positive electricity all day apparently. On September 1 and 2, I was not able to get any measurements, but on the 3rd at 1.10 p.m., I got negative readings from −28 to −17 div., wind light, S. by W. By 2.45 it had changed to +6. Next morning at 10.5 a.m. it varied from −136 to −44; this was on the roof. I then took it to the ground, to a place quite open, and found readings from −460 in gusts of wind to −162 when the wind was light. The wind was fresh, westerly. Up to 1h. 14m. it continued negative, but at my next reading, 3 p.m., it was +35, and remained steadily positive, the wind having now gone round to the east (sea breeze).

5th, 6 a.m., positive, from 9 a.m. to 2.5 negative, and thereafter positive.

This continued with the exception of the 9th, when it was positive all day till the 13th.

On the 20th the reading at 9.55 was −34, but at 11.55 it was +44, the wind in the meanwhile having changed from west (land wind) to east (sea breeze). A similar state of affairs still continues.

During all this time the weather in Madras has been fine, and for some days at first, when I made very special inquiries, I found that no rain had fallen within 100 miles of Madras. It may perhaps be worth mentioning that from the 8th to the 14th we have had the strange phenomenon of a bright green sun at sunrise and sunset, the sun appearing as a rayless globe, at which you could easily look, and yet so sharply defined that sunspots could be well seen with the naked eye. On the 22nd again, two days after the electricity had gone to positive, the green sun reappeared, and has now changed to a sort of golden green. I do not say that there is any connection between the two, but they seem worth mentioning together. I have got a large number of observations which I will reduce as soon as possible, and send to the Royal Society of Edinburgh, but there is no use doing this till things return to their normal state. It is worth pointing out that observations made at intervals of six hours might have entirely failed to find the negative electricity. I usually, for convenience, take observations at 9 a.m., before leaving for college, and the next would be at three, and both these are always positive. I have not got the exact scale of my electrometer, but I find that 100 Daniell's cells give only 24 div. of a deflection. I am very much disappointed that I have not got my new instrument yet. Had I had it I would have been able to get simultaneous observations carried on at Madras and at a place forty miles to the west, which might have given valuable results. My present instrument, though working better than before, needs constant recharging. For example, at noon yesterday the earth reading was 1750, and at six this morning it was only 1440.

C. MICHIE SMITH

Christian College, Madras, September 26

Unusual Cloud-Glow after Sunset

YESTERDAY evening a most extraordinary sunset effect was seen here, which made a deep impression on all who observed it. The sky was nearly clear when the sun set at 4.18, and the air transparent. A few cirrocumulus fleeces became lighted up with a pink and then with a deep red colour immediately after sunset. A very peculiar greenish and white opalescent haze now appeared about the point of the sun's departure, and shone as if with a light of its own, near the horizon. The upper part of this pearly mist soon assumed a pink colour, while the lower part was white, green, and greenish-yellow. About 4.35 the sky from near the horizon towards the zenith had begun to turn to a brilliant but delicate pink, and some pink cirrus-like streaks stretched apparently horizontally towards the south-east. The coloured portion of the sky spread out like a sheaf from the horizon, and apparently consisted of a very high, thin filmy cirrus disposed in transverse bands or ripples, close together, and very delicate in form, outline, and tint. Below the pink, and between it and the point where the sun had set, remained the very curious, opalescent, shining, green and white vapour, hanging, as it were, vertically, and changing very little during many minutes. The borders of the pink sheaf were definite, and finely contrasted with the deep blue sky. As darkness came on, the pink glow seemed to increase in brightness, and at five o'clock cast a fine weird light over the hills. The moon was now bright in the south-east, and began to cast dark shadows. About five the colour slowly receded from the part nearest the zenith towards the horizon, and as it retired left a clearly visible filmy ripple of cirrus of a faint gray tint. At 5.25 the greater part of the colour was gone, and the cloud remained bright only near the horizon. At 5.32, however, it began to grow again, and in a short time (5.40) the whole extent of the film was again glowing bright pink, producing a most striking effect in contrast with the silvery moon, dark sky, and bright stars in the north and east. The pink light then slowly withdrew towards the horizon, remaining bright and deep coloured low down till 5.50. At 5.58 the last pink disappeared. The whole phenomenon from first to last was in the highest degree peculiar and striking. It was remarkable, first, for the interval which elapsed between the time of sunset and the time at which the cloud became bright, next for the light, filmy character of the cloud, thirdly for the bright green glow near the place of sunset, fourthly for the small transverse ripple form of the cloud, fifthly for the permanence of shape and immobility of the cloud, sixthly for the very long endurance of the coloured reflected sunlight after sunset, one hour and forty minutes, and seventhly for the second illumination, which began more than an hour after sunset. It was certainly due to cirrus or a higher kind of cloud, because (1) parts of the illuminated sky stretched in long streaks southwards, and the glow remained long in these streaks, resembling very high cirrus; (2) when the light left the sky the first time, the part which had been illuminated remained visible as silvery gray cloud ripples, before the second after-glow rekindled it, and (3) because the colour became very gradually darker as time went on, and because the recessions of light both times were towards the place of sunset. A similar very high cirrus had also been specially marked long after sunset on November 8, and about the time of sunrise on November 9. The night following this rare display was exceedingly clear and fine. This evening (November 10) the light, high cirrus, all but invisible in full daylight, with its delicate ripples, assumed the pink tint about fifteen minutes after sunset, showing the upper air to be in the same abnormal condition as yesterday, and the phenomenon was feebly repeated. It would be interesting to ascertain the approximate height of cirrus on which sunshine remains one hour and forty minutes after sunset at this time of year.

F. A. R. RUSSELL

Dunrozel, Haslemere, Surrey, November 10

Shadow-Beams in the East at Sunset

THE phenomenon of beams of shadow meeting in the east at sunset, treated of in the pages of NATURE some months since (at which time you did me the honour of inserting a letter of mine), was beautifully witnessed here to-day and yesterday. Both days were unusually clear; there was, nevertheless, a "body" in the air, without which the propagation of the beams could not take place. Yesterday the sky was striped with cirrus cloud like the swaths of a hayfield; only in the east there was a bay or reach of clear blue sky, and in this the shadow-beams appeared, slender, colourless, and radiating every way like a fan wide open. This lasted from 3.30 to about 4.30. To-day the sky was cloudless, except for a low bank in the west; in the east was a "cast" of blue mist, from which sprang alternate broad bands of rose colour and blue, slightly fringed. I was not able to look for them till about 4.30, when the sun was down, and they soon faded. I have not before seen this appearance so far north, but on the south coast, where I first saw it, I think it might often be witnessed. It is merely an effect of perspective, but a strange and beautiful one.

Stonyhurst College, November 12 GERARD HOPKINS

The Java Eruption

THE accompanying paragraph may be of interest in connection with the Java catastrophe. I may mention that from the 28th of last month, when I first noticed it, there has been an exceptional red glow after sundown, and a strange green tint in the sky, while till the last few days the moon has had a distinctly green tint; this green tint has been noticed in many parts of India.

F. C. CONSTABLE

Karachi, October 16

A FLOATING LAVA BED.—Sir,—It may be interesting to some of your scientific readers to know that the steamship *Siam*, on her voyage from King George's Sound to Colombo, on August 1, when in lat. 6° S., 89° E., passed, for upwards of four hours, through large quantities of lava, which extended as far as could be seen (the ship was going eleven knots at the time). The lava was floating in a succession of lanes from five to ten yards wide, and trending in a direction north-west to south-east. The nearest land was the coast of Sumatra (distant 700 miles), but as there was a current of fifteen to thirty miles a day, setting to the eastward, the lava could not have come from there, and I can only imagine it must have been an upheaval from somewhere near the spot. I may mention the soundings on the chart show over 2,000 fathoms. There was a submarine volcano near the spot in 1879.—EDWARD ASHDOWN, Commander, P. and O. steamship *Siam*. (*Sind Gazette Bulletin*, October 12.)

Towering of Birds

WHEN shooting in Fifeshire last October I fired at a partridge at a distance of about forty yards; the bird flew on for a short distance, and then began to rise, not in the manner in which a towering bird generally ascends, but soaring as if it did so voluntarily. After rising to the height of 100 or 150 yards very much after the fashion in which some hawks soar, its flight was suddenly deflected downwards obliquely for a considerable distance,

when it swerved, and came towards the ground in a different direction, alighting as though it were in possession of its natural powers, some hundreds of yards from the place whence it rose. On going to the spot where it had settled, it was found to be alive and crouching in the long grass. The keeper ran in and placed his hand on it, when the bird struggled and tried to get away; he killed it seeing that it was wounded. On examining the bird immediately after I found that it had been struck by two pellets of No. 6 shot, one of which had penetrated the pectoral muscles, but had not injured the cavity; the lungs and other viscera were uninjured. The other pellet had entered behind and below the left eyeball, and, passing forward, had emerged on the other side, passing above the upper mandible. The brain was uninjured, but the lower part of the left eyeball was cut and distended with blood. There was no other injury. No doubt the shock had confused the bird, and caused its strange flight, which, though upward, was very different in its character from that of ordinary towering where the lungs are perforated, and unconsciousness is the result of the circulation of non-aërated blood.
J. FAYRER

Meteors

PERMIT me to point out to Mr. J. M. Hayward (NATURE, Nov. 8, p. 30) that his observation of the large meteor of November 4 possesses no scientific value, inasmuch as he has omitted to mention the important features of its appearance. The time is given as "just now" (or November 4), and the broad path of fire which this fine meteor discharged upon its course must have been situated *somewhere* in the south-east, for your correspondent states he saw it "on turning to the south-east."

I had endeavoured to show in NATURE of the preceding week (Nov. 1, p. 6) that these delightfully vague forms of expression as applied to meteors are wholly inadequate, and, as such, cannot receive any attention at the hands of those who investigate these phenomena.

Had Mr. Hayward given us the essential details of his observation, it might have proved very valuable, for a large meteor (perhaps identical with the one he refers to) was observed at many places on the night of November 4. As recorded at Chelmsford, Bath, and Bristol the paths were:—

Time.		Mag.	From α	From δ	To α	To δ	Observer.
1883	h. m.		°	°			
Nov. 4	10 14	= ♀	8	S. 20	355	S. 30	H. Corder, Chelmsford.
Nov. 4	10 12	6 × ♃	33	S. 6	9	S. 23	J. L. Stothert, Bath.
Nov. 4	10 12	> ♃	36	N. 1½	16	S. 19	W. F. Denning, Bristol.

The several estimates of brilliancy are very discordant, but the time and paths agree so closely that there is little doubt the observations refer to the same meteor.

Another fine meteor was seen here on October 26 at 9h. 17m. It gave a succession of four lightning-like flashes. Path from α 288 δ 56° + to α 333° δ 59° +. This was not the only fireball visible that night, for I see by NATURE (November 8, p. 44) that "On October 26 at about 7 p.m. a splendid meteor was seen in the district of Hernö and, Sweden." It appeared "with a blinding white lustre in the zenith and travelling very rapidly down to the horizon." In this case again we have to deplore the extremely vague manner of the description. Had the precise direction of flight been given, it would have been interesting to determine whether this fireball belonged to the same stream as the equally fine one recorded at Bristol on the same night.
W. F. DENNING

Bristol, November 10

THE meteors during October have been numerous, and the most of them proceeded from some point in Auriga. With the exception of about nine days of unfavourable weather, I have seen several meteors night and morning throughout October, but they were generally small and transient. I have counted fifty-two from 10 p.m. of October 3 to 4·30 a.m. of the 4th, many of them large and of several seconds' duration. The largest of these passed slowly from the first bright star on the left of Capella, in Auriga, to a point about 1° below α Cygni. The smallest of them blinked rapidly before the eye in the zenith over the Milky Way, which, this night, was the principal theatre of their display. From 3.30 to 4.30 a.m. I counted forty of the fifty-two meteors. From 1 a.m. to 4 of October 8 I observed very brilliant meteors. One at 2.25 a.m. darted from about 1° above Capella and disappeared at a point ½° from Phad in the Plough, without exploding and without leaving any trace of light behind. It was as large as Venus. At 2.40 a.m. a very large and brilliant meteor dashed out from a point midway between Capella and the first bright star to its right in Auriga, and sped along above the Pleiades and Aries through the Square of Pegasus, and exploded 3° beyond it, leaving no fire in its wake. October 15, 11.38 p.m., a very unusual meteor sailed slowly from β Ceti to within 1° of Betelguenx, in the right shoulder of Orion. After travelling two-thirds of its journey, it exploded into four, three of which formed the head of an arrow, and the fourth adorned its tail, all the four sending out bright nebulous light behind them. At 2.50 a.m., October 26, a large ball of fire (bolide), apparently seven inches in diameter, illumined the heavens with great brilliancy as it descended from about midway between the third and fourth bright stars on the left of Capella, exploding twice during the last half of its journey, and disappearing just as it reached the moon. It had no tail. It was seen by some of the Paisley night police, and one of them was frightened that it would dash the moon out of the heavens. This bolide had no detonation in either of its two explosions, and the last of it was only about the size of Jupiter. One policeman describes it as a large fiery ball of the size of the full moon, but this is an exaggeration. The extraordinary meteor of October 15, after its explosion, was described by an observer as a well-formed arrow of flaming fire, followed by a ball of fire with a tail. To me it appeared to resemble the head and body of a fish, as well as the form of an arrow.
DONALD CAMERON

Mossvale, Paisley, November 6

ON the evening of Saturday last, at 10.12 p.m., a remarkable meteorite was observed close to Trinity College, Glenalmond, in Perthshire. It presented the appearance of a bright spherical ball, which moved horizontally from east-north-east to west-south-west at a height roughly estimated at 300 feet. When it began to curve downwards it disappeared from view, but it left behind it a luminous trail of great brilliancy, which was seen for fully forty seconds, its brilliancy gradually diminishing till it entirely faded away.
W. BESANT LOWE

Trinity College, Glenalmond, Perth, November 12

"Anatomy for Artists"

I AM quite unable to do as your correspondent "An Art Student" suggests, for the second edition of the above-named book has been just issued. I may add, however, that the reasons which led me deliberately to adopt the plan alluded to in regard to the illustrations of the bones still remain, in my opinion, sound, and I trust that the majority of my readers of the past, present, and future editions have not been and will not be "discouraged" by the effort which I desire them, for their own sakes as students, to make.
JOHN MARSHALL

10, Savile Row, W., November 12

P.S.—It seems that *I* ought to have two "letters of reference" attached to myself, for I am not "Dr." but "Mr." Marshall.

Earthquake

NATURE on October 25 contained notices of shocks of earthquake which were felt at a quarter to one o'clock on the night of October 19 (11h. 20m. Greenwich M.T.) at Cadiz and other places on the coast of Andalusia. I have information that about 17h. 45m. later these shocks, which were travelling from east to west, had apparently reached Bermudas. In a letter just received from ex-Chief Justice Darrell, dated October 22, he remarks:—"A very unusual event occurred here on the 20th of this month, in a shock of an earthquake, which however was slight; no life was lost, nor serious damage done to buildings; but the shock, which lasted less than a minute, at about a quarter past one p.m. was universally and unmistakably felt throughout the colony. It is said to be only the third time that any earthquake has been experienced in Bermuda in the last forty years." A quarter past one in Bermuda would be about four and a half minutes past five at Greenwich, requiring, if the shocks originated in the same wave, a rate of transmission of about 158 geographical miles an hour, or 2·6 miles per minute; less than half the rate at which the great shocks of 1755 and 1761 crossed the Atlantic from Lisbon to Barbados, which is given by Mallet as 7·3 miles, or 6·3 geographical miles per minute.[1]

J. H. LEFROY

"Partials"

IN your number of Nov. 1, p. 6, I noticed an article the object of which was to account for the existence of "partials." Were the theory therein set forth correct, we should have a constant number of "partials" for any given "fundamental" tone of constant force regardless of its source; whereas it is a well-known fact that, while the tones of some instruments are rich in "partials," those of other instruments have but few.

CROMWELL O. VARLEY

Cromwell House, Bexley Heath, Kent

SCIENCE AND ENGINEERING

IN the address delivered by Mr. Westmacott, President of the Institution of Mechanical Engineers, to the English and Belgian engineers assembled at Liége last August, there occurred the following passage:—"Engineering brings all other sciences into play: chemical or physical discoveries, such as those of Faraday, would be of little practical use if engineers were not ready with mechanical appliances to carry them out, and make them commercially successful in the way best suited to each."

We have no objection to make to these words, spoken at such a time and before such an assembly. It would of course be easy to take the converse view, and observe that engineering would have made little progress in modern times, but for the splendid resources which the discoveries of pure science have placed at her disposal, and which she has only had to adopt and utilise for her own purposes. But there is no need to quarrel over two opposite modes of stating the same fact. There *is* need on the other hand that the fact itself should be fairly recognised and accepted, namely, that science may be looked upon as at once the handmaid and the guide of art, art as at once the pupil and the supporter of science. In the present article we propose to give a few illustrations which will bring out and emphasise this truth.

We could scarcely find a better instance than is furnished to our hand in the sentence we have chosen for a text. No man ever worked with a more single-hearted devotion to pure science—with a more absolute disregard of money or fame, as compared with knowledge—than Michael Faraday. Yet future ages will perhaps judge that no stronger impulse was ever given to the progress of industrial art, or to the advancement of the material interests of mankind, than the impulse which sprang from his discoveries in electricity and magnetism. Of these discoveries we are only now beginning to reap the benefit. But we have merely to consider the position which the dynamo-electric machine already occupies in the industrial world, and the far higher position which, as almost all admit, it is destined to occupy in the future, in order to see how much we owe to Faraday's establishment of the connection between magnetism and electricity. That is one side of the question—the debt which art owes to science. But let us look at the other side also. Does science owe nothing to art? Will any one say that we should know as much as we do concerning the theory of the dynamo-electric motor, and the laws of electro-magnetic action generally, if that motor had never risen (or fallen, as you choose to put it) to be something besides the instrument of a laboratory, or the toy of a lecture-room. Only a short time since the illustrious French physicist, M. Tresca, was enumerating the various sources of loss in the transmission of power by electricity along a fixed wire, as elucidated in the careful and elaborate experiments inaugurated by M. Marcel Deprez, and subsequently continued by himself. These losses—the electrical no less than the mechanical losses—are being thoroughly and minutely examined in the hope of reducing them to the lowest limit; and this examination cannot fail to throw much light on the exact distribution of the energy imparted to a dynamo machine, and the laws by which this distribution is governed. But would this examination ever have taken place—would the costly experiments which render it feasible ever have been performed—if the dynamo machine was still under the undisputed control of pure science, and had not become subject to the sway of the capitalist and the engineer?

Of course the electric telegraph affords an earlier and perhaps as good an illustration of the same fact. The discovery that electricity would pass along a wire and actuate a needle at the other end was at first a purely scientific one; and it was only gradually that its importance, from an industrial point of view, came to be recognised. Here again art owes to pure science the creation of a complete and important branch of engineering, whose works are spread like a net over the whole face of the globe. On the other hand, our knowledge of electricity, and specially of the electro-chemical processes which go on in the working of batteries, has been enormously improved in consequence of the use of such batteries for the purposes of telegraphy.

Let us turn to another example in a different branch of science. Whichever of our modern discoveries we may consider to be the most startling and important, there can I think be no doubt that the most beautiful is that of the spectroscope. It has enabled us to do that which but a few years before its introduction was taken for the very type of the impossible, viz. to study the chemical composition of the stars; and it is giving us clearer and clearer insight every day into the condition of the great luminary which forms the centre of our system. Still, however beautiful and interesting such results may be, it might well be thought that they could never have any practical application, and that the spectroscope at least would remain an instrument of science, but of science alone. This however is not the case. Some thirty years since Mr. Bessemer conceived the idea that the injurious constituents of raw iron—such as silicon, sulphur, &c.—might be got rid of by simple oxidation. The mass of crude metal was heated to a very high temperature; atmospheric air was forced through it at a considerable pressure; and the oxygen uniting with these metalloids carried them off in the form of acid gases. The very act of union generated a vast quantity of heat, which itself assisted the continuance of the process; and the gas therefore passed off in a highly luminous condition. But the important point was to know where to stop; to seize the exact moment when all or practically all hurtful ingredients had been removed, and before the oxygen had turned from them to attack the iron itself. How was this point to be ascertained? It was soon suggested that each of these gases in its incandescent state would show its own peculiar spectrum; and that, if the flame rushing out of the throat of the converter were viewed through a spectroscope, the moment when any substance such as sulphur had disappeared would be known by the disappearance of the corresponding lines in the spectrum. The anticipation, it is needless to say, was verified; and the spectroscope, though now superseded, had for a time its place among the regular appliances necessary for the carrying on of the Bessemer process.

This process itself, with all the momentous consequences, mechanical, commercial, and economical, which it has entailed, might be brought forward as a witness on our side; for it was almost completely worked out in the laboratory before being submitted to actual practice. In this respect it stands in marked contrast to the earlier processes for the making of iron and steel, which

[1] Mallet's Fourth Report, British Association, 1858.

were developed, it is difficult to say how, in the forge or furnace itself, and amid the smoke and din of practical work. At the same time the experiments of Bessemer were for the most part carried out with a distinct eye to their future application in practice, and their value for our present purpose is therefore not so great. The same we believe may be said with regard to the great rival of the Bessemer converter, viz. the Siemens open hearth; although this forms in itself a beautiful application of the scientific doctrine that steel stands midway, as regards its proportion of carbon, between wrought iron and pig iron, and ought therefore to be obtainable by a judicious mixture of the two. The basic process is the latest development, in this direction, of science as applied to metallurgy. Here, by simply giving a different chemical constitution to the clay lining of the converter, it is found possible to eliminate phosphorus—an element which has successfully withstood the attack of the Bessemer system. Now, to quote the words of a German eulogiser of the new method, phosphorus has been turned from an enemy into a friend; and the richer a given ore is in that substance, the more readily and cheaply does it seem likely to be converted into steel.

These latter examples have been taken from the art of metallurgy; and it may of course be said that, considering the intimate relations between that art and the science of chemistry, there can be no wonder if the former is largely dependent for its progress on the latter. I will therefore turn to what may appear the most concrete, practical, and unscientific of all arts—that, namely, of the mechanical engineer; and we shall find that even here examples will not fail us of the boons which pure science has conferred upon the art of construction, nor even perhaps of the reciprocal advantages which she has derived from the connection.

The address of Mr. Westmacott, from which I have already taken my text, supplies in itself more than one instance of the kind we seek—instances emphasised by papers read at the meeting where the address was spoken. Let us take, first, the manufacture of sugar from beetroot. This manufacture was forced into prominence in the early years of this century, when the Continental blockade maintained by England against Napoleon prevented all importation of sugar from America; and it has now attained very large dimensions, as all frequenters of the Continent must be aware. The process, as exhaustively described by a Belgian engineer, M. Mélin, offers several instances of the application of chemical and physical science to practical purposes. Thus, the first operation in making sugar from beetroot is to separate the juice from the flesh, the former being as much as 95 per cent. of the whole weight. Formerly this was accomplished by rasping the roots into a pulp, and then pressing the pulp in powerful hydraulic presses; in other words, by purely mechanical means. This process is now to a large extent superseded by what is called the diffusion process, depending on the well known physical phenomena of *endosmosis* and *exosmosis*. The beetroot is cut up into small slices called "cossettes," and these are placed in vessels filled with water. The result is that a current of endosmosis takes place from the water towards the juice in the cells, and a current of exosmosis from the juice towards the water. These currents go on cell by cell, and continue until a state of equilibrium is attained. The richer the water and the poorer the juice, the sooner does this equilibrium take place. Consequently the vessels are arranged in a series, forming what is called a diffusion battery; the pure water is admitted to the first vessel, in which the slices have already been nearly exhausted, and subtracts from them what juice there is left. It then passes as a thin juice to the next vessel, in which the slices are richer, and the process begins again. In the last vessel the water which has already done its work in all the previous vessels comes into contact with fresh slices, and begins the operation upon them. The same process has been applied at the other end of the manufacture of sugar. After the juice has been purified, and all the crystallisable sugar has been separated from it by boiling, there is left a mass of molasses, containing so much of the salts of potassium and sodium that no further crystallisation of the yet remaining sugar is possible. The object of the process called osmosis is to carry off these salts. The apparatus used, or osmogene, consists of a series of trays filled alternately with molasses and water, the bottoms being formed of parchment paper. A current passes through this paper in each direction, part of the water entering the molasses, and part of the salts, together with a certain quantity of sugar, entering the water. The result of thus freeing the molasses from the salts is that a large part of the remaining sugar can now be extracted by crystallisation.

Another instance in point comes from a paper dealing with the question of the construction of long tunnels. In England this has been chiefly discussed of late in connection with the Channel Tunnel, where, however, the conditions are comparatively simple. It is of still greater importance abroad. Two tunnels have already been pierced through the Alps; a third is nearly completed; and a fourth, the Simplon Tunnel, which will be the longest of any, is at this moment the subject of a most active study on the part of French engineers. In America, especially in connection with the deep mines of the western States, the problem is also of the highest importance. But the driving of such tunnels would be financially if not physically impossible, but for the resources which science has placed in our hands, first, by the preparation of new explosives, and, secondly, by methods of dealing with the very high temperatures which have to be encountered. As regards the first, the history of explosives is scarcely anything else than a record of the application of chemical principles to practical purposes—a record which in great part has yet to be written, and on which we cannot here dwell. It is certain, however, that but for the invention of nitroglycerine, a purely chemical compound, and its development in various forms, more or less safe and convenient, these long tunnels would never have been constructed. As regards the second point, the question of temperature is really the most formidable with which the tunnel engineer has to contend. In the St. Gothard Tunnel, just before the meeting of the two headings in February, 1880, the temperature rose as high as 93° Fahr. This, combined with the foulness of the air, produced an immense diminution in the work done per person and per horse employed, whilst several men were actually killed by the dynamite gases, and others suffered from a disease which was traced to a hitherto unknown species of internal worm. If the Simplon Tunnel should be constructed, yet higher temperatures may probably have to be dealt with. Although science can hardly be said to have completely mastered these difficulties, much has been done in that direction. A great deal of mechanical work has of course to be carried on at the face or far end of such a heading, and there are various means by which it might be done. But by far the most satisfactory solution, in most cases at least, is obtained by taking advantage of the properties of compressed air. Air can be compressed at the end of the tunnel either by steam-engines, or, still better, by turbines where water power is available. This compressed air may easily be led in pipes to the face of the heading, and used there to drive the small engines which work the rock-drilling machines, &c. The efficiency of such machines is doubtless low, chiefly owing to the physical fact that the air is heated by compression, and that much of this heat is lost whilst it traverses the long line of pipes leading to the scene of action. But here we have a great advantage from the point of view of ventilation; for as the air gained heat while being compressed, so it loses heat while expanding; and the result is that a current of cold and fresh air is continually issuing from the machines at the face of the heading, just where it is most wanted. In consequence, in the St. Gothard, as just alluded to, the hottest parts were always some little distance behind the face of the heading. Although in this case as much as 120,000 cubic metres of air (taken at atmospheric pressure) were daily poured into the heading, yet the ventilation was very insufficient. Moreover, the high pressure which is used for working the machines is not the best adapted for ventilation; and in the Arlberg tunnel separate ventilating pipes are employed, containing air compressed to about one atmosphere, which is delivered in much larger quantities, although not at so low a temperature. In connection with this question of ventilation a long series of observations have been taken at the St. Gothard, both during and since the construction: these have revealed the important physical fact (itself of high practical importance) that the barometer never stands at the same level on the two sides of a great mountain chain; and so have made valuable contributions to the science of meteorology.

Another most important use of the same scientific fact, namely, the properties of compressed air, is found in the sinking of foundations below water. When the piers of a bridge, or other structure, had to be placed in a deep stream, the old method was to drive a double row of piles round the place and fill them in with clay, forming what is called a cofferdam. The water was pumped out from the interior, and the foundation laid in the open. This is always a very expensive process, and in rapid streams is scarcely practicable. In recent times large bottomless cases, called caissons, have been used, with tubes attached to the roof, by which air can be forced into or out of the interior. These caissons are brought to the site of the proposed pier, and are there sunk. Where the bottom is loose sandy earth, the Vacuum process, as it is termed, is often employed; that is, the air is pumped out from the interior, and the superincumbent pressure then causes the caisson to sink and the earth to rise within it. But it is more usual to employ what is called the Plenum process, in which air under high pressure is pumped into the caisson and expels the water, as in a diving bell. Workmen then descend, entering through an air lock, and excavate the ground at the bottom of the caisson, which sinks gradually as the excavation continues. Under this system a length of some two miles of quay wall is being constructed at Antwerp, far out in the channel of the River Scheldt. Here the caissons are laid end to end with each other, along the whole curve of the wall, and the masonry is built on the top of them within a floating cofferdam of very ingenious construction.

There are few mechanical principles more widely known than that of so-called centrifugal force; an action which, though still a puzzle to students, has long been thoroughly understood. It is, however, comparatively recently that it has been applied in practice. One of the earliest examples was, perhaps, the ordinary governor, due to the genius of Watt. Every boy knows that if he takes a weight hanging from a string and twirls it round, the weight will rise higher and revolve in a larger circle as he increases the speed. Watt saw that if he attached such an apparatus to his steam engine, the balls or weights would tend to rise higher whenever the engine began to run faster, that this action might be made partly to draw over the valve which admitted the steam, and that in this way the supply of steam would be lessened, and the speed would fall. Few ideas in science have received so wide and so successful an application as this. But of late years another property of centrifugal force has been brought into play. The effect of this so-called force is that any body revolving in a circle has a continual tendency to fly off at a tangent; the amount of this tendency depending jointly on the mass of the body and on the velocity of the rotation. It is the former of these conditions which is now taken advantage of. For if we have a number of particles all revolving with the same velocity, but of different specific gravities, and if we allow them to follow their tendency of moving off at a tangent, it is evident that the heaviest particles having the greatest mass will move with the greatest energy. The result is that, if we take a mass of such particles and confine them within a circular casing, we shall find that, having rotated this casing with a high velocity and for a sufficient time, the heaviest particles will have settled at the outside and the lightest at the inside, whilst between the two there will be a gradation from the one to the other. Here, then, we have the means of separating two substances, solid or liquid, which are intimately mixed up together, but which are of different specific gravities. This physical principle has been taken advantage of in a somewhat homely but very important process, viz. the separation of cream from milk. In this arrangement the milk is charged into a vessel something of the shape and size of a Gloucester cheese, which stands on a vertical spindle and is made to rotate with a velocity as high as 7000 revolutions per minute. At this enormous speed the milk, which is the heavier, flies to the outside, while the cream remains behind and stands up as a thin layer on the inside of the rotating cylinder of fluid. So completely does this immense speed produce in the liquid the characteristics of a solid, that if the rotating shell of cream be touched by a knife it emits a harsh grating sound, and gives the sensation experienced in attempting to cut a stone. The separation is almost immediately complete, but the difficult point was to draw off the two liquids separately and continuously without stopping the machine. This has been simply accomplished by taking advantage of another principle of hydromechanics. A small pipe opening just inside the shell of the cylinder is brought back to near the centre, where it rises through a sort of neck and opens into an exterior casing. The pressure due to the velocity causes the skim-milk to rise in this pipe and flow continuously out at the inner end. The cream is at the same time drawn off by a similar orifice made in the same neck and leading into a different chamber.

Centrifugal action is not the only way in which particles of different specific gravity can be separated from each other by motion only. If a rapid "jigging" or up-and-down motion be given to a mixture of such particles, the tendency of the lighter to fly further under the action of the impulse causes them gradually to rise to the upper surface; this surface being free in the present case, and the result being therefore the reverse of what happens in the rotating chamber. If such a mixture be examined after this up-and-down motion has gone on for a considerable period, it will be found that the particles are arranged pretty accurately in layers, the lightest being at the top and the heaviest at the bottom. This principle has long been taken advantage of in such cases as the separation of lead ores from the matrix in which they are embedded. The rock in these cases is crushed into small fragments, and placed on a frame having a rapid up-and-down motion, when the heavy lead ore gradually collects at the bottom and the lighter stone on the top. To separate the two the machine must be stopped and cleared by hand. In the case of coal-washing, where the object is to separate fine coal from the particles of stone mixed with it, this process would be very costly, and indeed impossible, because a current of water is sweeping through the whole mass. In the case of the Coppée coal-washer, the desired end is achieved in a different and very simple manner. The well known mineral felspar has a specific gravity intermediate between that of the coal and the shale, or stone, with which it is found intermixed. If, then, a quantity of felspar in small fragments is thrown into the mixture, and the whole then submitted to the jigging process, the result will be that the stone will collect on the top, and the coal at the bottom, with a layer of felspar separating the two. A current of water sweeps through the whole, and is drawn off partly at the top, carrying with it the stone, and partly at the bottom, carrying with it the fine coal.

The above are instances where science has come to the aid of engineering. Here is one in which the obligation is reversed. The rapid stopping of railway trains, when necessary, by means of brakes, is a problem which has long occupied the attention of many engineers; and the mechanical solutions offered have been correspondingly numerous. Some of these depend on the action of steam, some of a vacuum, some of compressed air, some of pressure-water; others again ingeniously utilise the momentum of the wheels themselves. But for a long time no effort was made by any of these inventors thoroughly to master the theoretical conditions of the problem before them. At last, one of the most ingenious and successful among them, Mr. George Westinghouse, resolved to make experiments on the subject, and was fortunate enough to associate with himself Capt. Douglas Galton. Their experiments, carried on with rare energy and perseverance, and at great expense, not only brought into the clearest light the physical conditions of the question (conditions which were shown to be in strict accordance with theory), but also disclosed the interesting scientific fact that the friction between solid bodies at high velocities is not constant, as the experiments of Morin had been supposed to imply, but diminishes rapidly as the speed increases—a fact which other observations serve to confirm.

The old scientific principle known as the hydrostatic paradox, according to which a pressure applied at any point of an inclosed mass of liquid is transmitted unaltered to every other point, has been singularly fruitful in practical applications. Mr. Bramah was perhaps the first to recognise its value and importance. He applied it to the well known Bramah press, and in various other directions, some of which were less successful. One of these was a hydraulic lift, which Mr. Bramah proposed to construct by means of several cylinders sliding within each other after the manner of the tubes of a telescope. His specification of this invention sufficiently expresses his opinion of its value, for it concludes as follows:—"This patent does not only differ in its nature and in its boundless extent of claims to novelty, but also in its claims to merit and superior utility compared with any other patent ever brought before or sanctioned by the legislative authority of any nation." The telescope lift has not come into practical use; but lifts worked on the hydraulic principle are becoming more and more common every day. The same principle has been applied by the genius of Sir William Armstrong and others to the working of cranes and other machines for the lifting of weights, &c.; and under the form of the accumulator, with its distributing pipes and hydraulic engines, it provides a store of power always ready for application at any required point in a large system, yet costing practically nothing when not actually at work. This system of high-pressure mains worked from a central accumulator has been for some years in existence at Hull, as a means of supplying power commercially for all the purposes needed in a large town, and it is at this moment being carried out on a wider scale in the East End of London.

Taking advantage of this system, and combining with it another scientific principle of wide applicability, Mr. J. H. Greathead has brought out an instrument called the "injector hydrant," which seems likely to play an important part in the extinguishing of fires. This second principle is that of the lateral induction of fluids, and may be thus expressed in the words of the late William Froude:—"Any surface which in passing through a fluid experiences resistance must in so doing impress on the particles which resist it a force in the line of motion equal to the resistance." If then these particles are themselves part of a fluid, it will result that they will follow the direction of the moving fluid and be partly carried along with it. As applied in the injector hydrant, a small quantity of water derived from the high-pressure mains is made to pass from one pipe into another, coming in contact at the same time with a reservoir of water at ordinary pressure. The result is that the water from the reservoir is drawn into the second pipe through a trumpet-shaped nozzle, and may be made to issue as a stream to a considerable height. Thus the small quantity of pressure-water, which, if used by itself, would perhaps rise to a height of 500 feet, is made to carry with it a much larger quantity to a much smaller height, say that of an ordinary house.

The above are only a few of the many instances which might be given to prove the general truth of the fact with which we started, namely, the close and reciprocal connection between physical science and mechanical engineering, taking both in their widest sense. It may possibly be worth while to return again to the subject, as other illustrations arise. Two such have appeared even at the moment of writing, and though their practical success is not yet assured, it may be worth while to cite them. The first is an application of the old principle of the siphon to the purifying of sewage. Into a tank containing the sewage dips a siphon pipe some thirty feet high, of which the shorter leg is many times larger than the longer. When this is started, the water rises slowly and steadily in the shorter column, and before it reaches the top has left behind it all or almost all of the solid particles which it previously held in suspension. These fall slowly back through the column and collect at the bottom of the tank, to be cleared out when needful. The effluent water is not of course chemically pure, but sufficiently so to be turned into any ordinary stream. The second invention rests on a curious fact in chemistry, namely, that caustic soda or potash will absorb steam, forming a compound which has a much higher temperature than the steam absorbed. If, therefore, exhaust steam be discharged into the bottom of a vessel containing caustic alkali, not only will it become condensed, but this condensation will raise the temperature of the mass so high that it may be employed in the generation of fresh steam. It is needless to observe how important will be the bearing of this invention upon the working of steam-engines for many purposes, if only it can be established as a practical success. And if it is so established there can be no doubt that the experience thus acquired will reveal new and valuable facts with regard to the conditions of chemical combination and absorption, in the elements thus brought together.

WALTER R. BROWNE

THE LITERATURE OF THE FISHERIES EXHIBITION[1]

II.

THE depopulation of our littoral fisheries is the text of a paper on "Crustacea," by Mr. T. Cornish, who proposes to meet the difficulty by establishing a market for "middle-sized" Crustacea (and even fishes), other than those which we now eat, either as "luxuries or dainties." There is an amusing but authoritative air of originality about this paper. Mr. W. S. Kent, on the other hand, proposes the "Artificial Culture of Lobsters" as a remedy for the same evil, and recounts some interesting experiments made by himself—on a small scale—in which he succeeded in rearing the young lobsters taken captive. The leading developmental phases are set down for the guidance of others, but the account given is deficient in record of the earlier stages of the process. This is important, as the writer (presupposing

[1] Concluded from p. 36.

success such as has attended the artificial cultivation of the Salmonidæ) states, without apparent proof, that the cultivation might go on after the removal of the *eggs* from the parent. Should this be so, choice must then lie between the methods of Messrs. Cornish and Kent. The latter has overlooked the fact that our Irish lobster fisheries appear to be capable of much greater development, and we doubt how far an accusation brought against the "West-end chefs" is a logical one. We are at a loss to see the drift of Mr. K. Cornish's remarks, which form part of the discussion upon these two papers.

Early in the career of these meetings, our freshwater fisheries received attention at the hands of Sir Jas. Maitland, whose liberality in the matter of salmon-culture is well known in all fishing circles. The author, who regards the artificial propagation of the Salmonidæ as in its infancy, records the technique and results of a long practical experience, and indicates lines for future investigation, both as regards the migratory and non-migratory forms. He shows that by skilful attention he can rely upon hatching out 99 per cent. of Loch Levan trout ova, and, while discussing all sides of the question, he wisely points out that the object to be aimed at is "not to incubate the largest number of eggs in a given space," but so to manipulate them that "the largest number of healthy fish may result"—a statement involving difficulties for the study of which we must refer the reader to the paper itself. Intimately connected with this department is the question of the salmon-disease fungus, which forms the topic of a paper on "Fish Diseases," by Prof. Huxley. The author's investigations in the matter are well known to readers of NATURE, but all connected with freshwater fishing owe a debt of gratitude to the learned Professor for having thus sifted a voluminous literature upon the subject, and diagnosed in faultless style this pest. Its geographical limits are—for the first time—mapped out; the fuugus is shown to *cause*, and not merely accompany, the disease, and its propagation is conclusively shown to be favoured by causes which though unknown must necessarily be limited. Every inducement is given to the daily worker among these fishes to cooperate in the further study of the disease, in even the purely scientific aspects of which much yet remains to be done. The remarkable fact that the disease is in no way correlated with the "productiveness" of a river is fully demonstrated, and must carry its own lesson.

A somewhat analogous topic forms subject-matter for a paper on "The Destruction of Fish by Internal Parasites," by Dr. S. Cobbold. There is, however, the most marked contrast between it and that of Prof. Huxley, and we venture to say that the statements made on the first two pages and elsewhere, are calculated to frighten rather than encourage (by appealing to the experimental side) possible workers in a field for which the author claims so much. We are compelled to put this work down with a feeling of disappointment, the more so seeing that much of the space which might have been turned to better account is devoted either to a mere reiteration of statements made again and again by the author during the earlier sittings of the Conference, or to needlessly lengthy and verbose discussions upon minor points, to the exclusion of more important ones.

The all-important topic of "Food of Fishes" is attacked by Dr. Day. There is much in his paper that is of value, he having incorporated the observations of others with his own to the best advantage. The extreme importance of this subject is obvious to all concerned, but when—to say nothing of the question of inter-preying—we consider the extent to which it is known that the food of fishes may vary under conditions of most of which we know absolutely nothing, it is obvious that there opens up a field of labour, involving all sorts of side issues, work in which must necessarily be both prolonged and tedious. The paper, however, suggests certain lines along which a fruitful advance might be made. In the discussion which followed, the chairman (Prof. Huxley), taking a philosophic grasp of the question, resolves it into a balance in favour of "the ultimate store of food" furnished by "the Diatomaceæ which occur on the surface."

Mr. R. B. Marston, in an exceedingly practical paper on "Coarse Fish Culture," adduces reasons for which it is obvious that repopulation of our fresh waters must go on as matters stand, and can be very beneficially maintained. The question is one of growing importance, especially as it affects those who, although living far inland, still have the power of rearing good fish-food. We doubt, however, how far it is not possible to obviate certain of the difficulties mentioned, by more careful "nursing" alone. In advocating the introduction of the prolific Black Bass, the writer makes a statement, partly borne out by the experience of the Marquis of Exeter who first introduced the fish into Britain, but diametrically opposed by that of Sir Jas. Maitland—and which, if correct, is of great importance—viz. that it "thrives best in just those waters which are *not* suited to trout and salmon."

It is well known that the natural salmon stock of five of our largest rivers is practically exterminated, and that the fish present themselves annually at their unsavoury mouths, but to be baffled by causes, chief among which is that of pollution; in other cases, less markedly offensive, the fish are known to be slowly but certainly receding The Hon. W. F. B. Massey Mainwaring, in a paper upon "The Preservation of Fish Life in Rivers by the Exclusion of Town Sewage," first points out the main causes of actual death, and then proceeds to advocate the claims of the well-known A.B.C. process, exhibited by the Native Guano Company. For this he claims success, greater than that which has attended any such known chemical method, all at present pointing to irrigation and intermittent-downward-filtration, as the best solution of the difficulty. All the artificial breeding in the world cannot be of avail in waters thus becoming more deadly, and to the chemist the utilisation of waste offers a good field for work. There are other doubtful points about this paper, beyond the limits of a short notice, but it is sincerely to be hoped that when the present inquiry into the London sewage question terminates, the adoption of some treatment beneficial to our waters may perpetuate its action.

Closely allied are the interests of "Forest Protection," advocated by Mr. D. Howitz, the more especially as there is evidence to show that the disappearance of salmon has been at times associated with the clearing of forests. The author points out that, while the question has naturally more interest for other countries than our own, it is possible to maintain throughout the year, by the interaction of natural forces, a better equilibrium of life in shallow water. Although much yet remains to be done in this work, the arguments adduced are practical and weighty. The author advises the use of certain trees as being, from his own experience, preferable, the question of growth of timber not being overlooked.

All the aforementioned papers point indirectly to the "outcome" of the present movement, in so far as they suggest methods of improvement. Those which remain are either directly addressed to that subject itself, or to others demanding immediate attention.

Prof. Leone Levi brings forward a mass of statistical knowledge upon "The Economic Condition of Fishermen," stated to be "generally unsatisfactory." The paper abounds in useful information, not the least important being that which deals with the relationships existing between boat-owners and fishermen; the author also states that at present the workers are in proportion excessive "to the amount of production," and wisely recommends a "weeding" of those parasites—neither fishermen nor fools—said to exist. The "fortunes of the fisheries and agriculture in the last twenty years" are significantly compared; but this and other matters dealt with are beyond the limits of our present notice.

In "The Principles of Fishery Legislation" the Right Hon. G. Shaw Lefevre, proceeding to deal with the sea fisheries, exclusive of Crustacea and littoral forms, recalls the circumstances which led up to the passing of the Sea Fisheries Act of 1868—the result of an inquiry before a Commission of which he was himself a member. This Act, essentially one repealing restrictive legislation and giving increased liberty, has lately, as our readers doubtless know, been much under discussion, and the statistics here brought forward speak for themselves as to the wisdom and successful working of the laws then laid down. When we consider the state of the question, as reviewed by the author, we must admit that to alter would be to mar such statutes as these, unless prompted by fresh acquisitions to our knowledge. Speaking of the littoral species, the author shows that restrictive action has exercised no beneficial influence whatever upon our oyster fisheries, and in connection with this subject good evidence has been brought before the Conference to show that actual harm has often been done by premature legislation. These considerations all point to a conclusion, reiterated again and again in the papers before us, and affording consolation to all save a small faction, which pleads injury, but for what reason we know not. This valuable paper is supplemented by one upon "The Basis for Legislation on Fishery Questions," by Lieut.-Col. F. G. Solá, Secretary to the Spanish Commission. Much of this paper is necessarily taken up in discussing Spanish fisheries, but the moral points in the direction indicated above. Speaking of "an absolutely restrictive system," the writer ably remarks that, "under the shade of those abuses established, recognised, or tolerated by former laws, there will have grown up a crowd of well-to-do interests, which it is not possible to disregard." These words and those which follow, will bear all the consideration we can give them.

Setting aside the popular sensational aspect of the "Fish Markets" question, of which those in authority have lately heard enough, that of "Fish Transports and Fish Markets" demands early consideration and prompt action. His Excellency Spencer Walpole, in dealing with it, confines himself to that "internal traffic" in which lie many sources of evil. Speaking of the necessity for railway reform, the author does not, as might be imagined, advocate State management, but seeks solution of the "suicidal policy" now existing, by insuring—between land and water carriage—a "healthy competition." All we can hope is that the matter may be thus easily rectified, meanwhile the fact remains that the future of great and important fisheries must depend upon the issue. The author enters into a discussion of the market-question, but as so much concerning this rests with the City Corporation we await their views. Despite the protest lodged by Mr. Sayer on p. 20, we cannot but regard the silence of, and want of concerted action among, the Billingsgate men, as an unhealthy sign.

The perils of a fishing life are patent to all, and when we hear a cry raised on all hands for increased harbour accommodation, and read that the failure of our fisheries is often due to want of weather forecasts, it is obvious that an important claim is established. Mr. Scott, in a paper on "Storm Warnings," brings a well-known experience to bear upon this matter, and compares our own condition and apparatus with those of other countries, notably the United States, Germany, and Holland. Our greatest need at present is shown to be want of observatories on the west coasts of Ireland and Scotland, and the author points out the significant fact that "storm signals are hoisted at 111 stations only over the whole United States, while we in these islands have nearly 140 for a much smaller area." Speaking of the famed American storm-warnings, the need of mid-ocean observatories is discussed, as the storms almost invariably "change their character *en route*." Much other valuable information is embodied in this paper.

Prof. Lankester, writing on "The Scientific Results of the Exhibition," after making some admirable remarks about the "so-called practical man" and other topics, sets up a plea for a zoological observatory or "station." While no one will fail to enter into the spirit of his paper, we are of opinion that the plan—as concerning fisheries alone—need not be so elaborate as that suggested by him. No subject has created a greater revolution in the minds and actions of fishermen of late, than the discovery of Profs. Sars and Malm that the eggs of certain of our deep-sea fishes develop at the surface, and even were this not so no one would gainsay Prof. Lankester's cry of "more zoology." When we read that "the herring fishery is a lottery," and that simply because we know nothing of the real nature and causes of the movements of those fishes, it is quite obvious in what direction our earliest observations must be pursued. For this purpose a transportable zoological laboratory, with proper boats and appliances, such as that used in the recent successful experiments in the Netherlands, would amply suffice, and we conceive of such as best embodied in "A National Fishery Society," for which Mr. Fryer urges a strong, and it seems to us an exceedingly just, claim. All modern advance in the fishing industry points to the conclusion that Governmental action must be slight but firm; this being so, both common sense and precedent show it to be absolutely necessary that some such mediating body as that which the author would have established, should exist. Such a society would, of necessity, acquire in time all necessaries for work and progress, but, until this stage at least is reached, Britain—whose waters are second to none—cannot hope to hold her own in the matter of International Fisheries. We heartily recommend our readers to reflect upon a speech, made by Mr. Birkbeck, M.P., Chairman of the Executive Committee, which follows the aforementioned paper.

Such are the aims and scope of the Literature of the Great International Fisheries Exhibition, and when the remaining publications are forthcoming it will form a collection upon which both the fishermen and all concerned must be congratulated. It has been impossible to do more than indicate the general line of work in this brief notice, no note having been taken of the extent to which certain papers overlap; it will be obvious, however, where abuse lies, where reform is needed, and along what lines the expected "outcome" must proceed.

The style of these books, produced by Messrs. W. Clowes and Sons, leaves nothing to be desired; the few typographical errors which occur being unavoidable in dealing with the technicalities of such an extensive subject.

NOTES

THE adjudication of medals for the present year by the Council of the Royal Society is as follows:—The Copley Medal to Prof. Sir William Thomson, F.R.S., for (1) his discovery of the law of the universal dissipation of energy; (2) his researches and eminent services in physics, both experimental and mathematical, especially in the theory of electricity and thermodynamics; a Royal Medal to Prof. T. A. Hirst, F.R.S., for his researches in pure mathematics; a Royal Medal to Prof. J. S. Burdon-Sanderson, M.D., F.R.S., for the eminent services which he has rendered to physiology and pathology, especially for his investigation of the relations of micro-organisms to disease, and for his researches on the electric phenomena of plants; the Davy Medal to Marcellin Berthelot, For. Mem. R.S., and Prof. Julius Thomsen for their researches in thermo-chemistry.

PROF. HUXLEY and Sir Joseph Hooker having been elected members of the Salters' Company, were present at a dinner given by the Company on Tuesday evening, and both took praiseworthy advantage of the opportunity to remind our "City men" of some wholesome truths. Prof. Huxley said he had no doubt that an immense field of usefulness lay open for the Guilds and the Corporation of London. Happily it was a field which was not altogether unploughed, and one in which the road had been practically shown towards doing an immense amount of good. He wished to express an opinion which he had formed with great care, and which he uttered with a full sense of responsibility, that the work which had been undertaken in the name of the City and Guilds of London, and which had at present resulted in the foundation of an institute for technical education, was one of the greatest works, if properly comprehended, which had ever been taken in hand, whether they viewed it with reference to the commercial prosperity of the country, to its social organisation, or to the preservation of the condition of political equilibrium; for at the present time the wealth and prosperity of the country were a cloud generated out of the application of physical science, and taking that science away the cloud would vanish like any other baseless fabric of a vision. The future predominance of the commercial power of England depended upon whether its merchants had the wisdom to appreciate the gifts which science gave them. If, however, these elements were disregarded, London would perish as surely as Carthage. The social state and the preservation of the condition of political equilibrinm depended, he argued, upon a proper knowledge of science. The institution to which he had referred provided for all those requirements, and it was one of the greatest privileges of the office which he at present held that he should be associated with those engaged in the organisation of this system, and who, he trusted, would carry on the enterprise to a successful conclusion.

THE death is announced of the well-known American mineralogist, Mr. Lawrence Smith, at Louisville, Kentucky. Mr. Smith devoted himself mainly to the investigation of meteorites, and did much to increase our knowledge of these bodies. He was a corresponding member of the Paris Academy of Sciences.

CAPT. DAWSON and party of the British Circumpolar Expedition, which wintered at Fort Rae, Great Salt Lake, arrived safe and well at Winnipeg on November 2, having succeeded in crossing the height of land at Portage la Loche before the closing of the navigation by ice, which some of the resident authorities of the Hudson's Bay Company in the north-west thought they would be unable to do if detained on Slave Lake until the end of August.

M. CHARCOT, the chief surgeon of La Salpetrière, in Paris, has been nominated member of the Academy of Sciences.

IT has beeen arranged that the tercentenary of Edinburgh University shall be celebrated on April 16, 17, and 18 next.

THE results of the late Cambridge higher local examination were very discouraging as regards Group E (Natural Science). Only two out of sixty-six candidates gained a first class, and thirty-one failed. The following are extracts from the Examiners' reports:—Elementary Paper: The answers indicated an imperfect comprehension of principles, and an inadequate practical acquaintance with the subject-matter of the various sciences. In Chemistry the papers as a whole were markedly inferior to those of last year, showing want of knowledge of any practical arrangements for the simplest experiments. In Physics the work of all the candidates was very poor. The general want of clearness and definiteness of expression was very noteworthy. No marks were gained for answers to the numerical questions, and in but few cases were they attempted. In Physical Geography and Geology the answers were on the whole unsatisfactory. The candidates seemed to have studied the subject chiefly in books, for though one or two showed proofs of having acquired some practical knowledge in the Museum, nearly all, when describing the physiography and stratigraphical geology of an English district, gave indications that their knowledge was gained by reading, and not by actual observation in the field. In Physiology the answers of different candidates were very unequal. Some were extremely good, while a considerable number showed ignorance of the most rudimentary facts. There was very little evidence of a personal acquaintance with minute anatomy. In Zoology most of the answers were characterised by vagueness, want of precision, and a marked, often grotesque, ignorance of the meaning of the most ordinary technical terms. The reading of most of the candidates seems to have been very diffuse and unintelligent, while not one of the candidates had any real grasp of the principles of the subject. In Botany the answers were very weak. They indicated a tendency to neglect the external morphology and anatomy, and to pass on to special morphology and life-histories of the lower forms before the above-named branches of the subject had been properly mastered.

AMONG the lectures to be given at the London Institution during the coming season are the following:—December 3, Mr. G. J. Romanes, F.R.S., Instinct; 6, Rev. W. Green, the High Alps of New Zealand; 13, Prof. G. W. Henslow, the Glaciers of the Alps; 20, Prof. W. H. Flower, F.R.S., Whales; 27, Prof. H. Armstrong, F.R.S., Water (juvenile lecture); 31, Dr. Rae, F.R.S., the Eskimos and Life among them. January 3, Dr. Donald MacAlister, How a Bone is built; 7, Mr. H. Seebohm, Arctic Siberia; 10, Mr. Alfred Tylor, Celtic and Roman Britain; 17, Mr. H. Dixon, Explosives. February 7, Mr. Norman Lockyer, F.R.S., the last two Eclipses of the Sun; 18, Mr. J. Bryce, M.P., D.C.L., an Ideal University; 21, Prof. R. S. Ball, F.R.S., the Doctrine of Evolution applied to the Solar System; 25, Dr. E. B. Tylor, F.R.S., the Three Sources of History—Records, Monuments, and Social Laws. March 6, Prof. Schuster, F.R.S., the Aurora Borealis.

HERR CARL ROHRBACH of Leipzig has lately described a method of procuring a fluid having extraordinarily high refractive and dispersive powers. 100 parts of iodide of barium are mixed with 130 parts of scarlet biniodide of mercury. About 20 c.c. of distilled water are added to the powders, and they are then stirred up with a glass rod while heated in a test tube plunged into an oil bath previously warmed to 150° or 200° C. A fluid double iodide of mercury and barium is formed, which is then poured into a shallow porcelain dish and evaporated down until it acquires a density so great that a crystal of epidote no longer sinks in it. When cold, even topaz will float in it. It is then filtered through glass-wool. The fluid so prepared has a density of 3·575—3·588, boils at about 145°, and is of a yellow colour. Its refractive index is 1·7755 for the C line, and 1·8265 for the E line of the spectrum. For the two D lines of sodium the refractive indices are 1·7931 and 1·7933 respectively. So great is the disperson that, using a single hollow prism with a refracting power of 60°, the dispersion between the two D lines is almost exactly 2' of angle.

THE latest official report of the Imperial German Post Office states that at the end of October the telephone was fully in operation in the following thirty-six cities and towns, within the Imperial postal territory (which does not include Bavaria or Würtemberg):—Aix-la-Chapelle, Altona, Barmen, Berlin, Beuthen, Brunswick, Bremen, Bremerhaven, Breslau, Burstcheid, Charlottenburg, Chemnitz, Cologne, Crefeld, Deutz, Dresden, Düsseldorf, Elberfeld, Frankfort-on-Main, Gebweiler, Geestemünde, Hamburg, Hanover, Harburg, Kiel, Königsberg, Leipzig, Magdeburg, Mayence, Mannheim, Mülhausen (in Alsace), Potsdam, Stettin, Strasburg, Sulzmatt, and Wandsbeck. In four other towns—Halle, Karlsruhe, M. Gladbach, and Rheydt—the arrangements for its introduction have progressed so far that it will most probably be in operation in them before the end of this year. It is therefore likely that by the end of 1883 forty towns within the Imperial German postal territory will possess the advantages of the telephone, against twenty-one last year, and seven in October, 1881.

THE programme of the Yorkshire College Students' Association for the present session is a varied and interesting one. A "Yorkshire College Photographic Club" has recently been formed, and has already a good roll of members, including several members of the College staff. A prize competition has been arranged, and the Society has every prospect of success. The secretary of the Photographic Club is Mr. W. O. Senior.

ONLY six months ago a Society of Natural Science was formed at Bournemouth, and already it has 103 members, the president being Prof. Allman, F.R.S. The Society being established upon the most comprehensive basis, recognises every department of physical science as coming within the scope of its investigations. It is open to all, without limitation of class or sex. During the past session various papers have been read, and during the summer months bi-weekly morning and evening walks were taken under the leadership of the appointed heads of sections for botany, entomology, marine and terrestrial zoology and geology. The Committee contemplate devoting part of its funds to be awarded annually as prizes for the best and most systematically arranged collections of natural history specimens, made solely by each exhibitor, as an inducement to the younger members to cultivate habits of careful observation and systematic study of nature. The Society held a very successful *conversazione* on the 7th inst. at Bournemouth, and so attractive was the exhibition connected therewith, that it was kept open the following day. Captain Hartley, chairman of the Bournemouth Improvement Commission, opened the *conversazione* by giving some account of the origin and objects of the Society. The exhibition was of a very varied and instructive character, and at intervals during the day short popular lectures were given on such subjects as air, sound, the moon, natural magic, while e Rev. G. H. West exhibited and explained from time to time various apparatus illustrating physical phenomena. Altogether the Society gives promise of a successful career.

MR. GEORGE MURRAY will deliver a lecture on the potato disea e at the Parkes Museum of Hygiene, 74A, Margaret Street, Regent Street, on Thursday, the 22nd instant, at 8 p.m.

SEVERAL members of the French Chamber of Deputies having contended that the transmission of telegrams was not so easy with underground wires as with aërial lines, M. Cochery has invited a number of opponents and electrical engineers to demonstrate on the lines now in existence, that the difference, if there is any, is quite immaterial.

AT a recent meeting of manufacturers and artisans convened by the Mayor at Coventry, resolutions were enthusiastically carried in favour of the adoption of a system of technical education in the city. It is proposed to provide a building for the consolidation and extension of the science classes, a lecture-hall, and reading-room, with a reference library of works appertaining to trade and manufactures, and to establish in connection with these three workshops for the practical teaching of mechanics (toolmaking, weaving, and watchmaking). It is estimated that about 4000*l*. will be needed for the building, and 3000*l*. for the fixtures and equipment of the building and workshops, in addition to which it will be necessary to provide an annual income of at least 300*l*. Subscriptions and donations exceeding 1000*l*. were promised at the meeting.

THE piercing of the Arlberg Tunnel, which will be 10,270 metres long, thus ranking third in the world, was expected to be completed to-day. The work began on November 13, 1880, on the western and eastern sides simultaneously, and has therefore lasted just three years, instead of four, as was calculated. Special trains will bring over two hundred invited guests from Austria, Italy, and Switzerland, to witness the final boring and the connection of the two galleries.

MR. G. J. SYMONS writes to the *Times* to say that Miss Eleanor Nunes, who had been keeping an extremely accurate record of the fall of rain at Langtree Wick, Torrington, Devon, died last spring, having left the sum of 100*l*. to him "to be applied to meteorological purposes." Mr. Symons announces that he is prepared to consider applications from all parts of the kingdom for rain-gauges to be sent gratuitously on loan subject to very easy conditions, and to send them to all accepted applicants who reside five miles from any rain-gauge now at work, and the same distance from any other applicant.

THE *Romando* has arrived at Cherbourg after a journey of two months, from Cape Horn. The results of the wintering have been important, and the crew is in good health.

THE diminution of credit rendered inevitable by the state of French finances will bear very little on the Budget of Public Instruction; the work of building the Meudon Observatory will not be stopped, and is proceeding favourably.

WE learn from a trustworthy source that there is again talk of transporting the Paris Observatory to some distance from the city, to a site in the vicinity of the new Flammarion Observatory.

THE Portuguese Government has appointed the explorers Capello and Ivens to proceed again on an expedition to West Africa, for the purpose of completing their map of the province of Angola, and of exploring the Congo. The explorers will leave by the packet on December 6.

NEWS has reached Europe of the assassination of M. De Brazza, but it is conjectured that this is the French explorer's brother, and not the explorer himself.

IN our note on the Royal Society last week, Dr. Warren De La Rue's name was given incorrectly.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. C. R. Browne; two Red tailed Guans (*Ortalida ruficauda*) from Tobago, West Indies, presented by Mr. Alfred C. Priestly; two Gold Pheasants (*Thaumalea picta* ♂ ♂) from China, presented by Mr. H. W. Tyler; two Bar-breasted Finches (*Munia nisoria*) from Java, presented by Mr. J. Abrahams; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. John Colebrook, F.Z.S.; two Long-eared Owls (*Asio otus*), European, presented by Mr. C. Purnchard; a Masked Parrakeet (*Pyrrhulopsis personata*) from the Fiji Islands, presented by Miss J. D. Smith; two Alligators (*Alligator mississippiensis*) from the Mississippi, presented respectively by Mr. Roland Bridgett and Mrs. M. E. Symons; a Peregrine Falcon (*Falco peregrinus*), European, a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, deposited; a Bennett's Wallaby (*Halmaturus bennetti* ♀) from Tasmania, two Black Wallabys (*Halmaturus ualabatus* ♂ ♂) from New South Wales, a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♂) from South Australia, a Mexican Eared Owl (*Asio mexicanus*) from Mexico, a Downy Owl (*Pulsatrix torquatus*) from South America, an Annulated Worm Snake (*Vermicella annulata*) from Western Australia, purchased.

MOVEMENTS OF THE EARTH[1]

II.

Measurement of Time

It has been shown how, by the application of geometrical and optical principles, the measurement of angular space has been carried down to the 1/10oth of a second of arc, such a quantity being 1/129,600,000th part of an entire circumference, and when such an accuracy as this has been attained, and the altitude or the azimuth of the sun, or moon, or any other heavenly body can be correctly stated with this exactitude, it will be seen how much better off in the way of defining positions is the modern astronomer than was Hipparchus with his 1/3rd, and Tycho Brahé with his 1/4th of a degree. To do this, however, is not enough. It is not only necessary accurately to define the position of a heavenly body, it is necessary also to know at what particular time it occupied that position. The next thing to be done, then, is to see how far we moderns have got in another kind of measurement, no longer the measurement of arc—the measurement of angular distance—but the measurement of *time*.

The measurement of time, however, is not quite so simple a matter as was the measurement of space. A certain angular measurement of space, or the angular distance between two bodies, whether that distance be a degree, or a minute, or a second, is a very definite thing, having a beginning and an end; but time, so far as we can conceive, has neither beginning nor end; so that the problem of the measurement of time has to be attacked rather in a different way. Here again it will be as well that the matter should be studied historically.

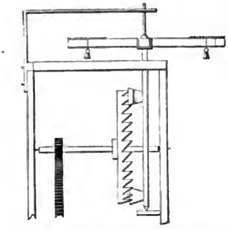


FIG. 18.—Ancient Clock Escapement.

What more natural than that man having got the idea of the flow of time, should have begun to measure it by the flow of water, or the flow of sand? The earliest time measurers were really made in this way; water or sand being allowed to drop from one receptacle to another. There were difficulties, however, in thus determining the flow of time. In the first place the thing was always wanting to be wound up, so to speak, something was wanted to continue the action, and to prolong it; and the first appeal to mechanical principles was made with that view.

The first real clock put up in England was put up in Old Palace Yard, in the year 1288, by the Lord Chief Justice of that time, who had to pay the expense of it as a fine for some fault he had committed. Its construction was somewhat after this wise. One method of dealing with the flow of time was to call in the aid of wheelwork; but, as is well known, if a weight acts upon a train of wheels the velocity increases as the rotation goes on. Therefore the science of mechanics was called in to supply some principle which could be applied to prevent this unequal velocity of a train of wheels. Consider the arrangement shown in Fig. 18.

The wheelwork train is capable of being driven by a falling weight. On the same axis as the smallest wheel, and therefore the one which turns most rapidly, will be seen another wheel provided with saw-like teeth. Then at the top is a weighted cross-bar, from the centre of which a perpendicular rod, provided with pallets, comes down to engage the teeth of the pallet-wheel. Now suppose the clock to be started. The weight is allowed to fall, and the wheels, including the pallet wheel, begin to revolve; then begins a reciprocating action between the swinging bar and the wheel with which it acts, because the pallets which act on the bar as they are on either side of the centre of motion really drive the bar first in one direction and then in the other. The teeth of the pallet wheel are continually coming into contact with the pallets of the swinging bar. First suppose that one of the teeth has encountered the upper pallet; it pushes this aside, and swings the bar in one direction. No sooner, however, has this been done than another tooth in the wheel at the bottom of the bar encounters the pallet and swings it in the opposite direction. In this way it is obvious that the bar is continually meeting and being met by the teeth of the rotating wheel, swinging first in one direction, and then in the other, the result of this reciprocal action being to prevent the increase in the velocity of the wheels which would otherwise take place.

It is in this way, then, by the performance at constant definite intervals of an equally constant definite amount of work, that the regularity of action of the clock is produced. The greater the distance of the weights on the cross-bar from its centre of motion, the longer will the bar take in swinging, the slower will be the action of the clock; so that the clock may be regulated by altering the position of these weights, bringing them nearer to, or removing them further from the centre of motion of the bar, according as it is desired to hasten or retard the action of the clock's mechanism. Yet at whatever distance from the centre of motion the two weights be placed, assuming always that they are both at the same distance from it, there is still this constantly-recurring performance, at equal intervals, of an equal amount of work which produces the regular action of the clock. This was the kind of clock then which was put up in Old Palace Yard. But that did not go well enough, giving such inaccurate results that Tycho Brahé had to discontinue its use. Fortunately some few years later two most eminent men, Galileo and Huyghens, had their attention drawn to this very problem. The first of these, Galileo, was at that time studying medicine. He happened one day to be in the Cathedral at Pisa, where, it will be remembered, they have a most beautiful lamp which swings from a great height in the cathedral. Galileo was at this time working at that branch of his medical studies which deals with the pulse, and he looked at this lamp and found that its swinging was perfectly regular. To-day perhaps it may seem very natural that this should be so, but Galileo had the advantage of being before us, and that is why it did not seem quite so natural to him. There was at that time no known reason why it should swing in perfect regular rhythm. He found that the lamp when swinging, no matter with what amplitude, took practically the same time for each swing, timing it by his pulse. His idea was that this would be an admirable method of determining the rate of a man's pulse, and the first clock on this principle was constructed from that medical point of view, being called a Pulsilogium. Some years afterwards, however, the extreme importance of such an arrangement from an astronomical standpoint became obvious, and very much attention was given to it. It is unnecessary to add that this swinging body is nowadays called a pendulum. The most perfect pendulum made in those early days is represented in Fig. 19.

The fundamental difference between that and the modern pendulum is that part of the pendulum between S and A was elastic. It was made elastic for the reason that although Galileo could not find any difference between the times of the oscillations of the lamp in Pisa Cathedral, according as its amplitude of swing was large or small, yet such a difference did exist, although it was only a slight one; and the only method of getting a perfect pendulum which should make its swing in exactly equal times, independent of its arc of oscillation, was to construct this so called cycloidal pendulum. It was so named because in its swing its elastic portion was held by the curved guides seen in the figure, and made to bend in that particular curve. By this means the pendulum instead of swinging through the arc, K U R, was made to oscillate through D U L. But when the pendulum was at the points D and L, it was practically a shorter pendulum than when at rest. In other words, whilst the pendulum was swinging from U to D and from U to L, its curvature, and consequently its vibrating length was continually changing. In that way, by continually varying the length of the swinging part, it was found possible to make a pendulum which, independent of the length of its arc of oscillation, would make its swing in times which for all practical purposes were absolutely equal in length. That was the most

[1] Continued from vol. xxviii. p. 604.

perfect pendulum of that time. Nowadays, the cycloidal pendulum has been replaced by one which swings through a very small arc, and the continual shortening during the oscillation in the cycloidal pendulum is by this means dispensed with, whilst the friction also being much reduced, there is less interference from that source. With this very small swing the difference between the arc of the circle described and the cycloid in which the cycloidal pendulum swung is practically indistinguishable.

The great difference between the modern clock and the ancient one is that in the former the pendulum is interfered with as little as possible whilst swinging, and makes each swing under precisely similar conditions. To attain this is to have done much. In the first place, if the clock has a heavy weight, that weight will probably interfere a good deal with the swinging of the pendulum. The clockweight, therefore, must be as light as possible. Secondly, if the wheelwork is always in contact with the pendulum, this also will interfere with its free and natural movement. There must be, then, such an arrangement that the wheelwork shall be brought into contact with the pendulum only for the shortest possible time. Thirdly, it must be remembered that the different substances which it is most convenient to use in the construction of pendulums, vary their dimensions with the variations of the temperature and moisture of the air in which they are placed, and great care must be taken to eliminate any errors which might arise from such a

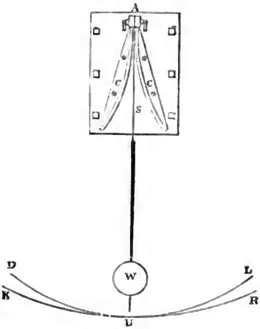


FIG. 19.—Cycloidal Pendulum.

source. How are these various conditions complied with? The first, that the clockweight must be small, is not difficult to adhere to; but it will be well to consider the way in which the second condition, that the action between wheelwork and pendulum shall be the least possible, is met. This is done by employing what is called an escapement. It is so named because the pendulum in its swing is allowed to escape from the wheelwork, and thus retain a perfect freedom. The particular form of escapement about to be described is that which, for a reason that will appear immediately, is called the dead-beat escapement (see Fig. 20).

The escape wheel is the modern representative of the toothed wheel of the old clock, whilst the projections W and D are modifications of the pallets on the swinging bar in that instrument. Let the pendulum move in the direction of the arrow. The tooth T has just been released, thus permitting the tooth V to engage the other pallet D. Now whilst the tooth remains on the pallet, the escape wheel remains locked, while the pendulum is quite free to swing, there being nothing to retard it save the very slight friction between the tooth and the surface of the pallet. The rotation of the escape wheels, however, brings the tooth on to the oblique edge of the pallet, and with it in this position the pendulum is aided in its forward swing. Then the pallet escapes, receiving an impulse, but since this is received almost as much before the pendulum has reached its vertical position as after it has passed that point, no increase or diminution in the time of its oscillation takes place. It is in this way that the second of our conditions is complied with, the wheelwork being effectually prevented from interfering with the regularity of the pendulum's swing. It is called the dead-beat escapement, because when the tooth falls on the circular portion of the pallet and locks the escape wheel, the seconds-hand fitted to it stops dead without recoil, because the arc of the surface of the pallet is struck from the centre of motion. In an astronomical clock a still more modern form of escapement, called the gravity escapement, is sometimes employed.

It will perhaps be convenient at this stage to compare the fineness of the division of time given by a clock of this description with the fineness of the division of the second of arc we have already discussed. There is, however, a little difficulty about this, because at present there seems to be no special reason why any particular unit of time should be selected. Ordinarily a day is divided into twenty-four hours, each of these twenty-

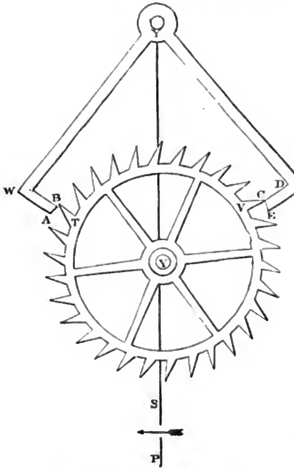


FIG. 20.—Dead-beat Escapement.

four hours is subdivided into sixty minutes, these again being each divided into as many seconds. The origin of this division of time will be seen later on; for the present let the fact remain that it is so.

Now a modern clock beats practically true seconds, and astronomers after a little practice gain the power of mentally breaking that second up into ten divisions, each of which is of course one-tenth of a second, so that we can say that a day may be divided into 864,000 parts, and in this way institute a comparison of the fineness of the division of time with those minute measurements of angular space with which we so recently dealt.

It is a familiar fact that the length of a pendulum which vibrates seconds is some thirty-nine inches, and it is easy to understand that there are many conditions in which a clock of this kind, with its pendulum of more than a yard long, cannot be used. Not only indeed is there this inconvenient length of the pendulum, but it is necessary that the clock to which it belongs should be rigidly fixed in an upright position. The question therefore arises, is this clock which deals out seconds of such accuracy the only piece of mechanism that can record and divide our time, or is any other time-measuring instrument available? Fig. 21 shows part of such an instrument, known as the Chronometer, in which, whilst the principles necessary to be followed in the construction of the clock have been adhered to, the pendulum has been dispensed with, and the perfect stability and verticality of position so important to the clock, are here unnecessary.

In this instrument the pallets of the dead-beat escapement have been replaced by a detent, D. Let us consider the action. The escape-wheel, S, is advancing in the direction of the hands of a clock. One of its teeth meets the detent, and the wheel is locked. Then what happens is this: when the balance-wheel, R_1, swings, the circle, R_2, centred on it shares its motion. This, it will be seen, is armed with a little projection.

We left the escape-wheel locked. Now assume that the balance-wheel is swinging in the direction of the arrow. It carries the small circle with it, and the piece, P_2, in its motion, coming into contact with the end of the spring, seen projecting beyond the arm of the detent, raises it and the detent, so releasing the tooth of the escape-wheel. The slight retardation which the balance receives in consequence of this action is immediately compensated. The moment the escape-wheel moves on again, one of its teeth meets the projection, P_1, and the balance-wheel receiving this fresh impulse goes on to complete its swing. Then it returns and swings in the opposite direction, this time without acting in any way on the detent. When the balance-wheel made its first swing and the point P_2 met the projecting end of the spring, the

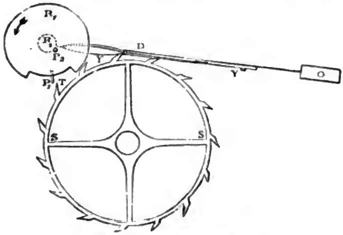


Fig. 21.—Chronometer Escapement.

latter could then only bend from the end of the arm with which the detent is provided and against which the point P_2 forced it. But on the return swing the spring is found capable of bending from the more distant point of its attachment to the shank of the locking-piece. It is therefore easily pushed aside; there is no change in the position of the detent, nor is any resistance offered to the motion of the balance-wheel, which goes on to complete its swing. Then another tooth is caught, the escape-wheel is again locked, and again released by the lifting of the detent. So the action goes on, the teeth of the escape-wheel being constantly detained and as constantly released by the action of the point P_2. The balance-wheel, it will be noted, receives its impulse only at every alternate swing, whereas in the clock the pendulum receives its impulse at each vibration.

Time then can be divided down to the 1/10th of a second, or as we expressed it, down to the 864,000th part of a day, not only by a clock, but also by this chronometer. Having obtained this 1/10th of a second by these instruments, the question arises as to whether it be possible to get a still finer division. It will be seen that a very much finer division than this can be obtained, the 1/100th part of a second being a measurable quantity; not that such a small fraction of time as this is ever necessary in astronomy, nor will it be until the present astronomical methods have ceased to exist. If it were possible to get all observations made by photography, then it would be worth while recording with such minuteness, because photography would always behave in the same way, whereas two observers never have the same idea as to the time of occurrence of any phenomena which they observe. Yet, although so great an accuracy as this is not attempted, it will be quite worth while to consider the means by which this exquisite fineness of the division of a second of time has been arrived at. We shall see that just in the same way as an appeal to mechanical principles resulted in an improvement in the construction of our clock, so this fineness in the division of time has been obtained by an appeal to the principles of electricity. Let it be assumed that the seconds pendulum of our clock swings with perfect accuracy and with absolute uniformity from second to second, in spite of changes of temperature and other perturbing influences; and having assumed this, let us see how electricity can be made to aid in the measurement of time. The instrument used is called a chronograph. It consists of a metal cylinder revolving by clock-work and covered with cloth, over which a piece of paper can be stretched. Below the cylinder and parallel with it is a track along which a frame carrying two electromagnetic markers or prickers is made to travel uniformly by the same clock that drives the cylinder. Wires connected with a battery lead from one of these magnets to a clock and from the other to a key, which can be depressed whenever an observation is made, and a current so sent to the magnet. The effect of this is to cause it instantaneously to attract its iron armature and cause the pricker with which it is connected to make a mark on the paper above.

The connection of the chronograph with the clock is as follows:—The bearing shown in the middle of the diagram (Fig. 22) is a continuation of the bearing on which the seconds hand of the clock is supported, and there is a little wheel which does its work quietly at the back of the clock in exactly the same way that the seconds hand does its work quietly in front of it. What

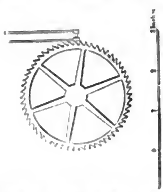


Fig. 22.—Electrical contact apparatus at back of clock.

that wheel does is this. Every time that each of its teeth—and there are sixty of them—comes to the top of the wheel it touches a little spring. That little spring then makes electrical contact, and a current is sent flowing through parts of the apparatus already described. Now the teeth in that wheel, being regularly disposed around its circumference, always succeed one another after exactly the same interval of time, and there is no difference or distinction from second to second, or from minute to minute. But suppose that before the clock is started one of these teeth is filed off, and so filed off that when the seconds hand points to 0 seconds, and the minute hand to a completed minute, this part of the wheel shall be at the top, and there shall be no electrical contact established, for the reason that the tooth of the wheel is not there to act on the spring. In that way it is easy to manage matters so that the beginning of each minute shall be distinguished from all the other fifty-nine seconds which make up the minute. Let the cylinder, covered with paper, revolve once in a minute. In that case, the electrical current will make a hole or a mark on that paper every second, and as matters are so arranged that the prickers shall be travelling along at the time that the dots are made upon the revolving paper they are thus made along a continuous spiral, and since we have supposed the cylinder to revolve once in a minute, the beginning of each minute will be in the same line along the spiral. Then, according to the length of the cylinder, a second of time will be obtained written in dots, sixty of them round the cylinder representing sixty seconds. Suppose now that a man with a perfect eye makes an observation, recording it by sending a current through the apparatus and making a dot on the paper. He will then have an opportunity of observing on the paper the precise relation of the dot which represents the time at which the observation was made to the other dots which represent the various seconds dotted out by the clock, and not only the exact distance of the observation prick from the nearest *second*, whether it be ½, or 1/10th, or 1/100th of the distance between that second and the next, but the omission of the record of the first second in the minute will give the relation that observation has to the nearest *minute*.

For the sake of simplicity the case of one observer making one observation has alone been considered; but if the work be properly arranged, then not only one electromagnet, but two, or three, or four, may be at work upon the same cylinder at the same time, each making its record, and that is how such work is being done at the Greenwich Observatory.

Observing Conditions

This power of measuring and dividing time then having been obtained, we seem to have reached our subject, "The Movements of the Earth." Yet even now there are one or two other matters which require to be discussed before we consider the movements themselves. The first of these is the important fact that the earth is spherical in its form. There have been many views held at different times as to the real shape of the earth, but the only view we need consider is that stated. In going down a river in a steamboat, or, better still, in standing upon the sea-shore at some place, such as Ramsgate, where there are cliffs, and where, consequently, one may get from the sea-level to some height above it, it is observed that when any ship disappears from our view by reason of its distance it seems to disappear as if it were passing over a gentle hill.

It does this in whatever direction it goes. This familiar fact is a clear proof that the earth is a sphere, and is so obvious that it may seem unnecessary to mention it, but it was as well to do so for a reason which will appear shortly. Besides this argument in favour of the spherical shape of the earth there is the argument from analogy: the moon is round, the sun is round, all the known planets are round. The stars are so infinitely removed from us that it cannot be determined whether they also

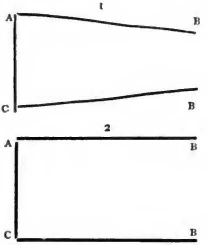


Fig. 23.—Model to illustrate parallax.

are spherical, but doubtless they are as round as the earth. This point of the tremendous distance of the stars is an important one to bear in mind. Their distance cannot be conveniently stated by thousands, nor even by millions of miles, it is something far greater than that. It may be asked why it is that such a statement can be thus positively made. For this reason: the stars have been observed now for many ages, and the historical records of ancient times show that the chief constellations, the chief clusters of stars visible in the heavens now, were seen then. In the Book of Job, for instance, there is a reference to the well known constellation of Orion, and there is very little doubt that for thousands and thousands of years that constellation has preserved the familiar appearance of its main features. The constellation called Charles's Wain, or the Great Bear, was also known to the ancients. If the stars were very near to the earth this could not be. If they were close to us the smallest motion either of earth or star would at once change their apparent position, and would prevent this fixity of appearance, and the skies would be filled, not with the constellations with which we are so familiar, but with new and ever-changing clusters of stars. This constancy of the constellations, not only from century to century, but from era to era, clearly proves then that the stars of which they are made up must be at an infinite distance from the earth.

Let us consider the question of distance a little further. If two pieces of wood (see Fig. 23) joined together by a cross-piece be taken, a moment's thought will make it obvious that the angles which A B and C B make with the cross-piece A C, will vary with the distance of the body, which can be seen first by looking along A B and then by looking along C B. If these pointers be directed to a very near object in the room, they must be greatly inclined (as in 1). If something more distant be taken, there is less inclination, and if it were possible to sight St. Paul's by looking first along A B and then along C B, there would be still less. And if something at a still greater distance were sighted, say St. Giles's at Edinburgh, the inclination of A B and C B would be still smaller than it was in the case of St. Paul's, because St. Giles's is at a much greater distance. It follows then that in sighting an object so infinitely removed from us as a star, the light from it will be in a condition of parallelism, and A B and C B consequently be placed quite parallel in viewing it (see 2). That is another reason for saying that the stars are at this infinite distance from the earth. Why it is so important to insist on this point will appear very clearly by and bye.

Now suppose that in the centre of this lecture-theatre a little globe were hung to represent the earth, the walls of the theatre and the people in it representing the heavens surrounding the earth. Now in such a case it is clear that the appearances presented would be the same whether the heavens moved round the earth or the earth itself were endowed with motion. Let us, without making the assertion, assume that the earth does move. It is perfectly obvious, since the apparent motions of the heavens are so regular, that if that be so she must move with wonderful constancy and regularity; she does not first move in one direction and at one inclination, and then at another; that would be very serious.

If she rotates she must rotate round some imaginary line called an axis. This introduces an important consideration because, whether the earth itself rotates on an axis or the heavens move round the earth—and in the latter case the heavens must also move round an axis—in either case the motion must be an equable one; so that if the matter is thus limited to a constant axial rotation or a constant revolution, as it would be called in the case of the stars, several things will happen. Let us take the former case, in which the earth itself moves. Then the motion of the surface of the earth will be least at those points which are nearest the ends of the axis on which it turns. Take the case of an observer at such a point, he will be carried a very little distance round during each rotation; similarly, if the stars move, a star near the ends of the axis on which the stars move will be carried a very little distance round during each revolution of the celestial sphere.

Change the position of the man on the earth from the pole to the equator. Then he will be carried a very considerable distance round in each rotation of the earth: similarly with the stars; if they move, a star in the celestial equator will be carried round a very great distance during a revolution. That is the first point. Another point is that if we assume the earth to rotate we must carefully consider the varying conditions which are brought about by the different positions of an inhabitant of the earth under those circumstances. For instance take the case of a man at the equator, he looks at things from an equatorial point of view, and in the rotation of the earth he plunges straight up and straight down. Similarly, if the stars' daily revolution belongs not to the earth but to the stars, to an observer at the equator of the earth they would appear to move straight up and straight down; and now in dealing with this question and endeavouring to ascertain whether it be the earth or the stars which move it is most necessary to consider the relation of the movements or apparent movements of the stars to the place from which they are observed, and in so doing it is found that there is an immense difference between the conditions which obtain at the poles and at the equator with reference to the phenomena which are observable in each case.

Let us take a globe to represent the earth, and let London be considered the central point for our observations. Now at all places on the earth, in whatever direction we look, we see an apparent meeting of earth and sky; and supposing our observation to be made on an extended plain or at sea, the surface of the earth or sea may for simplicity's sake be considered as a plane bounded by the circle where the earth and sky seem to meet. This is known as the circle of the horizon. To repre-

FIG. 24.—Diagram to show how the inclination of the horizon of London will change with the rotation of the earth.

sent this a piece of paper may be put over London on our globe (see Fig. 24), and London may be brought to the top. When that has been done, remembering that the stars are placed at so infinite a distance, the horizon which cuts the centre of the

FIG. 25.—Diagram to show how the inclination of the horizon of a place on the equator changes in one direction only.

earth, and which is called the true horizon, may be considered as being practically the same thing as the small sensible horizon of London, represented by our piece of paper, when at the top of the globe, because the two planes will be parallel. For, whether a star be seen from the equator or from London, owing to its tremendous distance it will appear to occupy the same position in space. Now let the globe be made to rotate, then the inclination of the plane of the horizon of any place, of our horizon of London for instance, is continually changing during the rotation (Fig. 24). An exception, however, must be made with regard to the poles of the earth. At these two points the inclination will be constant during the whole of the rotation.

If now a point on the equator be brought to the top of the globe, it will be seen, as the globe is rotated, that the observer's horizon rapidly comes at right angles to its first position (see Fig. 25). This will show that the conditions of observation at different parts of the earth's surface are very different, and this whether it be the earth or the stars which move.

Let us now consider with a little greater detail the conditions which prevail in the latitude of London. Let London be again brought to the top of the globe. Let O (Fig. 26) represent an observer in the middle of the horizon, S W N E. Let Z be the zenith, which, of course, would be reached by a line starting from the centre of the earth, and passing straight up through the middle of the place of observation. S' is a star, and we want to define its position. How can this be done? Imagine first a line drawn from the observer to the zenith. Imagine next another line going from the observer to the star, or, what is the same thing, from the centre of the earth to the star. Then the angle inclosed by these two lines will give us the angular distance of that star

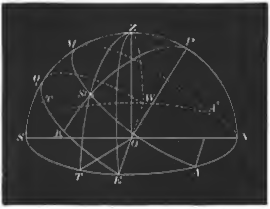


FIG. 26.—Observing condition at London.

from the zenith, or similarly we may take the angle included between imaginary lines joining observer with horizon and star, and thus obtain the star's altitude.

Again, its position may be stated not only with regard to the zenith and to the horizon, but to some other point, say the north point. In that case a line or plane, Z E W, is imagined passing from the zenith through the observer, and the distance between E and N will give the star's angular distance from the north point of the horizon. Again, suppose it be desired to define the star's position with reference, not to the zenith, but with reference to the pole of the heavens, that point where the earth's axis if prolonged into space would cut the skies. In that case since P in our diagram marks the position of the pole, a line PS' will give what is called the polar distance of the star; and lastly, if the angular distance of the star from the equator of the heavens be required, since the prolongation of PS' would cut the equator, the distance from S' to the point of intersection will give the angular distance of the star from the equator; in other words its declination.

We have taken London, but of course each place on the earth has its sphere of observation with its zenith and the north, east, south, and west points. With regard to the axes of the earth and the heavens, they both possess north and south points, and in the heavens as in the earth, the equator lies midway between them. J. NORMAN LOCKYER

(*To be continued.*)

OUR ASTRONOMICAL COLUMN

THE OBSERVATORY, CHICAGO.—Prof. G. W. Hough has issued his annual Report to the Board of Directors of the Chicago Astronomical Society, detailing the proceedings in the

Dearborn Observatory for 1883. The 18-inch Alvan Clark equatorial has again been employed in close observation of the great red spot and other phenomena of the planet Jupiter. Since the first observations at Chicago in September, 1879, it is stated that the red spot had not changed very materially in length, breadth, outline, or latitude. There had been a slow, retrograde drift in longitude, causing an apparent increase in the time of axial rotation. At the last opposition the deduced mean-rotation period was 9h. 55m. 38·4s. against 9h. 55m. 34·8s. in 1879.

Prof. Hough gives the following mean results of micrometrical measures of the red spot :—

	1879	1880	1881	1882
	"	"	"	"
Length ...	12·25 ...	11·55 ...	11·30 ...	11·83
Breadth ...	3·46 ...	3·54 ...	3·66 ...	3·65
Latitude ...	−6·95 ...	−7·14 ...	−7·40 ...	−7·52

The Chicago observer considers that while the spot has remained nearly stationary in latitude, the south edge of the great equatorial belt has gradually drifted south during the late opposition, until it is nearly coincident with the middle of the spot, and further, that "the two do not blend together, but are entirely distinct and separate." A depression formed in the edge of the belt (as shown in two drawings of the planet's disk, on December 29, 1882, and February 20, 1883), which corresponded in shape with the oval outline of the spot, the distance between the two being about a second of arc. The spot was extremely faint at the last observation for longitude on May 5. The equatorial white spot, first observed in 1879, was again visible during the last opposition; the rotation period 9h. 50m. 9·8s. deduced in the previous year, satisfying the observations.

The great comet of 1882 was micrometrically measured from October 4 to November 20, and sketches of the nucleus and envelope made. Subsequently to October 6 three centres of condensation were usually visible. As the comet receded from the sun, the head increased in length from 25" on October 4 to 139" on November 20. As late as March 6 there appeared to be three centres of condensation connected by matter of less density.

Difficult double-stars have been measured by Prof. Hough and Mr. S. W. Burnham, amongst them the interesting binaries, 40 Eridani (Σ 518), β Delphini, δ Equulei, and 85 Pegasi. Measures of the companion of Sirius gave for the epoch 1883.12 position 39°·9, distance 9"·04; the distance is diminishing about 0"·3 annually, so that in a few years it will be beyond reach of any except the largest telescopes. With the excellent measures obtained at Chicago more must soon be known as to the period of δ Equulei, reputed the most rapid of all binaries.

Tempel's Comet, 1873 II.—The following are places for Greenwich midnight, deduced from M. Schulhof's elements :—

1883		R.A. h. m. s.		N.P.D. ° '		Log. distance from Earth		Sun
Nov. 16	...	18 20 48	...	113 42·1	...	0·2867	..	0·1288
18	...	18 28 22	...	113 52·1	...	0·2877	...	0·1287
20	...	18 35 59	...	114 0·6	...	0·2888	...	0·1286
22	...	18 43 38	...	114 7 6	...	0·2900	...	0·1287
24	...	18 51 19	..	114 13·1	...	0·2912	...	0·1289

This comet approaches pretty near to the orbit of the planet Mars; in heliocentric longitude 312° (equinox of 1878), corresponding to true anomaly 6°·1, the distance is 0·050.

D'Arrest's Comet.—M. Leveau's ephemeris of this comet terminates on November 25. The following places are reduced from it to 6h. Greenwich M.T. :—

1883		R.A. h. m. s.		N.P.D. ° '		Log. dist. from Earth		Intensity of light
Nov. 16	...	17 15 44	...	105 13·3	...	0·3637	...	0·084
17	...	17 18 51	...	105 22·1				
18	...	17 21 59	...	105 30·8	...	0·3628	...	0·086
19	...	17 25 8	...	105 39·3				
20	...	17 28 19	...	105 47·7	...	0·3620	...	0·087
21	...	17 31 30	...	105 55·8				
22	...	17 34 43	...	106 3·7	...	0·3611	...	0·089
23	...	17 37 57	...	106 11·5				
24	...	17 41 12	...	106 19.1	...	0·3603	...	0·090

M. Leveau mentions that when Prof. Julius Schmidt last observed the comet at Athens in 1870 with a refractor of 0·17m. aperture the intensity of light was 0·150.

On November 16 the comet sets at Greenwich 2h. 10m. after the sun.

The planetary perturbations during the next revolution are not likely to be large, so that in 1890 the comet may be observed under similar conditions to those of 1870.

STANDARD RAILROAD TIME

The following letter, addressed to our American contemporary *Science*, is of interest :—

Though the subject of standard and uniform railway time has for some years been under consideration by various scientific and practical bodies, it does not appear in any way to have been exhausted, even in its main features. Besides, a certain bias has shown itself in favour of the adoption of a series of certain hourly meridians, and thus keeping Greenwich minutes and seconds, when contrasted with the practicability of a more simple proposition. There is also a feature in the discussion of the subject which bears to have more light thrown upon it: namely, what necessary connection there is between the railway companies' uniform time and the mean local time of the people, or the time necessarily used in all transactions of common life. Directly or by implication, certain time-reformers evidently aim at a standard time, which shall be alike binding on railway traffic as well as on the business community; and to this great error much of the complexity of the subject is to be attributed, and it has directly retarded the much-needed reform in the time-management of our roads.

We say all ordinary business everywhere must for ever be conducted on local mean solar time, the slight difference between apparent and mean time having produced no inconvenience; and we may rightly ask the railway companies to give in their time-tables for *public* use, everywhere and always, the mean *local* time of the departure and of the arrival of trains. It is the departure from this almost self-evident statement, and the substitution and mixing-up in the time-tables of times referred to various local standards, which has in no small measure contributed to the confusion and perplexity of the present system. The people at large do not care to know by what time-system any railroad manages its trains, any more than they care what the steam-pressure is, or what is the number of the locomotive. All the traveller is interested in is regularity and safety of travel; hence it was to be desired that, whatever the standard or standards of time adopted, the companies would refrain from troubling him with a matter which only concerns their internal organisation, or which is entirely administrative. We look upon the publication of the railway time-tables, by local time everywhere, as a *sine quâ non* for the satisfactory settlement of the time question, so far as the public at large is concerned; and it would seem equally plain that the best system for the administration of railroads would be the adoption of a uniform time, this time to be known only to the managers and *employés* of the roads.

We are informed in *Science* of October 12 that the solution of the problem of standard railway time is near at hand, and probably has already been consummated by the adoption of four or more regions, each having uniform minutes and seconds of Greenwich time, but the local hour of the middle meridian. To have come down from several dozen of distinct time-systems to a very few and uniform ones, except as to the hour, is certainly a step forward, and, so far, gratifying; but why not adopt Greenwich time, pure and simple, and have absolute uniformity? Probably this will be felt before long. The counting of twenty-four hours to the day in the place of twice twelve, and the obliteration from time-tables of the obnoxious a.m. and p.m. numbers, would seem to be generally acknowledged as an improvement and simplification, and perhaps can best be dealt with by adopting it at once, accompanied by a simple explanatory statement. C. A. Schott

Washington, October 18

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Oxford.—No election has yet taken place either for the Professorship of Botany or that of Rural Economy, which are now separated from each other. The Delegates of the Common University Fund have agreed to attach a Readership to the Chair of Botany, which will raise the income to 500*l*. a year. The

Professorship of Rural Economy will not be a resident one. The Professor will have to deliver twelve lectures. His stipend is 200*l*. a year.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, November 8.—Prof. Henrici, F.R.S., president, in the chair.—The following resolution, proposed by the President and seconded by Dr. Hirst, F.R.S., was carried unanimously, viz.:—"That the secretaries be requested to communicate to Mrs. Spottiswoode the expression of our sincere sympathy and the assurance of our deep sense of the loss which science has sustained by the untimely death of Mr. Spottiswoode."—The new Council was elected for the session 1883–84, viz.: Prof. Henrici, president; Sir J. Cockle, F.R.S., and Mr. S. Roberts, F.R.S., vice-presidents; Mr. A. B. Kempe, F.R.S., treasurer; Messrs. M. Jenkins and R. Tucker, honorary secretaries; other members, Prof. Cayley, F.R.S., Messrs. E. B. Elliott, J. W. L. Glaisher, F.R.S., J. Hammond, H. Hart, Dr. Hirst, F.R.S., W. D. Niven, F.R.S., Prof. Rowe, and Messrs. R. F. Scott and J. J. Walker, F.R.S. The Rev. J. J. Mylne and Mr. F. W. Watkin were elected members.—The following papers were communicated:—Symmetric functions, and in particular on certain inverse operators in connection therewith, Capt. P. A. Macmahon.—On a certain envelope, Prof. Wolstenholme.—On certain results obtained by means of the arguments of points on a plane curve, R. A. Roberts.—Third paper on multiple Frullanian integrals, E. B. Elliott.—Note on Jacobi's transformation of elliptic functions, J. Griffiths.—Symmedians and the triplicate-ratio circle, R. Tucker.

Linnean Society, November 1.—Frank Crisp, treasurer and vice-president, in the chair.—Messrs. T. E. Gunn and A. Hutton were elected Fellows.—A donation to the Society of several interesting letters of Linnæus (1736–1769) to G. D. Ehret, F.R.S., an eminent botanical artist of the last century, was announced by the Chairman, and a unanimous vote of thanks thereupon accorded to the Misses Grover and Mr. Chas. Ehret Grover for their valuable donation.—Mr. Crisp drew attention to specimens in fluid medium of *Limnocodium sowerbii*, as illustrative of Mr. P. Squires' method of preserving delicate and other medusæ.—Mr. H. Groves showed examples of *Chara braunii* from Ashton-under-Lyne, and Mr. Arthur Bennett of *Najas marina* and *N. alagnensis* from Hickling Broad, Norfolk, all being new to the British flora.—Mr. W. Fawcett exhibited *Testacella maugei* alive, the same being obtained by J. C. Mansel Pleydell in Dorset, and supposed to be indigenous to that county.—A paper was read on the changes of the flora and fauna of New Zealand, by Dr. S. M. Curl. He referred more particularly to the district of Rangitikei and to the alterations of the aspect of the vegetation within the last forty years. He likewise records his own experiments in the cultivation of trees, shrubs, and flowering plants introduced from widely different climes, remarking that while a few fail to grow with vigour, the majority by degrees adapt themselves to the altered conditions, and many valuable economic plants thrive accordingly.—Mr. J. Starkie Gardner read a paper on *Alnus richardsoni*, a fossil fruit from the London Clay of Herne Bay. The species has been described by Bowerbank and commented on by Carruthers, Ettinghausen, and many other authors who have written upon the plants of the Tertiary formation. Originally considered as allied to *Casuarina*, Dr. R. Brown suggested its affinities to the Proteaceæ, a view afterwards upheld by Carruthers and others. Ettinghausen thereafter regarded it as a product of a Conifer (*Sequoia*), and Saporta compared the fruit to that of *Dammara*. Mr. Gardner enters fully into the structural peculiarities of the fossil fruit in question, and satisfactorily demonstrates that it belongs to the Betulaceæ under the genus *Alnus*.—Another paper by Miss G. Lister was read, viz. on the origin of the Placentas in the tribe Alsineæ of the order Caryophylleæ. This communication is based on a series of observations on the development of a number of genera and species. She concludes that the capsule in the Alsineæ is developed on essentially the same plan as that of *Lychnis*, the difference in the various genera being merely dependent upon the relative height attained by the carpels on the one hand, and by the central axis on the other. This being so, we are bound to admit that if we accept, as we do, the carpellary origin of the placentas in *Lychnis*, the placentas in the Alsineæ, from *Sagina apetala*, which most resemble *Lychnis*, to *Cerastium triviale*, which most widely differs from it, are also carpellary.

Chemical Society, November 1.—Dr. Perkin, F.R.S., president, in the chair.—The following papers were read:—On the production of hydroxylamine from nitric acid, by E. Divers. Free nitric acid yields hydroxylamine when treated with tin, zinc, cadmium, magnesium, and aluminium. In the presence of hydrochloric or sulphuric acid the quantity with tin or zinc may be considerable. Without a second acid only traces can be detected. The author also discusses the action of nitric acid upon metals and the constitution of nitrites, in which he considers the metal to be directly united with nitrogen.—On the chemistry of lacquer (*Urushi*) (part i.), by H. Yoshida. Lacquer contains a peculiar acid, Urushic acid, extracted by alcohol, some gum resembling gum arabic, water, and a peculiar diastatic body containing nitrogen. The lacquer when exposed to moist air at 20° C. dries up into a hard lustrous varnish. This hardening is brought about by the action of the diastase upon Urushic acid, the latter being converted into oxy-urushic acid.—On some compounds of phenols with amidobases, by G. Dyson. The author has prepared and investigated anilin phenate, toluidin phenate, naphthylamin phenate, anilin β naphthate, toluidin naphthate, rosanilin phenate, xylidin naphthate, rosanilin aurinate, anilin aurinate.—On the alleged decomposition of phosphorous anhydride by sunlight, by R. Cowper and V. B. Lewes. In a paper at the British Association, Southport, the Rev. A. Irving stated that phosphorous anhydride prepared by passing air over heated phosphorus is decomposed by sunlight into phosphorus and phosphoric anhydride. The authors find that phosphorous anhydride thus prepared consists of a mixture of phosphoric anhydride, phosphorous anhydride, and phosphorus.

Physical Society, November 10.—Prof. Clifton in the chair.—Dr. J. Blaikley read a paper on the velocity of sound in air, in which he described a modification of Dulong's method of measuring it by the wave-length in a pipe lengthened. Dulong did not allow for the partial tones, which are an important factor, whereas Mr. Blaikley does. By means of organ pipes of different diameters, the author has found the velocity to be about 320 metres per second. Mean result with four tubes: one of 54·1 mm. diameter, velocity = 329·73 metres per second; one of 32·5 mm. diameter, velocity = 328·78 metres; one of 19·5 mm. diameter, velocity = 326·9 metres; one of 11·7 mm., velocity = 324·56 metres. The velocity diminishes as the tube is smaller in bore.—Mr. Bosanquet made a communication on the moment of a compound magnet, which he showed how to measure by the method already published by him. A compound magnet made up of eighteen small cylinders of magnetised steel placed end to end is hung in a cradle carried by a delicate bifilar suspension, and placed at right angles to the magnetic meridian. The deviation from zero produced by the magnet is noted; then the magnet is divided into two parallel rows of nine cylinders along the cradle, and the deviation again noted. The tangent of the angle of deviation from the east and west line, multiplied by a constant, is the moment of the magnet. The author also pointed out that to define the condition of a permanent magnet it was necessary to know the difference of magnetic potential, the "resistance" of the metal, and the resistance of the external space.—Mr. W. Lant Carpenter read a paper on measurements relating to the electric resistance of the skin, and certain medical appliances. The author's experiments, made upon himself, showed that the resistance of the body amounts to thousands of ohms, but is mainly due to the condition of the epidermis. If this is dry, the resistance is high By soaking the skin in salt and water, he reduced the resistance of parts of his body from 10,300 ohms to 935 ohms after 100 minutes' soaking. He infers that a large electrode should be used in applying electricity to the body, and that the skin should be soaked for twenty-five minutes previously. Mr. Carpenter also exhibited a "chain-band" of Mr. Pulvermacher, and a small voltameter by the same inventor, in which the liberated gases force some of the water up a graduated tube as a gauge of the current. The author drew attention to the necessity of seeing that the skin should be dry in handling some electric light machines, else disagreeable shocks might result. Prof. Ayrton believed that the danger of electric lighting currents lay rather in their discontinuity than their electromotive force. The Brush currents, which have proved fatal, are more discontinuous than those of the Gramme machine, &c. Adverting to the presence of electricity in the air as influencing health, he suggested that the influence might be studied by electrifying the air, say in a hospital ward. Mr. W. Coffin stated that statically electrifying patients had been tried at Bellevue Hospital, New York, without definite results.

PARIS

Academy of Sciences, November 5.—M. Blanchard, president, in the chair.—Funeral orations on the late M. Breguet, by M. Janssen and Admiral Cloué.—Notice by M. Daubrée of the death of Mr. Lawrence Smith, Corresponding Member for the Section of Mineralogy, who died at Louisville, Kentucky, on October 12.—On lighting by electricity, by M. Th. Du Moncel.—On one of the methods proposed by M. Lœwy for determining the right ascensions of the circumpolar stars, by M. F. Gonnessiat.—Remarks on M. Boussinesq's communication respecting the equilibrium of a ring subjected to normal pressure uniformly distributed, by M. Maurice Lévy.—Note on the decomposition of a number into five squares, by M. Stieltjes.—On the probability that a given permutation of n quantities is an alternating permutation, by M. Désiré André.—On the algebraic integration of linear equations, by M. H. Poincaré.—On a family of developable surfaces generated by the intersection of a given left curve at an angle depending exclusively on the coordinates of the point of intersection, by M. Lucien Lévy.—On the potential of the inductive force due to a closed solenoid with current of varying intensity; analogy with Felici's theorem of electromagnetism, by M. Quet.—On a new non-periodical galvanometer, by M. G. Le Goarant de Tromelin.—On the electric resistance of sulphur, phosphorus, and some other more or less insulating substances, by M. G. Foussereau.—On the influence of nitrate of soda and of nitrate of potassa on the cultivation of potatoes, by M. P. P. Dehérain.—Researches on the physiological properties of maltose, by M. Em. Bourquelot.—On the external application of metallic copper as a preservative against cholera, by M. Axel Lamm.—On the comparative toxic action of metals on microbes, by M. Ch. Richet.—Note on zooglœic tuberculosis, by MM. L. Malassez and W. Vignal.—On spermatogenesis amongst the edriophthalmous Crustaceans (genera Ligia, Idotea, Sphæroms, Gammarus, Talitrum), by M. G. Herrmann.—On internal sacculine, a fresh stage in the development of *Sacculina carcini*, by M. Yves Delage.—On the anatomical structure of the Phallusiadeæ, a family of Ascidians on the coast of Provence, by M. L. Roule.—On the intestinal cavity and sexual apparatus of *Spadella marioni*, by M. P. Gourret.—A second contribution to the history of the formation of coal, by M. B. Rensult.—On a ferriferous meteorite which fell at Saint Caprais de Quinsac, Gironde, on January 28, 1883, by MM. G. Lespiault and L. Forquignon.—On the diurnal variation of the barometer at different altitudes, and on the existence of a third barometric maximum, by M. Ch. André.—Note on the periodicity of earthquakes, by M. Ch. V. Zenger.—On the employment of sulphuric acid in the treatment of animal matter infected by contagious elements, by M. Darreau.

BERLIN

Physiological Society, October 26.—In the course of his investigations into the functions of the cortex of the cerebrum, Prof. Munk had often had occasion to collect experiences on the subject of the appearance of general epileptic spasms resulting from irritation of the cortex of the cerebrum. By this means he had been enabled to confirm not only the older clinical conclusion of Mr. Jackson, that epileptic spasms always proceeded from one group of muscles, and then overtook in a perfectly definite series more distant groups, and at last the whole body, but likewise the accuracy of Herr Hitzig's observation, that in the case of more powerful or longer continued irritations of the motory parts of the cortex of the cerebrum, the contractions of the group of muscles belonging to the irritated spot ended in general epileptic spasms. An experimental epilepsy of this kind Prof. Munk could produce from any spot of the motory part (the sphere of feeling), and the groups of muscles therefore followed each other exactly in the series in which the centra were stratified beside each other in the sphere of feeling, so that first the parts situated nearest the irritated spot, and then more distant parts became affected, till at last the whole body was subjected to epileptic contractions. Sometimes the whole of the groups of muscles on one side was attacked before the other side began to be affected; frequently, however, the irritation and the epileptic attack passed over at an earlier stage from one side to the other. That the experimental epilepsy originated in the motory section of the cortex of the cerebrum seemed to Prof. Munk indubitably established by the two following facts:—Let a small piece, say the centre for the movements of the upper extremity of the right side, be excided, and let the centre of the eye-muscles be irritated till epilepsy set in, then would the spasmodic contractions propagate themselves successively to all groups of muscles with the exception of the right upper extremity, which would remain at rest throughout the epileptic attack. Let, again, the centre of the eye-muscles (a part specially suitable for such experiments) of an animal be irritated so that an epileptic attack supervened, and after a corresponding pause let the irritations be repeated in the same part with equal strength and duration, then, in the event of the spasms reaching the muscles, say of the head or neck, by suddenly removing the irritated part of the membrane the epilepsy would also be terminated. Both phenomena were explainable only on the assumption that the irritation of the motory cortex of the brain was the cause of the experimental epilepsy. The assertion was advanced by another observer, that epilepsy could be generated not only from the front section of the cerebral cortex, but likewise from the sphere of vision. This position Prof. Munk induced Herr Danilo to put to the proof, but in spite of numerous experiments no confirmation of it could be gained. Electric streams, of a force and duration such as, applied to any part of the sphere of feeling, would undoubtedly have given rise to epilepsy, were quite powerless in this respect when applied to the sphere of sight. Not till streams of much intenser force and very considerably longer duration were applied to the sphere of sight was an epileptic attack produced. In this case, too, it was obvious that the result was due to the neighbouring parts of the sphere of feeling becoming irritated through propagation of the effect or by communication. If now at the beginning of the epileptic attack the irritated part of the sphere of sight were removed, the attack would not thereby be stopped. Nor was it of any greater consequence in the way of producing an attack that by a cross cut the irritated sphere of sight was freed from its substratum, if only it retained connection with the front part of the cortex. Let, however, the sphere of sight, by means of a perpendicular sagittal cut, be separated from the sphere of feeling, then could no epileptic attack be any longer produced by irritating the former. These facts seemed to Prof. Munk to conclusively demonstrate that experimental epilepsy could be produced only by irritation of the motory parts of the cortex of the cerebrum. He laid stress, however, on the fact that his experiences and experiments referred only to "experimental" epilepsy.

CONTENTS

THURSDAY, NOVEMBER 22, 1883

THE GERMAN FISHERIES COMMISSION

Vierter Bericht der Commission zur wissenschaftlichen Untersuchung der deutschen Meere für Jahre 1877-1881. II. Abtheilung. (Berlin: Paul Parez, 1883.)

THIS portion of the Fourth Report of what might perhaps be called the German Fisheries Commission is a folio volume of considerable thickness, consisting exclusively of three elaborate scientific memoirs, each of which is stamped with the thoroughness so characteristic of German work. The first, by Dr. Adolf Engler, deals with the marine fungi of Kiel Bay, the second, by Dr. R. Möbius and Fr. Heincke, with the fish fauna of the Baltic, and the last contains an account of the properties and history of the eggs of certain fishes, by Dr. von Hensen.

The second, which we shall first consider, is the most important and the largest—extending to nearly 100 pages—and consists of an elegant and concise description of all the species of fish hitherto found in the Baltic. As the work is founded on observations extending over twenty years, made with the advantages of constant residence on the Baltic shore and of control over the collections in the Kiel Museum, the list is as valuable as it is complete. This makes the absence of some forms we should naturally have expected all the more remarkable: we have especially noticed the absence of Myxine, but perhaps to those better acquainted with the distribution of this interesting form its absence will not be a matter of surprise.

The descriptions are preceded by an introduction which explains in a very lucid manner the principal points of fish organisation and their relative importance in identification. This is followed by a simple classificatory catalogue of the fishes described. In this catalogue all Teleostei are divided into Physostomi and Physoclisti. It is satisfactory to find the great fundamental characters which divide the Teleostei insisted upon, but there seems no objection to retaining the criterion of the fin rays for the Physoclisti, especially as this criterion brings out the affinity between Gadidæ and Pleuronectidæ.

The concise and elegant descriptions are supplemented by a useful fin formula which makes comparison easy. The food and habits of the fish are mentioned, the spawning habits being especially described, and each account is accompanied by a simple but extremely well executed woodcut, in which all the characteristic features are definitely indicated in outline. The object stated in the preface, to make identification practicable to laymen, has been certainly attained.

In the account of the herring considerable space is given to the discussion of the differences between the two races which the labours of the Commission have shown to exist in the Baltic. Perhaps before long it will be ascertained whether the same differences exist between the spring and autumn herring of the North Sea.

The last portion of this memoir consists of general considerations on the fish fauna of the Baltic. The authors find that this sea may be divided into three regions, each characterised by a distinct fish fauna, of which the Western receives the greatest number of occasional visitors from the North Sea. They conclude that the Baltic was once in open communication with the Arctic Ocean, and that some of the species of fish which entered at that time remain now as inhabitants of the Gulfs of Bothnia and Finland. This portion of the work is illustrated by an interesting map. Appended to the whole is a table of the spawning periods of the fishes constantly inhabiting the Bay of Kiel, and also an index of the Latin names of the fishes described, and another of their German, Danish, and Swedish synomyms.

Dr. von Hensen reports at length on the researches made by him during four years on the eggs of the plaice, flounder, and cod.

Agassiz described the eggs of the plaice as floating at the surface, while the Swedish naturalist, Malm, affirmed that they slowly and gradually sink. The first eggs that Dr. Hensen obtained from a ripe female plaice gradually sank. This being a question of the relation between the specific gravity of the eggs and of the salt water, Hensen carried out a series of investigations into the specific gravity of the different eggs and their natural condition when deposited by the fish. By an elaborate process of measurement and calculation he arrived at the specific gravity of the ripe eggs before extrusion, and ascertained the limit of specific gravity and the salt percentage in the water which determines whether the eggs of the cod and plaice shall float or sink. He found that cod's eggs floated in water which contained more than 1·85 per cent. of salt; and plaice eggs, when the percentage was above 1·78. These correspond to a specific gravity of 10145 and 10136 respectively, at 17°·5 C. He found from the observations of the Commission that the water in the Bay of Kiel has very often a specific gravity less than these. Thus there is an exception even to the statemen that cod's eggs float. As will be seen, they always float in the open ocean. It was found that the specific gravity of the eggs before extrusion was somewhat greater, and their volume somewhat less than in the fertilised eggs which had been in sea water, and further that the eggs swell somewhat by the absorption of water without salt.

The author next calculated, from the number of female fish taken on a given fishing-ground and the average number of eggs contained in each, the average number of eggs in the sea corresponding to a square metre of surface, and then made careful continuous nettings of the eggs to find if the actual number coincided. He fished the bottom, and the surface, and vertically. Eggs of the plaice and flounder were frequently taken at the bottom. He found the eggs pretty evenly scattered, and often obtained them in the proportion of 30-80 per square metre of surface. He then discusses what proportion of eggs are likely to be destroyed by their various enemies. This is the first attempt which has been made to estimate the actual number of eggs of fishes hatched in a particular area. The whole paper bears evidence of the most profound and careful work.

The memoir which stands first in the book gives an interesting account of the areas of sea-bottom in the Bay of Kiel known as "weisser" or "todter Grund." They are called "dead" by the fishermen because no fish are found on them, a fact probably due to the presence of sulphuretted hydrogen. The white felting which gives the name "white" is formed by threads of different species of Beggiatoa, a thread-like fungus classed with the Schizomycetes by Zopf and others who have stated that bacteria forms constitute a stage of their life-cycle. Thus *Monas Okenii*, *Bacterium sulphuratum*, *Clathrocystis rosea-persicina*, and *Beggiatoa rosea-persicina* have all been described as stages of a single life-history. Dr. Engler is extremely cautious on this point, and limits himself to what he has seen. He does not agree with Warming that *Monas Mülleri*, which occurs with the Beggiatoæ, is the young stage of one of them; although he has observed one species sending off motile spherical spores. Two new genera of thread-shaped fungi are described which were found on a *Gammarus locusta* living on the white bottom. The paper is illustrated by a number of admirably executed drawings.

Thus the volume forms a very considerable contribution to the accurate scientific knowledge of the Baltic, for the attainment of which the Commission was instituted. Like all the other work published by the Commission, it exemplifies in the most convincing manner the truth that, to obtain light on marine problems, what is required is not a mass of evidence from people all equally without knowledge on the subject, but continued and elaborate research.

MASCART AND JOUBERT'S "ELECTRICITY AND MAGNETISM"

Electricity and Magnetism. By E. Mascart and J. Joubert. Translated by E. Atkinson. Vol. I. (London: Thos. de la Rue and Co., 1883.)

WE took occasion some time ago to draw the attention of the readers of NATURE to the "Leçons sur l'Électricité et le Magnétisme," by Professors Mascart and Joubert; we have now to thank Prof. Atkinson for an English translation of this valuable work. This is not the place to inquire into the necessity for an English translation of *any French* scientific work, not to speak of one which makes such demands on the culture of its readers as this does. It is enough for us to know that the publishers and translator consider the number of semi-educated Englishmen sufficiently great to justify their venture; it is our part to speak to the merits of the work and the manner of the translation.

The alterations in the matter of the book are so slight as to call for no remark. Our first duty therefore reduces itself to a simple iteration of our high opinion of its value as a scientific manual. At the present time the public is well supplied with scientific instructors. The good intentions of all of them need not be doubted; but the inactivity or modesty of some and the incompetency of others have brought it about that there are large gaps in our repertory of science text-books either not filled at all or filled very unworthily. It would not be accurate to say that vol. i. of the treatise of MM. Mascart and Joubert fills the greatest of these gaps in the department of electricity and magnetism; nevertheless it fills a place not at present wholly occupied by any English text-book of merit. It has the misfortune, no doubt, of overlapping to a large extent the great work of Maxwell; but we believe that the tyro in the mathematical theories of electricity and magnetism will find it of the greatest advantage to use Mascart and Joubert as companion and commentary to Maxwell's volumes. In all that relates to fundamental points and general theory Maxwell should be studied, even where he is hardest to follow, because his work was written, not to evade, but to meet, difficulties. On the other hand, Mascart and Joubert will be found invaluable in matters of detail. We know of no text-book in any language that contains such an abundance of elementary illustrations of electrical and magnetic theory, all arranged with an elegance peculiarly French.

The English version now before us is neatly printed and solidly got up. The translation on the whole is very well done. It would be easy to pick out small inaccuracies here and there, particularly in the early chapter. For some of these the translator is not altogether to blame; for the introductory part of the work seems to us to be less clear and carefully written than the following chapters, where the authors enter more into detail; and in that part of the book the translation leaves little to be desired. We noticed very few misprints, but one calls for correction: the name of van Troostwyk's collaborateur in the decomposition of water by the voltaic current was Deimann and not Diemann. No doubt this mistake occurs in the original; but the individual in question, though perhaps not widely known, yet deserved better than to be made quite unrecognisable. This brings to mind the only complaint of any gravity we have to bring against the editor of the English translation. Why did he not do something to remedy the one serious defect of MM. Mascart and Joubert's text-book, viz. the want of sufficient references to original sources of information? It must be remembered that the scientific student who goes the length of MM. Mascart and Joubert's leading strings is expected one day to walk alone; and some indication should be given him of the paths that lead to farther knowledge. A defect of the kind might be overlooked in a school primer, written to enable the oppressed schoolmaster to screw a Government grant on the minimum qualification from some reluctant inspector, but is to be deplored in a work of the present pretensions.

Instead however of complaining farther of what MM. Mascart, Joubert, and Atkinson *have not* done (perhaps had not the leisure to do) for us, it will be more fitting to conclude by thanking them heartily for what they *have* done, and done so well.

G. C.

OUR BOOK SHELF

Energy in Nature. By William Lant Carpenter, B.A. B.Sc. (London, Paris, and New York: Cassell and Co.)

THIS book is, with some additions, the substance of a course of six lectures on the Forces of Nature, and their mutual relations, delivered under the auspices of the Gilchrist Educational Trust.

It is of the greatest importance that the general body of the people, and more especially the intelligent artisan class, should become acquainted with the leading principles of the science of energy. The series of lectures delivered with this object represents one of the best sustained efforts to bring this great subject before the minds of this class of the people, and in collecting together and publishing these lectures the author has done a work which must be regarded as a scientific boon to the artisan.

In one respect this task has presented difficulties of a peculiar nature, due to the fact that our country has taken a leading part in developing the principles of energy—this science has in fact grown here, and the terminology has grown with it. At the present moment there is no man of science who speaks of the forces when he means the energies of nature, but there is a lagging behind in this respect amongst the body of the people, to whom the word force is a familiar one, and the word energy, in a scientific sense, very much the reverse. Accordingly one of the first duties of the author has been to define the exact relations between force and energy in a way suitable to his audience—a task which he has successfully achieved.

While in respect of importance the science of energy holds a paramount place, it is also a subject which lends itself admirably to the mode of treatment adopted by the author of this volume. Probably no subject is more difficult of conception on general principles merely, and without reference to the actualities of life. The philosopher in his study may have but a vague conception of these general laws, and his assent to the definition of work may be purely intellectual. Perhaps he may never have witnessed a well marked case of the transmutation of energy, nor may he have the consciousness that he himself is frequently the subject of such transmutations. The artisan is, however, in a totally different position. After a day's hard toil he is well able to realise in a very vivid manner the meaning of the word *work*. To spend his personal physical energy, and to recruit it by food, are operations in which he is constantly and consciously engaged. Hence it follows that a theory which borrows all these facts as illustrations of its truth appeals to the artisan in a much more emphatic way than it does to the mere student of science. To use the scientific terminology, the latter may have more *kinetic* intellectuality than the former, but the artisan is in a *position of advantage* which enables him to grasp the truths of the science. A book, therefore, which, like the present, abounds in good illustrations and in clear and simple statements, carrying practical applications, is one peculiarly fitted to a class better qualified by education and experience to perceive the concrete than to appreciate abstract general principles. B. S.

Journal of the Royal Agricultural Society. Second Series, Part II. Vol. XIX. October, 1883. Price 6*s*. (London: John Murray.)

THE current number of the *Journal of the Royal Agricultural Society* has just reached us. It fully maintains the reputation so justly earned by previous numbers, and contains papers on many topics of present interest to agriculturists. Among the principal of these may be mentioned "The Progress of Fruit-Farming," by Mr. Whitehead, of Barming House, Kent, himself largely interested in this business. The continued reports upon Prize Farms are worthy of attention as showing what is being done on the best farms in various districts. A report on sheep-feeding experiments conducted at Woburn by Dr. Voelcker in his capacity of chemist to the Society, and a report on wheat mildew, by Mr. W. C. Little, of Stag's Holl, form the chief attractions to practical farmers. Among the more purely scientific or speculative contents may be mentioned a contribution from Rothamsted, by Sir John Lawes and his able coadjutor, Dr. Gilbert, upon the composition of drainage water collected at Rothamsted, and a valuable paper upon nitrogen as nitric acid in the soils and subsoils of certain fields on the same estate. The remainder of the volume is chiefly occupied with useful official matter, such as the Weather Report; the Botanical Report, by Mr. Carruthers; and Reports on Live Stock, Implements, &c., exhibited at York. A touching tribute is paid to the memory of a late president of the Society, the late Lord Vernon, by Mr. Wells, himself an ex-president. Perhaps the most striking and instructive paper is that by Mr. Thomas Bell upon the Yorkshire Prize Competition, containing a full report of the Tuyers Wood and East Park Farms, occupied by Mr. Turnbull. In these days, when dairying is justly attracting very special attention, it is highly interesting to receive sound information as to the methods used on thoroughly well-managed farms. A daily record of the milk yielded by each cow in a dairy containing 100 animals in milk is in itself highly useful, and worthy of imitation. It is impossible in a short notice like the present to open up the various topics dealt with. It has ever been the wise policy of the "Royal Agriculturist" to fill its pages with contributions from specialists upon their own specialities. There is no padding or superfluous discursiveness, and sometimes to the uninitiated there may appear to be a want of that introductory and explanatory matter which entices on the general reader. As a record of agricultural research and progress, the journal holds a high position, which the number just issued fully maintains. J. W.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On Chepstow Railway Bridge, with General Remarks suggested by that Structure

IN a letter to NATURE of some months past, suggested by a special subject of engineering, I pointed out the necessity of clearly understanding the effects of endwise pressure on metallic columns, in respect of its tendency to cause springing or buckling of the columns. I remarked that there is a total want of experiments on the subject (Mr. Hodgkinson's observations, made on a very small scale, being excepted), and I gave some details of a theory by which the effective arrangement of such experiments might perhaps be facilitated. I have lately observed in an engineering work a failure of a different class arising from endwise pressure, of a kind which I had not anticipated, and which appears to be perhaps more dangerous than even the buckling to which I had called attention.

In the neighbourhood of Chepstow, the River Wye is crossed by a railway bridge of a single span. The four corners of the bridge are supported by iron tubular vertical, columns of considerable length. One of these columns (on the Monmouthshire side of the river, and on the lower side of the bridge as regards the course of the river) is split, with several important longitudinal fissures. To avert the present destruction of the bridge, strong iron hoops have been placed surrounding this tube, drawn tight by screws and nuts, exhibiting a somewhat unsightly appearance.

For clear understanding of this state, the reader may figure to himself a cask or barrel, set on its end, and loaded on the top till its staves burst outwards; then he must conceive a hoop to be placed round the body of the cask, and drawn till the edges of the staves are wholly or nearly in contact.

I do not doubt that this column is now safe. But there are other columns supporting the bridge which are exposed to the same dangers: the bridge is heavy, the loads from the Taff and the Tawe are not light, and the jar of ponderous locomotives may try every original weak point or may create new ones; and I think it would be well provisionally to encircle the other supporting columns in the same way as the one which has failed

A symmetrical system of rings, with some attention to simple elegance, would remove the offensive effect produced by the bent bars of mere blacksmith's work which now surround a single column.

But it is not specially to the state of the Chepstow Bridge that I wish to call the attention of the public. It is to the total want of practical knowledge as to the enduring power of metals, with which this bridge was built, and with which other such bridges must at present be built. We are totally without experiment on the danger of springing or buckling, and on the danger of bursting (now, I believe, for the first time brought forward). And we might perhaps consider such experiments as well falling within the province of those organised bodies whose union is based on the promotion of the most important determinations in civil engineering.

The Institution of Civil Engineers (with which body I have a much-valued honorary connection) has lately departed in some measure from the strict subject of engineering to which its attention had been successfully given for so many years. I venture to suggest that this body might well take up the conduct of experiments bearing on engineering. The examination of the effects of force in mere crushing of external surfaces has been admirably prosecuted by American engineers. But the examination of bending and bursting, as the effects of end-pressure, is still open to the engineers of Britain. The funds of the Institution appear to be amply sufficient for such purposes, and the undertaking of them would undoubtedly be considered as honourable to the body. G. B. AIRY

The White House, Greenwich, November 17

Physiology in Oxford

A PARAGRAPH appeared in the *Spectator* of Saturday, the 10th inst., on the Oxford memorial concerning the University Physiological Laboratory. That part of it which affects Magdalen College appears to me to rest upon erroneous information, and is certainly calculated to spread an entirely false and misleading impression of the attitude of this College in the matter, and of the University in general.

If you will allow me to quote the paragraph, and at the same time give you the actual facts, I think yon will easily form an opinion on the real state of the case.

The paragraph states that the signatures were received "from members in Oxford and its suburbs, and the rest from a circle of abont fifteen miles round."

The fact is that the signatures are not drawn exclusively from either the smaller or even the larger area, one of the so-called Magdalen signatures being that of a member of the Hereford Cathedral choir.

The paragraph goes on to say:—"We are told that Magdalen men have signed it more nnmerously than any other College but one, and, in proportion to the size of the College, more numerously than any. Now, as Prof. Burdon Sanderson is *ex officio* a Fellow of Magdalen, and as Magdalen has for years past had a physiological laboratory of its own, this popularity of the memorial among Magdalen men is highly significant."

On this I have to remark that the signatnres are representative neither of the governing body of the College, nor of its resident members.

The governing body of the College consists of the President and twenty-four Fellows; of these twenty-five *three alone have signed the memorial*. The resident members, as shown by the list of congregation, number twenty-two; of these twenty-two *only six* have signed.

Finally, as regards the last paragraph, it is true that Magdalen College has for years past had a physiological laboratory of its own, and it is further true that the University teaching of physiology has been carried on there, previous to the advent of Dr. Burdon Sanderson, for years past under a Government licence with the full and express consent of the whole governing body of the College, a fact which is indeed significant, but hardly in the way in which the *Spectator* appears to have been informed. EDWARD CHAPMAN

Magdalen College, Oxford, November 15

Green Sunlight

MR. G. H. HOPKINS' observation that the parting ray at sunset is sometimes brilliant emerald-green brings to my memory a somewhat similar experience. On September 13, 1865, watching on the summit of the Rigi for sunrise, I caught the very first possible glimpse of the sun's disk as, on a very clear morning, he emerged from behind the sharply-defined outline of a distant mountain. The very first rays, although necessarily proceeding from the comparatively obscure limb of the sun, were dazzlingly brilliant, and of a superb emerald green colour. But almost instantly, as more of the sun appeared and his light grew sensibly more intense, the green passed away or was merged in the yellowish white of ordinary sunlight.

In my case I do not doubt the phenomenon was purely subjective, for before sunrise the sky was all lit up of a magnificent crimson hue. Every one must have noted how the moon when surrounded with bright crimson clouds looks more or less decidedly green.

A very striking effect of this sort, like the others an example of the well-known visual phenomenon of "accidental colours," may be artificially obtained, any time the moon shines, by burning an ordinary "blue" signal light. After my eye had been intensely excited by such a light close at hand, I have seen the moon, near or at its full, of a deep plum colour, by which I mean the colonr of the bloom on a black plum or on a well colonred Hamburg grape. Or, in place of these, the *violet* of my friend Prof. Piazzi Smyth's exquisite chart of colours in his "Madeira Spectroscopic," or the *bleu violet* of Chevreul's chromatic circle. I recommend the experiment as easy of performance and exceedingly beautiful in its effects. Possibly a small blue light would suffice. But, on the occasion to which I have referred, certainly not less than thirty ounces of nitre, ten of sulphur, and five of black antimony sulphide were employed. These, mixed in fine powder, may be burned in a case about six inches high and four in diameter; of course in the open air, and where no mischief may accrue from an intensely hot and voluminous flame.

In a communication made to the Royal Society of Edinburgh in 1852 (*Trans.* vol. xx. pp. 445–471), I adduced evidence to prove that a continuous thin layer surrounds the sun's photosphere, of which upturned portions form the red protnberances seen at total solar eclipses; and I then showed that if the well known darkening of the sun's limb be dne to absorption in his atmosphere, it can only be caused by such a *thin* envelope. The existence of this envelope, the sun's chromosphere, is now fully established. If, from the red colour of its upper portions, we may infer the resultant tint emitted by the whole to be red, then, by a well known law, the discolouration of the sun's limb due to its absorption should be of a greenish hue. But such an effect would necessarily be but slight, and could not explain the brilliant green witnessed on the Rigi. Nor do I recollect any instance where the first emerging rays of the photosphere at the end of a total eclipse have been observed to be green. WILLIAM SWAN

Ardchapel, Dumbartonshire, November 8

A LETTER from Barinas, Venezuela, states that on September 2, from daylight until noon, and from 3 p.m. to sundown, the sun appeared like a globe of burnished silver. Between noon and three o'clock it was of a bluish-green colour. This appearance in the western hemisphere seems to dispose of the suggestion of the Java eruptions as the cause of green suns in India. HYDE CLARKE

Mangrove as a Destructive Agent

AS I have never seen the mangrove mentioned bnt as a conservative or productive agent as regards geological change, it may be interesting to readers of NATURE to hear of its acting in a contrary direction.

In several parts of eastern tropical Africa, where the shores are mostly of upraised coral limestone, I have noticed the effect of mangrove in eating away this rock, but nowhere have I seen it so well marked as in the Island of Aldabra, some two hundred miles to the north-west of Madagascar, and which I surveyed in 1878.

Aldabra is an upraised atoll about twenty-two miles long, and presents low cliffs of about fifteen to twenty feet of solid coral rock to the sea and also to the lagoon, which is, at low water, nearly dry

The mangrove has established itself on the edges of the lagoon, doubtless from seed transported by the currents, and, in all places where it has done so, tortuous creeks or little gorges run back into the coral, filled with mangrove trees (standing in deep mud of the adhesive and fœtid nature so characteristic of mangrove swamps), which stretch out their roots to the coral walls around them, and, as it seemed indubitably to me, in some way decompose the softer parts and eat their way in. The island is riddled with these creeks, always filled with mangrove, and opening into the lagoon.

The outer face of the island is of course being slowly undermined by the sea at high water, presenting overhanging cliffs impossible to scale, and the island is wearing away from that cause also, but the destruction from the mangrove is much more important, and at no very distant period, as it seemed to me, the upraised island will be again reduced to its original level as an ordinary atoll.

It would be interesting to know how long the mangrove has been there, for as Aldabra is one of the two oceanic groups in which the giant tortoises still exist indigenous, it must have been in its present condition of upraised atoll, I imagine, for a long period. It could never have been much larger in diameter, from the soundings round it, but the mangrove may have greatly increased the size of the lagoon by steady working at the inner rim of the islands, the actual area of which is now but small, from their narrowness.

I may mention that the island is covered with low, tangled scrub, which has managed to find foothold and sustenance on the rock, for there is but little or no soil, and the top of the rock is everywhere cut up by sub-aërial action into the sharp, honeycombed, and jagged surface which upraised coral in the tropics, uncovered by grasses, soil, &c., always wears into, and which, by the way, makes it extremely difficult to walk over, a difficulty much increased in this instance by these mangrove channels, as well as the tough nature of the matted, thorny bushes. A walk in Aldabra is the most aggravating and slowest piece of locomotion I have ever engaged in: and nothing short of the patience, perseverance, and general disregard of time of the tortoise tribe can make it an agreeable residence. Some of my negro sailors were sent into the bush to hunt for tortoises, and after three days' search brought back one, which is now in the Gardens of the Zoological Society; but they returned nearly as guiltless of artificial clothing as their captive.

W. J. L. WHARTON

H.M.S. *Sylvia*, Monte Video, October 10

The "Cloud-Glow" of November 9

THE beautiful after-glow of Friday, the 9th instant, was most striking as seen from the west side of Hampstead Hill, where its first development was made more effective by a frame of dark cumulus, with a fringe of dusky green tint, carried up from the sunset quarter by a westerly breeze, rather rolled up like a curtain, exhibiting the richly-coloured scene behind as it was withdrawn. I estimated the altitude of the upper edge of the glow at about 30°; but at Freshwater, Isle of Wight, it has been described as extending nearly to the zenith. There would be no difficulty in calculating approximately the height of the cirrus—as desired by Mr. Russell—if it could be assumed that the reflection was from the same matter in both cases, which is improbable.

J. J. WALKER

Waking Impressions

A CURIOUS case I have just read in a recent number of NATURE recalls a somewhat similar experience of my own, rather earlier in date. I awoke in the middle of a story told by an internal voice—a voice felt, not heard. I listened with curiosity and interest, as totally unprepared for what was coming as if the narrator had been Gladstone or Ruskin. I believe when I awoke I had a dim recollection of what had gone before, but I strove afterwards in vain to recall it. All I know of the history of the mysterious lady is the following fragment: "She had many admirers, but she gave the preference to Tom, because he promised to marry her in the West Indian fashion. He drew her three times through a hoop, once standing, once sitting, once lying, which signified that he would never desert her in youth, maturity, or old age."

I have not the least idea who "she" was. I know no one I call Tom except an old schoolfellow long married, and, to the best of my belief, I never heard of such a custom in the West Indies or elsewhere. Once since I have waked in the middle of a dream which went on, but it was a dream of a very commonplace character.

WILLIAM RADFORD

Sidmouth

Barytes from Chirbury

I AM indebted to Mr. Yelland of Wotherton for sending me some fine examples of the crystals described by Mr. Miers in NATURE, vol. xxix. p. 29, and am collecting several particulars respecting their occurrence. Some time ago I commenced a determination of the faces, but my work has been interrupted.

The characteristic plane E is mentioned by Carl Urba (Groth, *Zeitschrift fur Crystallographie*, v. 433, 1881) as occurring on barytes crystals from Swoszawice in Galizien. In a measurement I made last year to determine this plane on one of the Wotherton specimens I obtained E E' as 39° 59', and, using Miller's distance for *b d* leads to the symbol 412, and by calculation the distance *a* E as 26° 2'. Carl Urba gives its calculated distance as 26° 4', and measured distance as 25° 58'.

C. J. WOODWARD

Birmingham and Midland Institute, Birmingham, Nov. 10

"Salt Rain and Dew"

LOOKING over the "School Geography" of Dr. Clyde (Edinburgh, 1870), I find, on page 32, in the paragraph headed "Russian Lakes," the following remarkable statement:—"In the south-east region, not only the lakes, *but the very rain and dew likewise are salt*, a phenomenon common to all the shores of the Caspian and Sea of Aral" (the italics are mine). Will some one of your readers kindly refer me to the traveller's tale in which this myth originated.

HARRY N. DRAPER

Esterel, Temple Road, Dublin, November 17

AN INDIAN WEATHER FORECAST

THE period of drought in Upper India, which happily came to an end in the latter part of August, was not entirely unforeseen, as will be shown by the following extracts from the Government *Gazette*; and the facts will probably be not without interest to meteorologists in Europe and elsewhere.

Extract from the "Gazette of India" of June 2, 1883

"That the unusually dry weather now prevailing over the North-Western Himalaya, and that which, though less abnormal, characterises the whole of North-Western India at the present time, is an effect of the unusual accumulation of snow, is a conclusion justified by the experience of the last few years; and were it not that the snow is rapidly decreasing under the unobstructed radiation of the sun, there might be some reason, judging from the present limited experience, to anticipate some retardation of the rains of the Upper Provinces, and possibly even in Western India generally. But, on the other hand, the fact that, during the months of April and May, the atmospheric pressure over the greater part of the country has been below the normal average of the season, is one which, arguing from the same experience, portends favourably for the timely influx of the monsoon. In Bengal it may be said that the present prospects are wholly favourable.

(Signed) "HENRY F. BLANFORD,
Meteorological Reporter to the
Government of India

"Simla, May 18, 1883"

"Since the above was written, there has been heavy rain for many days on the outer hills, and more or less on the plains of the Punjab, and apparently a very heavy fall of snow on the higher ranges. At the present time, as seen from Simla, the latter are white with snow, down to a level of about 11,000 or 12,000 feet. And some 500 feet of the top of the Chor (11,982 feet) is also covered with a snow-cap. If, therefore, the mountains of Lalwul, Spiti, and other more distant ranges have shared this fall, if it is as extensive as it is apparently heavy on the visible ranges, and if the views which the experience of recent years seems to justify, viz. that an unusual extent and thickness of snow on the Himalaya is productive of dry north-west and west winds in North-Western India, are valid, we must be prepared for a long spell of dry weather and a retarded rainfall in the Upper Provinces. The present season will serve as a test of the validity of the above view.

(Signed) "HENRY F. BLANFORD,
Meteorological Reporter to the
Government of India

"Simla, May 31, 1883"

Information was subsequently received to the effect that the heavy snow of the winter months as well as that which fell at the end of May was restricted to the outer range. In the interior of Lalwul and Spiti and in the Pangi valley the snowfall was very deficient. Nevertheless the May fall on the outer range seems to have sufficed to produce the effect predicted.

Extracts from a Memorandum on the Chief Weather Characteristics of the Month of June, 1883, in India, in the "Gazette of India"

"In Bengal, after some weeks of close cloudy weather, with occasional showers, the monsoon rains were ushered in on June 13, with a little cyclonic storm, formed apparently on the coast of the Sunderbuns. From the coast on the three following days this storm passed inland, on a north-west course, bringing heavy rain in its track, as far west as Behar, and a moderate fall up to Allahabad; beyond which, for a time, the rains did not advance. . . . At Bombay it blew strongly on the 11th, 12th, and 13th, but not from the monsoon quarter; and afterwards the wind fell light, and so continued till the 24th, when the monsoon set in steadily. But the rainfall has been light throughout the month, and, at its close, was six inches short of the normal average. On the 26th or 27th a second cyclone was formed at the head of the Bay of Bengal, causing heavy rain around the coasts, and especially those of Orissa and Ganjam; then, travelling westward, the centre reached Cuttack on June 30; Seoni on July 1; Indore on the 2nd; and lay between Kurrachee and Rajkot on the 3rd. It caused very heavy rain in Gujerat, flooding the rivers, and interrupting railway communication between Bombay and Baroda.

"In the North-Western Provinces, with the exception already mentioned, the rains did not set in before the 26th, but throughout the month the wind was, in general, easterly, and occasional thunderstorms occurred. In the Punjab also, the first rain fell between the 26th and 29th, but in the eastern half of the province the prevailing high temperature was mitigated by an occasional duststorm. . . .

"In Lower Bengal rain of importance fell on twenty-two days. The total fall of the month was five inches in excess. . . .

"In Rajputana, Sind, &c., the number of days on which rain fell was only four, and the average total was less by three-quarters of an inch than even the small amount which generally falls in this region in the month of June. . . .

"From the above it appears that, over a large tract of country, the monsoon so far has been weak. On May 28 it was reported to have burst at Cochin; and between that date and June 5 it appears to have spread along that coast as far north as Goa. In Bombay itself the weather has been showery, but there have been no very heavy falls of rain. On the Bengal side, on the contrary, the south and south-west winds have brought up even more than the normal amount of rain, and the weather at the head of the Bay has been somewhat exceptionally rough In Northern India the monsoon current has been much delayed, and in parts of the North-Western Provinces and the Punjab continuous rain has hardly yet set in.

(Signed) "W. L. DALLAS,
Assistant Meteorological Reporter
to the Government of India"

Extracts from a Memorandum on the Chief Weather Characteristics of July, 1883, in India, in the "Gazette of India"

"Except in the North-Western and at a few Central stations, the rainfall of the month shows on the whole comparatively little departure from the average.

"After the disappearance of the storm noticed in the June summary, which passed from the Bay of Bengal across India, &c., . . . there occurred a general rise of the barometer, a corresponding decrease in the humidity of the atmosphere, and a cessation of the rainfall, over a large tract of country for two or three days. On the 5th or 6th, however, rain recommenced generally and continued for some time. In the eastern half of the North-Western Provinces, Assam, Bengal, Burmah, and the south of the peninsula, it fell more or less on every day, till the close of the month, but over Western and North-Western India the fall ceased about the 19th, and from that date till the end of the month a decided break in the rains occurred, and fine weather set in.

"On the plains of the Punjab there were only eleven wet days; the break in the rains, which commenced on the 19th, being very decided in this province. In consequence the amount of rain for the month, and, except in the Indus valley, the total since June 1, was several inches below the average. . . .

"The weather in the western half of the North-Western Provinces was similar to that experienced in the Punjab, but in the eastern half it was wetter, the number of rainy days being nineteen. In the Meerut division five inches less than the average amount fell during the month; while at Lucknow eight inches and at Allahabad one and a half inches more than the average was registered. . . .

"In Lower Bengal and parts of Behar the rainfall was several inches above the July average; while in Purneah, Patna, and Orissa it was deficient. The average number of wet days was twenty-six, and no break in the rains of any consequence occurred within these provinces. . . .

"In Rajputana the rainfall was about the average amount, and occurred on thirteen days; scarcely any fell after the 17th. . . .

(Signed) "W. L. DALLAS,
Assistant Meteorological Reporter
to the Government of India"

Extract from a Memorandum of the Chief Weather Characteristics of August, 1883, in the "Gazette of India"

"The month just elapsed was one of very deficient rainfall throughout India, except in the provinces of Madras, Berar, and Assam. The break in the rains, which during the latter half of July was very general in North-Western and parts of Central India, became even more pronounced throughout that region during the first three weeks of the month under review; and extended, though in a modified degree, to Behar and a large part of Bombay. The drought was apparently at its height, both as regards extent and intensity, during the second week in August. . . . On the 19th, however, a change commenced. The air became slowly damper over the Central and North-Western Provinces, and the sky more cloudy: and very gradually these changes spread, till at the close of the month rain had extended to the Punjab, Rajputana, and Gujerat; in Rajputana and a large part of the Punjab and the North-Western Provinces it was only on the last two days of the month that rain began to fall, and even then in small amounts. . . .

(Signed) "W. L. DALLAS,
Assistant Meteorological Reporter
to the Government of India"

The above extracts speak for themselves. The results do not accord precisely with the terms of the prediction, inasmuch as the rains, instead of being simply retarded, penetrated for about a fortnight to the Upper Provinces, and then gave place to the dry north-west winds, which are characteristic of periods of drought. But there is no reason to regard the snows as inactive during this rainy interval. At Simla this rainy period was one of frequent thunderstorms and on more than one occasion of hail,[1] and in fine intervals the existence overhead of the ominous north-west wind was established by the steady drift of the higher clouds (*cirro-cumulus*, &c.). The outflow of dense air from the snow-fields was therefore active, although it was only at a later period that it descended to the level of the lower hills; and then, chiefly as the result of diurnal convection, to the plains of North-Western India.

The full discussion of the evidence for the dependence of dry winds on the snowfall will be undertaken elsewhere. It must not, however, be supposed that the Himalayan snows are to be regarded as the *sole* cause of drought. Causes of wider incidence are sometimes in operation. Thus, in 1876 and 1877, an unusually high atmospheric pressure prevailed over nearly the whole of Asia and Australia. Whether there was any unusual accumulation of snow on the vast mountain tracts of Central Asia or over the northern plains in those years would be an interesting subject of inquiry were the means of information forthcoming. H. F. B.

NORDENSKJÖLD'S GREENLAND EXPEDITION[2]

III.

WE give a few extracts from Baron Nordenskjöld's concluding letters on his journey down the west coast of Greenland and his visit to the east coast :—

At Ivigtut a visit was made to a valley which, on account of its copious flora, has been named Grönnedal (Green valley), and another to the spot where the inland ice falls into the Arsukfjord. In the former place Dr. Nathorst found, in a kind of syenite, a blue mineral which seems to be sodalite. This discovery is chiefly remarkable from the circumstance that this mineral is also found in the vicinity of the small kryolite deposit at the Ilmen mountain in the Ural, which seems to indicate that a kind of relation exists between these two minerals, both strong in natron, which circumstance may be of service to the geologist in search of kryolite. From the excursion to Grönnedal Herr Kolthoff brought with him some rare butterflies and other insects, while of the botanical finds there were splendid specimens in bloom of *Linnæa borealis*, which is quite plentiful about Ivigtut. It has not before been known to exist in Greenland. The zoologists found only three kinds of land mollusks, viz. a physa, a vitrina, and a helix, which were all few in number. The entomological harvest consisted of a few beetles, butterflies, and insects of other kinds.

On their way to Julianehaab, as they steamed down the narrow fjord in pitch darkness and a perfect calm, "we saw suddenly behind the vessel on the surface of the sea a broad but clearly defined band of light. It shone with a steady, yellowish light, somewhat like that of phosphorescent elements, while, in spite of the speed maintained, viz. four to six knots, the band came nearer and nearer. When it reached the ship it seemed as if we were steaming through a sea of fire or molten metal. After a while the light travelled beyond the vessel, and we saw it at last disappear on the horizon. Unfortunately I had not an opportunity of examining it with the spectroscope. It was beyond doubt of a different nature to the bluish-white phosphorescent light, which throughout its appearance was seen distinctly in our wake, and as the light was perfectly steady it cannot have been caused by the phosphorescence from a passing shoal of fish. A shoal of fish would have occasioned some stir in the sea, but in this case the surface was calm throughout, while phosphorescence from the same would have been bluish in character, not yellow as this was. The Esquimaux stated that a glacier river in the vicinity shed a thin layer of brackish clay-water over the surface of the fjord, and fancied that this circumstance was in some way or another connected with this grand phenomenon, which they themselves had never before witnessed. There was at the time no aurora visible, the sky being covered with clouds. The cause of this remarkable phenomenon, which made the *Sophia* seem to steam through a sea of fire for fully fifteen minutes, I have been unable to ascertain; maybe it was a phenomenon such as this which made Lig-Lodin, of the Greenland Saga, relate to King Harald Sigurdson that he had once sailed over a spot where the sea was on fire."

At Fredriksdal Nordenskjöld engaged two Esquimaux to act as pilots in the sounds on the east coast, north of Cape Farewell. One of them stated that remains of buildings, which were not built by the Esquimaux, are to be found in nearly every great fjord on the east coast, particularly in the large ones of Umanak, Ekaleumiut, and Igdluluarsiut. Entire walls do not remain standing, but though low they are extensive. The largest ruin is said to exist at Igdluluarsiut. A fine kind of soft stone is to be found on an island south of Umanak, from which pots were made to three feet in diameter. This mineral deposit is of special interest in reference to the ethnography of Greenland, as the Umanak fjord is situated in lat. 63°. This name is, however, a common one for places among the natives. Ivar Baardsen, in his famous description of Greenland, states that a soft stone was found on Renö, outside the Einafjord, from which the largest vessels were made. Cannot the mineral deposit at Umanak be identical with this? These statements, as well as others received from the "Eastlanders," and the remarkable Norse characteristics possessed by the same, which the missionary Hans Egede pointed out long ago, seem to Baron Nordenskjöld to refute the theory now mostly advanced as to the Norse colonies, viz. that they were situated on the south-west coast of Greenland.

In spite of predictions of failure and even disaster before he left Europe, Nordenskjöld decided to attempt to land on the east coast, south of the Arctic circle. After some difficulty they succeeded in anchoring in the Kangerlutsiok Bay, but on account of the state of the ice they had to stand to sea again, and steamed along the ice-belt lining the coast, in order to find an opening by which the shore might be reached. The fauna of the sea here was very poor, and they only saw in two days one whale, a few seals, and a very small number of sea birds. The abundant fauna of the coasts of Spitzbergen and Novaya Zemlya is thus entirely wanting on the east coast of Greenland. The cause of this may be the great depth of the sea right up to the shore, which prevents the animals from fetching their food from the bottom; perhaps also the war of extirpation which the natives seem to have carried on for years has also contributed thereto. The auk and the *Uria grylle* are, however, said to breed in large numbers on the rocks off Cape Farewell. The Esquimaux pilot stated that he had been told by old people that they could remember the *Alka impennis* having been found here. The natives called it Isaro-

[1] These accompaniments are characteristic of the spring rainfall both on the hills and the plains, not of the monsoon rains, and indicate demonstrably in most cases the existence of a dry upper current.

[2] Continued from p. 42.

kitsok. Only a little distance out to sea they found a warm current—rising to 6° C.—coming from the south. The drift-ice was what Arctic skippers call "knatteris," *i.e.* little bits, viz. remains of large floes after the influence of the summer heat and the Gulf Stream. Very few icebergs were seen, and they appear to be far more numerous on the west coast. As it was now late in the season, and the coals were nearly done, Nordenskjöld had reluctantly to renounce the plan of reaching the fjords where the greatest ruins are said to exist, and, instead, attempt to reach the south shore by Cape Dan, a promontory which, if the Einafjord was situated at Umanak or Ekaleumiut, should be the Herjolf's Naze of the Sagas. "On the 4th, when off the Cape, we met the ice twenty miles from the coast, which was, however, passable, as it consisted mostly of large, loose floes only a few feet above water, while nearer the shore it again became heavier. Beyond this we saw an ice-free channel three to four miles wide. The sea was as smooth as a pond, and a boat could easily reach the shore. The mountains ran mostly into the sea with almost perpendicular declivities, without any grass-covered underland. Opposite us we saw a small bay, into which I steamed, in order to take the sun; but finding both the depth and the bottom unsuitable for anchoring, we only landed for a few hours, while some of the crew went on the hills above to look for a better harbour. The staff returned on board with a rich harvest from the steep slopes, the flora of which was copious beyond expectation. The sailors reporting a harbour near, I steamed thereto and cast anchor. It was a beautiful fjord, with several arms, which was only connected with the sea through a small opening, and was well sheltered. It was the first harbour on the east coast south of the Polar circle, in which a vessel had anchored for several centuries.[1] It was named 'King Oscar's Harbour.' If Cape Dan is the old Herjolf's Naze, this harbour is the "Sand" described by Ivar Baardsen, 'much frequented by the Norwegians and traders.' That the Norwegians had once been here was demonstrated by walls of loose stones erected on the mountains above the harbour, which had, no doubt, served as landmarks for finding the almost hidden opening of the fjord. We found, besides, some stone ruins of a smaller house, identical with those found on the west coast. These ruins are, of course, not extensive enough to demonstrate that here was situated one of the 'Bygder' (parishes) of Greenland, but they may certainly serve as sign posts for future explorers of the east coast. As soon as at anchor we went on shore, and spread in all directions in order to examine the neighbourhood. King Oscar's Harbour is surrounded by soft, close, grass slopes and flourishing shrubs. The fauna appeared to me more copious and the grass less mixed with moss than on the west coast in the same latitude. In one of the valleys a river flowed, the shores of which consisted of loose sand without any covering of grass. Here were found traces of the Esquimaux. Some of the footprints were days old, but others were so fresh that the moist sand had not had time to dry. Most probably they had taken flight on seeing the steamer forcing the barrier which had hitherto formed their shelter. We found plenty of remains of them in the shape of huts, graves, fox-pits, &c. The naturalists gathered here a quantity of fresh materials of the fauna and flora of East Greenland, among which I may specially mention the well-known *Potentilla anserina*, which is found so often near the Norse ruins in West Greenland, and which may, for that reason, be a sign of the Norse colonisation of East Greenland. We found traces of reindeer, but none of the musk-ox; neither did we see any bears or walruses, and only a few seals. Our whole bag was two ptarmigans.

[1] North of the Polar circle the east coast of Greenland is in many places easily accessible.

That the Esquimaux had decamped was very annoying, as they could no doubt have given some valuable information relating to this part of Greenland and the tribes which inhabit it."

After reconnoitring the coast still further, Baron Nordenskjöld decided that his best course was to return at once to Reikjavik. Before doing so, however, some hours were spent in dredging and in hydrographical research, as well as in photographing some of the coast scenery.

"Having thus given an account of the work of my expedition, I have to point out that we have been the first to penetrate into the heart of Greenland, and that our journey has resulted in learning something about this continent, the natural conditions of which may probably give us a clue to the true condition of Scandinavia during the Glacial period, the study of which is therefore of such great importance to the geology of North Europe. Besides this, valuable scientific data have been collected during my voyage along the east coast of the composition of the ice-belt which bars the way *from the east* to the southern part of Greenland, while many errors as to the state of the east coast of Greenland have been corrected. In addition to these objects one more has been attained, viz. the anchoring of a vessel by the shore of East Greenland, an achievement attempted in vain for centuries. If thus the work of the numerous expeditions despatched since the sixteenth century by sea to the part of Greenland lying opposite or south of Iceland to the part where the Norse Österbygd was or was not situated, it will be found that not one of them succeeded in reaching the coast.

"A few words more in conclusion as to the purely scientific results of the expedition. During the voyage of the *Sophia* along the coast of Greenland from Cape Dan past Cape Farewell to Cape York, and further from Cape York around Cape Farewell to Ingolf's Mountain, hydrographical researches and dredgings were effected whenever time and weather would permit. These labours were conducted by Herr Hamberg and Dr. Forsstrand. In addition, Herr Hamberg effected a number of analyses of sea water, and the gases contained therein, from various depths, while he brings home a series of the most carefully effected measurements of the temperature of the sea, which demonstrate that the *cold current* running along the east coast is, both in width and depth, very insignificant, and rests *even near the shore* upon one of warm water produced by the Gulf Stream. Davis Sound and Baffin's Bay, on the other hand, are filled with cold or very slightly warmed water *to the bottom*. Contrary, therefore, to the general belief, *the west coast of Greenland is washed by cold water, while a greatly heated current coming from the south runs along the east coast a distance of 40' to 50' only from the shore.* This current must exercise a great influence on the climate of the east coast, which may be more moist, but, I believe, not colder than that of the west coast.

"The dredgings have yielded Dr. Forsstrand a fine harvest of marine animals, &c., of which I may mention gigantic sponges from great depths in Denmark Sound (between Iceland and Greenland). The dredgings on the east coast were, however, greatly impeded through causes detailed above, and by the circumstance that the bottom consists mainly of huge boulders, which tore the net. Of the animal species existing on land or in fresh water, Herr Kolthoff has collected rich fresh materials of the Greenland fauna. Especially will the variety of insects collected be of great instructive value to science. On account of the limited accommodation on board, and from the circumstance that the flora of Greenland is well known through Danish and Swedish specialists, I took no botanist with me. But even in this field new materials have been gathered through the zeal given to such researches by Dr. Nathorst and Dr. Berlin whenever time permitted. The collections of microscopical plants which have been made, the true place of existence of which is the ice and the snow, must particularly be of great value. They are besides of additional interest to the expedition, as they belong to a new branch of science which has in the first instance been created by Swedish *savants*. The collections, perhaps, of most value to science have, however, been made by Dr. Nathorst from the North-West Greenland so-called basalt formation, which is remarkable for the quantity of fossil plants contained in the clay, sand, and tuff strata there. Of course some very fine palæontological collections have been brought from these parts before, especially by the Swedish expedition of 1870, and by some Danish ones under Dr. K. Steenstrup; but it is the first time that a palæontologist has visited this spot, and I am, in consequence, convinced that the objects gathered by Dr. Nathorst, when scientifically treated, will yield many new data on the copious flora which once covered the ice-laden regions round the Pole.

"Finally, the expedition has brought home some splendid specimens of the remarkable minerals found at the well known deposits at Kangerdluarsuk and Ivigtut, while I have on the inland ice collected, as previously stated, a great many samples of the dust found on the ice, and which I have named kryokonite. I hope, when this has been exhaustively analysed, to be able to furnish fresh proofs in support of the theory that this deposit is, at all events partly, of cosmic origin, and thereby contribute further materials to the theory of the formation of the earth. Dr. Nathorst was, as previously stated, prevented by the ice from reaching Cape York and examining the blocks of ironstone lying there, but their existence has been corroborated beyond doubt by the Esquimaux in the neighbourhood. Here the expedition obtained some valuable ethnographical objects, and it learnt a fact from the natives which may be of considerable importance as to the question of the wanderings of the tribes around the Pole, viz. that four 'Russian Esquimaux' had come to Wolstenholme Sound. They said they were the last survivors of a tribe which had left their place of habitation by the Behring Strait (or the northern shore of Asia?) in search of a new place of settlement, and who had at last reached Smith's Sound. These are the results of my expedition to Greenland in the *Sophia*. The scientific collections made will be distributed among the museums of my country."

A. E. NORDENSKJÖLD

THE ROTHAMSTED GRASS EXPERIMENTS[1]

THERE is at Rothamsted nothing which will more impress the visitor than the seven acres of meadow land in the Park, the many years' experiments upon which with different manures constitute the subject of the above-named memoir. The twenty parallel plots into which the area is divided appeal at once and forcibly to the eye by the obvious differences in their herbage. A plot here with rich green grasses waving luxuriantly upon it; another, on which the yellow meadow vetchling apparently constitutes the leading feature; a third, irregular, patchy, and much afflicted with the sorrel-dock; and yet another, on which, at the time of our visit (August), the white-flowered umbels of the earth-nut put everything else in the shade,—these and the like appearances convince with an eloquence which the pen is powerless to imitate.

The land in Rothamsted Park has probably been laid down with grass for some centuries. No fresh seed has been artificially sown within the last fifty years certainly, nor is there record of any having been sown since the grass was first laid down. The experiments commenced in 1856, at which time the herbage appeared to be of uniform character. With few exceptions the same description of manure has been applied year after year to the same plot; and two plots, the third and twelfth, have been continuously unmanured. For the first nineteen years the first crop only was cut and carried away, and the second crop was usually fed off by sheep who were receiving at the time no other food. Of recent years it has been more and more the practice to make the second crop also into hay, and it is intended to adhere to this plan in future, weather permitting.

The produce of every plot is weighed as hay, and the result calculated per acre. Taking the average of the first twenty years, the unmanured plots, 3 and 12, gave the lowest yields of all, 21¼ and 24 cwt. respectively. Next above these is plot 5, manured with ammonia salts[1] at the rate of 400 lbs. per acre per annum, the yield giving an annual average of 26¼ cwt. per acre. The highest average recorded, 62½ cwt. per acre, resulted from a mixed manure, containing 500 lbs. sulphate of potash, 100 lbs. sulphate of soda, 100 lbs. sulphate of magnesia, 3½ cwt. superphosphate of lime, 600 lbs. ammonia salts, and 400 lbs. silicate of soda,—a tremendous dressing, by the way. The average yields on the other plots, each one of which received different manurial treatment from that of the others, range themselves between these extremes.

But the mere quantitative estimation of the results was a comparatively simple task to that of making a qualitative examination of each crop. The proximate analysis was into the three classes of gramineous herbage, leguminous herbage, and miscellaneous herbage, the last-named containing all plants not referable to the Gramineæ or the Leguminosæ; and even this task would not be a very difficult one. But when it is stated that in certain seasons a complete botanical analysis was made, whereby each species of plant was separated from all the others, then the irksomeness of the work will be appreciated. For the details of these analyses we must refer to the memoir itself, but the following is worth reproducing. "To quote an extreme case in illustration of the difference in the character of the herbage, and of the difference in the degree of difficulty of separation accordingly, it may be mentioned that whilst a sample of 20 lbs. from one plot in 1872 only occupied from four to five days in botanical analysis, a sample of equal weight from another plot in the same year occupied thirty days."

The total number of different species of plants that have been detected on the plots is 89; of these, 20 are grasses, 10 are leguminous, and the remaining 59 belong to miscellaneous orders. The 89 species comprise 59 dicotyledons, 26 monocotyledons, and 4 cryptogams, 3 of which are mosses (Hypnum); they are arranged under 63 genera and 22 orders. Of the miscellaneous plants there are 13 species of Compositæ, 6 of Rosaceæ, 5 each of Ranunculaceæ and Umbelliferæ, 3 each of Labiatæ, Polygonaceæ, Liliaceæ, Caryophylleæ, Scrophulariaceæ, and Musci, 2 each of Rubiaceæ and Plantagineæ, and 1 each of Cruciferæ, Hypericineæ, Dipsaceæ, Primulaceæ, Orchidaceæ, Juncaceæ, Cyperaceæ, and Filices. Six genera only were represented by more than one species; these were Ranunculus, 5 species, Rumex 3, and Potentilla, Galium, Leontodon, and Veronica, 2 each. The 20 species of grass comprise 14 genera; Festuca is represented by 4 species, Avena by 3, Poa by 2, and Anthoxanthum, *Alopecurus*, Phleum, *Agrostis*, Aira, *Holcus*, Briza, Dactylis, Cynosurus, *Bromus*, and Lolium by 1 each. The fact that the four genera whose names we have italicised were only represented by one species each serves to indicate somewhat the nature of the land. Had it been wet or marshy in parts, *Alopecurus geniculatus* might have been looked for as well as *A. pratensis*. Had not the plots

[1] "Agricultural, Botanical, and Chemical Results of Experiments on the Mixed Herbage of Permanent Meadow, conducted for more than twenty years in succession on the same land." Part ii., the Botanical Results. By Sir J. B. Lawes, Bart., F.R.S., Dr. J. H. Gilbert, F.R.S., and Dr. M. T. Masters, F.R.S. *Phil. Trans.*, Part iv., 1882. Pp. about 250.

[1] "Ammonia salts"—in all cases equal parts sulphate and muriate of ammonia of commerce.

been quite away from hedgerows, several species of Bromus might have accompanied *B. mollis*, while *Arrhenatherum avenaceum* and *Brachypodium sylvaticum* might also have been looked for. The total absence of Glyceria further shows the fairly dry character of the soil. Lastly, the 10 species of Leguminosæ fall under 5 genera—of Trifolium 4 species, Lotus and Vicia 2 each, Lathyrus and Ononis 1 each.

Ten species of grasses occur on all the plots: *Anthoxanthum odoratum, Alopecurus pratensis, Agrostis vulgaris, Holcus lanatus, Avena flavescens, Poa pratensis, Poa trivialis, Dactylis glomerata, Festuca ovina*, and *Lolium perenne*. *Festuca eliator* was only found in one plot, and *F. loliacea* in two. *Phleum pratense* occurred in about one-fourth the number of plots, *Aira cæspitosa* in about one-half, *Briza media, Cynosurus cristatus, Festuca pratensis*, and *Bromus mollis* in sixteen or seventeen. No leguminous plant occurred in all the plots, but *Lathyrus pratensis* was found in nineteen plots, *Trifolium repens* and *T. pratense* in seventeen, *Lotus corniculatus* in sixteen, and *T. minus, T. procumbens, L. major, Ononis arvensis, Vicia sepium*, and *V. Cracca* only in one each.

These details will serve to indicate the nature of the flora of the plots. Certain miscellaneous plants common on many old pastures in this country are conspicuous by their absence. The dry and level character of the meadow will account for the absence of Caltha and Juncus. No species of Geranium is recorded. But the most noteworthy fact appears to be the absence of certain scrophulariaceous genera, which are by no means uncommon on old grass lands, namely, Bartsia, Euphrasia, and Rhinanthus. The quality of the land is probably too good for the first two, and the application of manure would certainly be against Euphrasia, but *Rhinanthus Crista-galli* is very common on old meadows, as, for example, in Derbyshire and Worcestershire.

The object which the authors kept in view in writing this section of their report was, in their own words, "to show both the normal botanical composition of the herbage, and the changes induced by the application of the different manuring agents, and by variation in the climatal conditions of the different seasons; and, as far as may be, to ascertain what are the special characters of growth above ground or under ground, normal or induced, by virtue of which the various species have dominated, or have been dominated over, in the struggle which has ensued." At the outset it was noticed that those manures which are most effective with cereals grown on arable land were also most active in increasing the quantity of grass amongst the herbage, and that the manures which are most beneficial to beans or clover produced the greatest proportion of leguminous herbage. Thus, the highest gramineous produce resulted from a highly nitrogenous manure, such as ammonia salts or nitrate of soda, with alkaline salts, particularly potash; but side by side with the increase in the total gramineous herbage there was a decrease in the actual number of species of grass. On the other hand, the highest percentage of leguminous produce was the result of a mixed mineral manure with potash. The percentage results on the following plots illustrate these points:—

	Plot 7	Plots 3 and 12	Plot 11
Gramineæ ...	61·78	67·43	94·96
Leguminosæ ...	22·71	8·20	0·01
Other Orders...	15·51	24·37	5·03
	100·00	100·00	100·00

Plot 7 was the most favourably manured for leguminous produce, it received mixed mineral manure alone, including potash; plots 3 and 12 were the two unmanured ones; plot 11 was the most favourably manured for gramineous produce, it received 800 lbs. ammonia salts with mixed mineral manure, including potash.

Special observations and complete botanical separations made at intervals of five years to determine the influence of seasonal variations show that "a given quantity of the produce grown under the same conditions as to manuring might be composed very differently in two different seasons."

The influence due to the special medium through which a particular plant-food, such as nitrogen, is presented to the plant, is aptly illustrated in the following extract:—"Because a particular grass, or other plant, is little benefited by ammonia salts for instance, it does not follow that it will not be favoured by nitrates; nor, because if while growing in association with other species it may not be specially benefited by a particular manure, does it follow that it would not derive advantage from the same substance when growing separately."

Nearly all the plants on the plots are perennials, very few are annuals, *Bromis mollis* being the only case amongst the grasses. The advantage possessed by deep-rooting over surface-rooting plants was well brought out in the droughty season of 1870, when the latter suffered considerably from lack of moisture. The locomotive power of underground stems is of great use to some plants: "the stock continues to grow at one end, year after year, the opposite end gradually dying away. In the course of a few years the plant therefore occupies quite a different position from that which it at first had." Notwithstanding the general rule that the chief effect of nitrogenous manures is to favour the extension of foliage and give it depth of colour, while that of mineral manures is to encourage stem formation and the production of seed, and notwithstanding that excessive nitrogenous manuring prolongs the development of the vegetative organs till perhaps the resources of the plant are exhausted or the season is over, while excess of mineral manures may induce premature ripening, yet so far as the experiments have gone no absolute change in the distinctive form of any plant has been effected by the prolonged use of the different manures, though changes of degree are sometimes very marked, as in the tufts of *Dactylis glomerata*.

The battle for life between the various species of plants growing in the meadow is dependent much less on the chemical composition of the soil than on its physical character, its capacity for holding water and its permeability to roots. The immediate source of victory lies very generally in the powerful root-growth of the survivors, the term "root" here covering all kinds of underground stem. The various influences affecting the struggle for existence amongst meadow plants are discussed by the authors in a fascinating manner, and this part of the memoir is of special value to the botanical student.

Every plant occurring on the plots is dealt with individually, and in the case of each grass and leguminous plant and of the more commonly occurring weeds, a table showing the relative predominance is given. The fact that plants closely allied morphologically may yet differ widely in their physiological endowments is strikingly illustrated by the two species of Poa, *P. trivialis* and *P. pratensis*. These two plants, sprung at no very distant period from a common ancestor—for this, we presume, is the morphological significance of their being placed in the same genus—differ only in the most trivial points: *P. pratensis* is smooth, stoloniferous, and has a blunt ligule; *P. trivialis* is rough, has no stolons, and possesses a long pointed ligule. We read that "the stolon-bearing *Poa pratensis* is specially benefited by nitrogenous manure in the form of ammonia salts (in combination with mineral manure), but not at all by nitrate of soda, whereas the more finely-rooted and non-stoloniferous *Poa trivialis* has declined markedly on the ammonia plots, but has remained very prominent on the nitrate plots, especially where the larger amount of nitrate was used with the mixed mineral manure." Thus in 1872, on plot 9 (mineral manure and ammonia salts) *P. pratensis* gave 22·67 per cent. of the total produce, and *P. trivialis* only 0·64; on plot 14 (mineral manure and nitrate of soda) *P. trivialis* gave 24·76, and *P. pratensis* only 2·57 per cent. It is suggested that the relatively shallow-rooting *P. trivialis* predominates on the nitrate plots by reason of its fine surface-roots arresting and taking up the nitrate before it has had time to penetrate too deeply; this plant invariably makes rapid growth upon the application of the nitrate of soda in the spring.

The remaining portion of the memoir is devoted to a discussion of the botany of each separate plot in each season of complete botanical separation, and is carried out with the same elaborate detail as the earlier portion. No one can read this memoir without being impressed with the great power, too frequently overlooked, possessed by the subterranean members of the plant body in deciding the struggle for existence; much of the internecine warfare is carried on in the dark.

It is quite possible, and indeed probable, that, had a similar series of experiments been simultaneously carried out in another part of England with a slightly different climate, and on a different kind of soil, the results might have differed, but only in slight details. Such a splendid series of experiments on grass land has never before been consummated, and the memoir embodying the results will well repay the most careful study and perusal not only of the agriculturist, but of the botanist, the chemist, and the evolutionist. It may perhaps be long before the great lessons learnt in Rothamsted Park have filtered down to those to whom they should be of most practical value, but we do not despair of a time coming when the intelligent manuring of grass lands for very specific objects will form a part of ordinary agricultural practice. Those who will put their hands to the plough in the field of agricultural research must be content to trudge along, laboriously and unnoticed, in the furrow. Their discoveries cannot be made in a week, or a month, as are many in electricity or in chemistry, but, like those at Rothamsted, which are now in their twenty-eighth year, and are still going on, they can only be looked for, even after the expenditure of much thought and of unflagging industry and perseverance, as "the long result of time."

W. FREAM

PALÆOLITHIC MAN—HIS BEAD ORNAMENTS

EVERY one who has noticed the objects found in caves of Palæolithic date knows the evidence which supports the idea that cave men wore bracelets and necklaces, but the evidence that the older river-drift men wore similar ornaments is more obscure. Still, when one notices the extreme beauty and precision of make of some Palæolithic implements, one cannot help surmising that the more ancient savages of our old river sides also had sufficient personal pride and ideas of ornament to sometimes decorate their bodies with beads in a similar fashion with the cave dwellers.

Dr. Rigollot ("Mémoire sur des Instruments en Silex," p. 16) refers to the well-known foraminiferous fossil from the chalk—*Coscinopora globularis*, D'Orb. (sometimes found in river gravels with Palæolithic implements), as beads probably used by Palæolithic men; and Sir Charles Lyell ("Antiquity of Man," p. 119) says: "Dr. Rigollot's argument in favour of their having been used as necklaces and bracelets, appears to me a sound one. He says (Dr. Rigollot) he often found small groups of them in one place—just as if, when swept into the river's bed by a flood, the bond which united them together remained unbroken." Mr. James Wyatt of Bedford, in describing these bead-like fossils (*Geologist*, 1862, p. 234), says he had examined more than two hundred specimens, and on making sections of some of them he saw markings which appeared to indicate "drilling with a tool after the object was fossilised." In specimens from the chalk the hole through the fossil, though commonly straight, exhibits of course no artificial drilling but shows the structure of the foraminifer.

I am not aware of any confirmation hitherto made of the two curious observations noted above, but so little is at present known of the habits of river-drift men that the following notes may prove of some interest. Where there is so much darkness the slightest glimmer of new light is welcome.

After long searching for the Coscinopora at Bedford without result, I lighted on many examples at Kempston in 1880. In this year I found in a few days over two hundred examples; they occurred with unabraded implements and flakes and carbonised vegetable remains. After this date the Coscinopora again ceased, and from then till now I have met with but few examples. The finding of the above-mentioned large number of specimens all congregated together appeared to lend some confirmation to Dr. Rigollot's view, for it seems unreasonable to believe that so large a number could by any natural possibility find a position in one place in any river gravel.

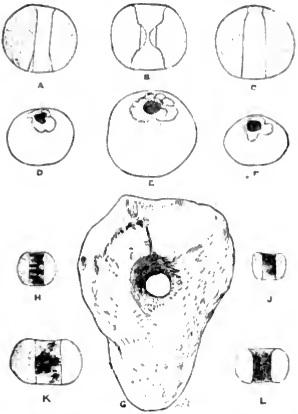
As my examples were found at Bedford, at a place where Mr. Wyatt must at one time also have found a considerable number, I naturally examined the specimens carefully to see if I could trace any artificial drilling or enlargement of the natural hole. I speedily noticed that the surface round each orifice in many of the beads was abraded as if by the constant contact of the bead next on a string. A few of the beads also had the hole artificially enlarged, sometimes at both ends, as at section A, sometimes in the middle, as at the section B, and sometimes at one end only, as at the section C. The dotted lines in these illustrations show the original natural orifice, the solid lines near the dotted ones show the enlargement by artificial drilling. The illustrations are all actual size. In most of the instances the drilling appears comparatively fresh, in others less so, but it must be remembered that the implements found with them were mostly unabraded, and vegetable remains were found. These specimens were found by myself. They were not touched or manipulated by the workmen. Other examples of these beads had one end near the orifice broken away as if in an attempt to enlarge the opening by breaking the substance of the fossil away as at D, E, F.

Whilst looking through the fallen material in the pit, the piece of naturally perforated fossil shell, illustrated actual size at G, attracted my attention. The hole is probably due to a shell-boring mollusk, but when I saw the object in the drift I distinctly noticed that a black substance entered at one side of the hole and emerged at the other; at the moment of picking the object up, this material fell to dust with part of the very friable surface of the fossil shell.

Some of the beads (as seen in section at H, J, K, L) also bore very distinct traces of a similar black substance within the orifice, although not seen till the sand and part of the black substance itself had fallen out. This black material I took to be the remains of part of the ligament on which the beads were originally strung by their Palæolithic owner, and with this idea in mind I sent some to an analytical chemist, who examined the material for me with the following result:—

"The testing for nitrogenous organic matters, of which animal tissues are composed, was tested in the same manner as testing water for such matter, that is, by converting it into ammonia; precautions were of course taken to eliminate from the results any ammonia already existing. The amount of ammonia was strikingly evident and showed with each bead examined separately. The blackening of the organic matter in the holes of the beads may have taken place in a manner similar to that of the formation of coal."

On testing the beads, which consist chiefly of carbonate of lime or chalk, without the black material in the orifice, the chemist reported that, "when treated in the same manner as those originally sent, they show the presence of a considerable amount of heterogeneous or animal organic matter, as was to be expected from their origin-- but not, I think, so much as those with the black deposit."



Palæolithic Bead Ornaments (*Coscinopora globularis*, D'Orb.), showing traces of the original ligament and artificial enlargement.

Mr. A. Clarke, analytical chemist of Huddersfield, who also made an analysis for me, reported as follows:—

"I divided the bead into three portions. No. 1. The thin dark crust forming the internal portion of the ring; this is most certainly organic matter. No. 2. A powdery part between No. 1 and the main body of the ring, consisting of small quantities of carbonates of iron and lime. No. 3. The outer main body of the ring, mostly carbonate of lime, and a small quantity of silica; here there is only a trace of organic matter, but it is most distinctly present."

WORTHINGTON G. SMITH

IS IKTIS IN CORNWALL, AND DID IRON AND COPPER PRECEDE TIN?

AT Penzance on October 19, 1883, I asserted that the invention of tin-smelting was Cornish, but disputed the claim of St. Michael's Mount to be the sole claimant to the title of Iktis, the tin-shipping port described by Diodorus Siculus 1800 years ago, and I thought the inventions of metals were in this order: (1) iron, (2) copper, (3) tin. We may consider the Romans invaded Britain purposely to obtain its metals, which were then worked extensively by the British inhabitants. I believe the Romans either adopted Celtic names of places or things, or translated their meaning. I find the Cornish district, or Land's End, described by Ptolemy the geographer in the second century as "Belerium," that is the land of mines, "bal" being Cornish for a mine. The word is also met with in Irish. In the same manner the skin boats used by the Cornishmen, which so much astonished the Greek travellers, were described by the Greeks under the name of "coracles," evidently a Celtic word from the Celtic root "cren" or "croen," skin. So tin, I think, is derived from the Irish word "teine," Welsh "tan," teine probably also expressing brightness. Even in the Malay Peninsula, in the East Indies, a word of similar sound, "timah," still stands for "tin," and not the Greek term for that metal "kassiteros."

Then the Cornish term "iarnn," for iron is similar to English "iron," German "Eisen," Welsh "haiarn," Greek "seiderion," in which *ei* is the important syllable. The Latin word "ferrum" is probably a form of "ierrum," and the Sanskrit "ayas" is for iron, metal. Nearly the same word for iron is therefore used in all the Aryan languages, while "æs" or "kalkos" stands for bronze or copper, and has only a comparatively local extension. The wide spread of the name for iron, or *ei*, is important, as it points to iron being the metal made before the division of the Aryan race, and therefore before copper or tin.

There is another and I believe new argument. The most easy process of copper-smelting, which even now is largely used, may have been the only plan known in prehistoric times. To use this process it was necessary to provide iron to precipitate copper from solution. At the present time 6000 tons of iron are sent annually to the Rio Tinto mines in Spain from Great Britain in order to precipitate the copper from solution.

It is possible that the discovery of the art of producing crude iron, which would be useful for precipitating copper, may have preceded the invention of bronze, and yet the art of forging difficult pieces may have been a later invention than that of casting bronze celts in metal moulds.

Iron, if not steel, appears to have been made in Egypt both in hearths and in crucibles certainly before 3124 B.C., but bronze was more used in Greece up to 650 B.C. than iron.

The smith in the sagas and folklore is the important person, not the caster or founder of bronze weapons. Why was the smith so important? Because he melted the small particles of gold found in the streams into small lumps, and with his hammer drew them out into wire and thin plates. Gold was made in such small quantities that it did not require large crucibles such as would be necessary for bronze. As iron was made by a simple welding or forging process, its production appears to be a more ancient art than bronze casting, which required large crucibles and mixing in exact proportions with tin, a process more difficult than in the infancy of metallurgy was likely to be invented. Then one ore of iron, ochre was the first metallic ore collected, long before the discovery of any of the metal. Ochre is found collected for use as a paint to ornament the cave men in the Palæolithic period, and is associated with limestone and charcoal. Accident in the fire might have thus led to the discovery of metallic iron in very early times. Such particles of iron placed in a certain stream in the Island of Anglesea (an early peopled district) would precipitate the copper in solution in that stream in a state of pure copper ready to mix with tin to make bronze.

Another point of great interest in this question is the position of Roman roads, proving a prior metallurgical trade, and therefore some considerable civilisation. The Romans erected their Roman villas and camps always near Roman roads, and these roads appear always arranged for military or metallurgical purposes, never for protecting agriculture, or levying imposts on the Britons. There is historical evidence that the Romans did not introduce metallurgy into Britain.

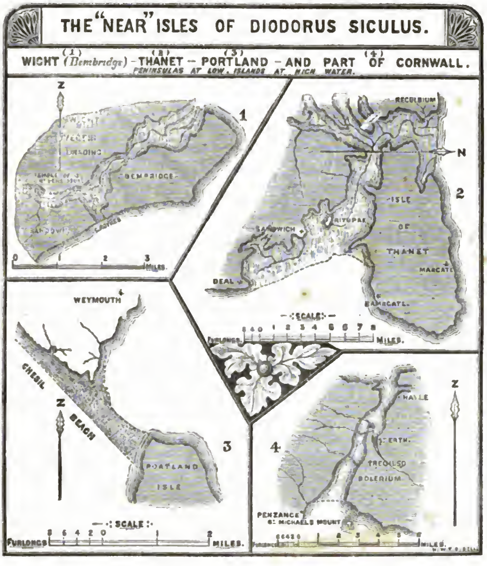
We may observe there is a great concentration of Roman roads at Winchester (Venta Belgarum). Roads meet at the point of junction from Exeter with this town, for bringing Cornish or Dartmoor tin, or lead and iron from the Mendips, to the Hampshire coast; iron from

South Wales, and lead from North Wales. There were, near Winchester, several great ports for Continental trade, viz. Magnus Portus (Portsmouth), Trisantonis and Clausentum (Southampton). Winchester is near Beaulieu. Below Beaulieu, six miles, is Stansoar (stone) Point, from "stannum," tin. This is nearly opposite Gurnard's Bay (Gubernators, across the Solent two miles), where there are remains of Roman villas. Thence to Newport and Brading, where the great Roman discoveries have been recently made. Among the "Islands of Britain" Ptolemy gives one as "Vectis," in Celtic Wyth.

Now Vectis has been hitherto treated as if it were only the name of an island, the Isle of Wight; but vectis is really the Latin term for a bolt, or security, and was probably applied to harbours, and is a translation of "Gwyth." A lock means also a canal lock.

If Prof. Rhys is right,[1] that "Ictis" and "Itius" are the same word, we may go further and say that the Portus Itius, from which Cæsar started from Britain, containing his 800 ships, was merely a technical term for a vectis or secure harbour attached to a town, such as that at the mouth of the Liane (Boulogne). It is only a century and a half since the natural basin of Boulogne has been partly filled up by the sea sand, and there was an estuary supplied by the Liane stream at the time of Cæsar, not unlike those drawn by me in shape, but without a through passage.

In fact, not only along the English coast, where



Dungeness Beach has blocked up the Roman Port Lymne, and the points where four islands have been joined to the mainland, as shown in the drawings, Figs. 1, 2, 3, and 4, but on the French coast great changes have been made by the same causes. At Sangatte and Calais, Wissant, Ambleteuse, Boulogne, St. Michael's Mount, and in fact at many places along the coast of the Pays Bas, the same filling up can be observed.

Cæsar's port of embarkation, Portus Itius, may have been named in the same sense as, according to Prof. Rhys, the old Irish wrote of the English Channel, viz. as Muir an Icht, which he renders the Sea of Icht, and which, according to the view I suggested, would be the sea of the passage, evidently a different meaning, although from the same roots, to the name, which, with the addition of Portus, we find in Cæsar. The term Portus Itius evidently was applied by the Roman writers to the harbour of Boulogne, although the city itself was called Gessoriacum. I think this philological explanation and the fact of the distance from Portus Itius (given by Strabo) thirty miles to Britain, removes every difficulty in the way of settling the position of the port from which Cæsar started. Of course the term Portus Itius might also apply to St. Valery-sur-Somme, where a passage has been partly closed, as at Marazion, in the historical period, but the distance given by Strabo is against it. Species of mollusks are found at both places, Marazion and St. Valery, not now living on the coast, and probably

[1] In a letter to A. Tylor, November 6, 1883.

these estuaries or passages were only entirely open in the Crag period.

I have said Vectis is equivalent with the Celtic word "gwyth," a passage. Now there is a closed passage or haven (a gwyth, or vectis, or iktis) from Sandown to Bembridge in the Isle of Wight (Fig. 1). From this passage the whole island gets its name "Gwyth" in Celtic, Latin "Vectis," Saxon "Wiht," English "Wight," never spelt "White," although it has white chalk cliffs.

The safety of any of the harbours called Vectis or Iktis arose from the fact of these islands (or parts of them) near the coast of Britain being peninsulas at low water and islands at high water. These were, therefore, typical natural harbours. The Greek writers, Diodorus Siculus and others, insist particularly upon this property of change with the tide. The remarkable tide contrasted strongly with the different circumstances in the Mediterranean. Now the prevailing winds on the south coast of England have caused modern beaches to form, particularly at all of these four passages on the south coast of England, and many of the passages have been closed, as we know, in the historical epoch. Their ancient form is clearly shown in my woodcut. Now the sea is entirely shut out by modern beaches and works.

The drawings show the changes which have occurred in Fig. 1, the Isle of Wight. Fig. 2 is the passage between the Isle of Thanet and Kent, closed in the historical period between Ritupæ and Regulhium. In Fig. 3, the Chesil Bank, has filled up the old waterway between the Isle of Portland and the mainland. Fig. 4, passage from St. Michael's Mount to Hayle. Gravel and stream tin-drift, closing up the ancient passage from near St. Michael's Mount at Marazion to Hayle.

The type of all that has happened is well seen, Fig. 1, Vectis, the Isle of Wight. Even in 1670 there was only a groyne and a small alluvial deposit near Sandown. Nearly all the passage to Bembridge was an estuary; now it is nearly all dry land.

The term "vectis" in Latin, or "iktis" in Greek, was no doubt applied to all the passages in these four islands.

The Cornish tin no doubt came in coracles, and by land on horses, to Magnus Portus or to Stansoar Point for shipment to Brading, and was shipped from these Hampshire ports and Isle of Wight ports to the banks of the Seine, to be carried on horseback in thirty days to Marseilles. Thus both the Bembridge peninsula and St. Michael's Mount were shipping places for tin, and both were properly called Iktis and Vectis, and as usual we find there was no error in the Greek observations.

Then as to the period when the contour lines of the south coast began to change. The Crag period was that in which the great estuaries round the British coast began to be filled up. Then pebbles and sand were driven along the coast. I believe all the four channels in the drawing, were open in the Crag period, and gradually closed up in the long period which intervened between the Crag and the present time. The continuous filling up has also occurred in the estuaries and passages on the opposite coast of the English Channel. It is probable that Portus Itius, at Gessoriacum? (Boulogne) obtained its name in a similar manner to Vectis and Iktis as I have already stated.

We find pure iron B.C. 3124 in Egypt. If iron was a necessity for the production of copper, and the metal tin was of no use without copper, we may place the inventions of the metals in the following order: (1) iron, (2) copper, (3) tin.

A. TYLOR

THE BEN NEVIS OBSERVATORY

SINCE the formal opening of the Observatory on October 17, workmen have been engaged in fitting up and finishing the interior, and pushing forward the provisioning of the establishment with tinned meats, biscuits, tea, coffee, &c., capable of lasting for six months, with fuel for a like period. Nothing that could be thought of has been left undone to render the observers as comfortable as possible during the winter. The telegraph cable is now in working order from the Observatory to Fort William, so that communication is always possible with the outer world. Mr. Omond, the superintendent, and his two assistants took up their residence on the top of the Ben about a fortnight ago; and it is extremely gratifying to learn that the building, every part of which during erection, and for some time after being roofed over, was soaked with water, is now thoroughly dry; the walls, roof, and windows have been officially inspected, and found to be perfectly tight in every respect; and in corroboration of this, during the storm of Thursday, the 8th inst., none of the finer snow particles of that elevated region entered the dwelling. As an additional protection against the severe weather which may happen, a large roll of tarpaulin, thirty-five feet long, was carried on the shoulders of twelve men to the top on Monday last week, and securely fixed over the roof of the building.

In a letter dated the 14th inst., Mr. Omond states that the Sunday previous was one of the finest days he ever saw; that Monday and Tuesday were nearly as good; and that on the Wednesday only the distant view was shut out by haze. Up to that date the top of the Ben had been all but free from stormy weather; indeed, while tempestuous weather raged below, the wind rose to a gale only on Thursday the 8th. A telegram was received direct from the Observatory on Thursday last week, which stated that the temperature for the day had been minimum 17° and maximum 28°, while inside the Observatory the temperature was 55°, which happened to be exactly the temperature of the Scottish Meteorological Society's office in George Street at the time.

A meeting of the directors was held at Edinburgh on the 15th inst., Sir William Thomson in the chair, at which Dr. Sanderson, the Treasurer, reported that the subscriptions now intimated amounted to a little over 5000*l*., nearly three-fourths of which sum had been subscribed since the middle of May last.

A scheme of work for the coming winter, consisting of hourly observations by night as well as by day, was agreed upon. The observations include the barometer; dry, wet, maximum, and minimum thermometers; direction and force of the wind; rain, sleet, snow, and hail; evaporation from snow; species, direction, and velocity of upper and lower cloud strata; and sunshine, together with thunder, lightning, halos, auroras, meteors, &c. In addition to the regular observations, Mr. Omond is to conduct physical inquiries into the hygrometry of this boreal climate by an instrument specially designed by Prof. Chrystal; inquiries as to the direction and speed of the wind and optical phenomena by instruments specially designed by Prof. Tait; and inquiries as to the best modes of conducting the observations under the special difficulties presented by the climate of Ben Nevis.

All the hourly observations will be extended on a daily sheet, three copies of which will be made, one for the Observatory, and two for the Scottish Meteorological Society, one of which will be sent to the Scottish Meteorological Council, London. Forms have also been supplied for monthly summaries of the observations. It has further been arranged that a series of similar observations at 8 and 9 a.m. and 2, 6, 9, and 10 p.m. be made at Fort William by Mr. Colin Livingstone, one of the Scottish Meteorological Society's observers.

A Redier's continuously-recording barograph and a Richard's continuously-recording thermograph have been supplied to the Observatory, and also to Mr. Livingstone, to be used as interpellation instruments. By the double set of hourly observations thus obtained, comparisons may be made between the atmospheric conditions on the top of the Ben and those at sea-level, which are of such vital importance in the larger questions of meteorology. It may be noted here that it was found necessary to take the barometer, which had been for upwards of two years exposed in the cairn to the severe weather of the Ben, to Edinburgh to be thoroughly overhauled. It has since been conveyed to its permanent place in the Observatory, and is in excellent order. The full equipment of the Observatory is delayed till next summer, when the directors will have before them Mr. Buchan's report on the instruments in use at the different European meteorological observatories he visited in the autumn, the work of the Observatory during the next eight months, and the results of Mr. Omond's investigations into different methods of observing on Ben Nevis.

NOTES

WE deeply regret to announce the death of Sir William Siemens on Monday night, at the age of sixty years. His death is attributed to rupture of the heart, the result of a fall which he sustained a fortnight since. We must defer to next week a detailed notice of Sir William's career and work.

IT is proposed to acquire for the Cambridge Museum of Comparative Anatomy the beautiful collection illustrating the fauna of the Bay of Naples, which Dr. Dohrn exhibited at the International Fisheries Exhibition. The cost will be only 80*l.*, little over that of the glass jars and the alcohol in which the animals are preserved.

LIEUT. WISSMANN, the African traveller, has just left Hamburg again on another three years' exploration in the Congo region. He has undertaken to furnish the Royal Museum at Berlin with all the natural history specimens which he may collect during his travels, and has even been prevailed upon by some anthropologists to take plaster casts of all the races he may come in contact with.

THE widow of the late Mr. John Elder, of Glasgow, has given the munificent sum of 12,500*l.* to the University of Glasgow for the purpose of endowing a chair of naval architecture.

WE regret to learn of the death of Mr. James Stewart, C.E., who has done so much for the exploration of the region around Lake Nyassa. At the time of his death he was engaged in the formation of a road between Lakes Nyassa and Tanganyika.

DR. HECTOR, F.R.S., stated at a recent meeting of the Wellington (N.Z.) Philosophical Society, that his two self-registering barometers had shown a remarkable up and down vibration on the revolving drum upon which the record is marked on dates corresponding with those of the Sunda earthquake, and a severe earthquake twenty-six hours afterwards, which was felt all along the northern coast of Australia. This agitation was quite distinct from those caused by ordinary atmospheric influences. He attributed the curious tidal disturbances which occurred on the New Zealand coast in August to those earthquakes.

IN a letter from Maranhao, Brazil, the writer states that from August 31 up to September 6, the sun, until 7 a.m., could be looked at without the least difficulty, its light being as soft and pale as the moon's.

AT its meeting, October 27, *Science* states, the Philosophical Society of Washington listened to a communication by Dr. T. N. Gill on the ichthyological results of the voyage of the *Albatross*, and to one by Prof. A. Graham Bell on fallacies concerning the deaf. Dr. Gill described two anomalous fishes, one of which required the institution of a new order.

HERR JACOBSON, who has spent four years on the north-west coast of America in making ethnological collections for the Berlin Museum, has recently returned, and will sail for Europe. Dr. Leonhard Stejneger has arrived in San Francisco, *en route* for Washington. He has spent a year in Behring Island in the study of its fauna, and in collecting remains of the extinct Arctic sea-cow.

AT the recent meeting of the American Association, Mr. C. V. Riley read a paper on "Some recent discoveries in reference to Phylloxera." Every new fact, he said, in the life-history of the insects of this genus has an exceptional interest, because of its bearing on the destructive grape-vine Phylloxera. The genus is most largely represented in this country by a number of gall-making species on our different hickories, and the full annual life-cycle of none of them has hitherto been traced. The galls are produced, for the most part, in early spring; the winged females issue therefrom in early summer; and thence forth, for the remainder of the year, the whereabouts of the insect has been a mystery. The author has for several years endeavoured to solve this mystery, and at last the stem-mother (the founder of the gall), the winged agamic females (issue of the stem-mother), the eggs (of two sizes) from these winged females, the sexed individuals from these eggs, and the single impregnated egg from the true female, have been traced in several species. There is some evidence, though not yet absolutely conclusive, that this impregnated egg hatches exceptionally the same season; also, of a summer root-inhabiting life. In *Phylloxera spinosa*, which forms a large roseate somewhat spinous gall on *Carya alba*, and which has been most closely studied, the impregnated egg is laid in all sorts of crevices upon the twigs and bark and in the old galls, in which last case they fall to the ground. Up to this time they have remained unhatched, and will in all probability not hatch till next spring, thus corresponding to the "winter egg" of the grape Phylloxera.

THE *Times* Calcutta Correspondent, in speaking of the possibility of opening up Thibet to Indian trade by way of Darjeeling, states that the Prime Minister of the Lama at Shigatze, said to be a most intelligent man, sent recently to Darjeeling for a supply of English books, photographic and other scientific apparatus.

THE piercing of the Arlberg Tunnel was unexpectedly completed on Tuesday afternoon last week. In length the new tunnel ranks third among the great tunnels of the world, its length being 10,270 metres, while the Mont Cenis Tunnel is 12,323, and the St. Gothard 14,900 metres. But while the excavation of the first lasted no less than fourteen years and a half, and that of the second about eight, the Arlberg Tunnel will have taken, when vaulted and ready to receive the first locomotive, not more than four years, thanks to the experience acquired during the construction of the first two Alpine tunnels, and to some innovations which constitute another important step in the art of engineering required for the construction of large tunnels. The engineers of the St. Gothard Tunnel introduced dynamite for blowing up the rock, already pierced through by the boring machine, which useful tool was naturally not disregarded in the construction of the new tunnel. It was also only natural that the Ferroux percussion boring machine, first introduced at the Mont Cenis works, should be again employed, under the supervision of the inventor himself, who in the meantime had considerably improved his powerful boring instrument; but this time the Brandt turning borer, first employed at the works of the St. Gothard, was allowed to compete with the Ferroux percussion borer, the former being used in boring on the tunnel's western side, and the latter on the eastern. To this end, several streams from the heights of the snow-covered Arlberg were gathered on the eastern side into reservoirs, from which two turbines and three water columns were directed to the machines, which compressed the air to five atmospheres, with which the Ferroux borer was worked; while on the western side pumped water was pressed through pipes to the tension of over a hundred atmospheres, to work the Brandt turning borer, which cuts cylindrical blocks of rock from the mountain. The eastern entrance to the Arlberg Tunnel—namely, St. Anton—is 1300 metres above the level of the sea, while the western entrance is only 1215 metres, by which difference a good ventilation of the future railway tunnel seems secured. The vaulting and all other necessary works will be finished at the latest on August 1, 1884.

A MEETING has been held at Chester, presided over by the Duke of Westminster, to take steps to provide the city with a museum, which is intended to be a centre of scientific information for Cheshire and North Wales. North Wales was represented at the meeting by the Duchess of Westminster, Earl Grosvenor, and Sir Robert Cunliffe, Bart.; the Chester Natural Science Society by its president, Prof. T. McKenny Hughes; and the Chester Archæological Society by Dean Howson and Mr. H. Tollemache, M.P. It was decided that the building should accommodate both these societies and the School of Art. The Duke of Westminster announced his intention of giving the greater part of the proposed site, and 4000*l.* towards the building fund.

THE Council of the New University College of South Wales, at Cardiff, have resolved to try to raise 3000*l.* for mechanical laboratories.

THE inaugural meeting of the International Electrical Association took place in Paris on the 15th in the large hall of the Société d'Encouragement. M. Cochery was voted by acclamation Honorary President, and M. Berger Acting President. The number of adhesions exceeds 1000.

THE following is an illustration of what private enterprise may effect for the benefit of science. When the Swedish ship *Monark* was leaving Sweden last year for Australia the second officer on board applied to the Zoological Museum at Upsala for the loan of a trawl and some vessels for preserving natural history objects. The results have been a collection of some 120 species of fish, 50 of insects, some birds, and about 100 varieties of the lower sea fauna of the Pacific, which have now arrived at Upsala.

ON November 2 the Imperial Russian Academy of Science celebrated its hundredth year with great ceremony. Count Tolstoy, the President and Minister of the Interior, acted as chairman.

MR. GAMEL of Copenhagen has placed the *Dijmphna* at the disposal of Lieut. Hovgaard for an Arctic expedition next year.

AT the Royal Institution Prof. Dewar will give six lectures at Christmas (adapted to a juvenile auditory) on "Alchemy in Relation to Modern Science." Before Easter, 1884, courses of lectures will be given by Mr. R. Stuart Poole, Professors McKendrick, Pauer, Tyndall, and Henry Morley, Capt. Abney, and others. The programme of the Friday evening arrangements will be issued shortly.

A SLIGHT shock of earthquake was felt on Friday at Malaga. A shock was also felt at Chios on the 16th. An earthquake occurred on the 19th at Vallo della Lucernia in the province of Salerno, Italy.

THE additions to the Zoological Society's Gardens during the past week include an Ourang-outang (*Simia satyra* ♂) from Borneo, presented by Mr. William Cross; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mrs. F. R. Flindell; a Hobby (*Falco subbuteo*), captured at sea, presented by Mr. C. Heat; six American Box Tortoises (*Terrapene carinata*), a Stink-pot Terrapin (*Aromochelys odorata*), seven Spotted Lizards (*Holbrookia maculata*), a Long-nosed Snake (*Heterodon nasicus*), two Striped Snakes (*Tropidonotus sirtalis*) from North America, presented by Mr. Samuel Garman, C.M.Z.S.; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, a Cerastes Viper (*Vipera cerastes*) from Egypt, deposited; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, a Negro Tamarin (*Midas ursulus*) from Guiana, an Indian Badger (*Arctonyx collaris*) from Assam, two Père David's Deer (*Cervus davidianus*) from Northern China, a Downy Owl (*Pulsatrix torquata*) from South America, purchased; a Sambur Deer (*Cervus aristotelis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

BRORSEN'S COMET.—Of the known comets of short period, two will arrive at perihelion in 1884, viz. D'Arrest's on January 13, and Brorsen's about September. The former has been sought after for several months, but hitherto, so far as we are aware, without success, and there now seems a probability that (as indeed was rather to have been anticipated) it will pass unobserved at this return. The second comet was discovered by Brorsen, an amateur at Kiel, on February 26, 1846, and ten days' observations sufficed to show that its period of revolution was about five and a half years: it afforded one of the most striking instances of a close approximation to the period being deduced from a short course of observation, Mr. Hind having inferred a revolution of 5·519 years from observations between February 28 and March 10 (*Astron. Nach.*, No. 557), while the exact period at the time is now known to have been 5·568 years. The comet has been since observed at its returns in 1857, 1868, 1873, and 1879, though missed in 1851 (perhaps through some confusion as to the date of perihelion passage), and again in 1863. The ephemeris for the last appearance in 1879 was prepared by Prof. L. R. Schulze of Dobeln, after the calculation of planetary perturbations since the return in 1873, the perihelion passage being fixed to March 30·0771 Greenwich M.T. The computed positions differed considerably from those observed, as was shown in M. Otto Struve's comparison with his own observations (*Bulletin de l'Académie des Sciences de St. Petersbourg*, t. v.), and these differences led him to remark:—"Eine Änderung in der angenommenen Perihelzeit würde für sich allein wahrscheinlich nicht genügen." It will be found, however, at the end of April or beginning of May. The errors may be removed by the assumption of a later time of perihelion passage; or by taking it March 30·5418 Greenwich M.T., a difference of + 0·4674d. from the computed epoch. Thus for the observation on April 30, we find, taking the differences in the order (c – o):—

	$\Delta\alpha$	$\Delta\delta$
By ephemeris	+ 1m. 38s. ...	+ 43′·8
With corrected perihelion	– 0m. 6s. ...	+ 0′·2

The mean sidereal motion determined by Dr. Schulze for 1879 would, without perturbation, bring the comet to perihelion again about 1884, Sept. 14·5, at which time it would be situate in about right ascension 154° with 14° north declination, distant from the earth 1·41, consequently rising more than two hours before the sun. The conditions are therefore likely to approach those under which the comet was observed in 1873.

Some six months after the discovery of this comet in 1846 attention was directed by Mr. Hind (*Astron. Nach.*, No. 582, and in a note to the Royal Astronomical Society) to the near approach which it must have made to the planet Jupiter in May, 1842, a first calculation indicating that on May 20 the distance between the two bodies was less than 0·05 of the earth's mean distance from the sun. This point was more closely examined by D'Arrest from improved elements in 1857 (*Astron. Nach.*, No. 1087); he found that the closest proximity occurred May 20·6924 Berlin M.T., when the comet was distant from the planet only 0·05112, and, carrying his computation backwards to the time when the comet entered the sphere of activity of Jupiter, he assigned approximately its elements previous to that time. A more elaborate investigation of the circumstances attending this near approach has been lately made by Dr. Harzer, in an inaugural dissertation published at Leipzig in 1848; he finds for the time of perijove passage, 1842, May 27·2849 Berlin M.T., and for the distance 0·05471; the elements prior to the great perturbation in this year are determined, and have been already transcribed in NATURE; they present a resemblance to those of the first comet which appeared in 1798, about which year Brorsen's comet might have been in perihelion; Dr. Harzer nevertheless expresses the opinion that, although Messier's observations of the comet of 1798 might be open to some degree of uncertainty, it is doubtful whether they would admit of being represented by an elliptical orbit with a short period. He had found the revolution prior to 1842 to be 5·170 years.

THE NAUTICAL ALMANAC.—The volume of this ephemeris for 1887 has been published during the past week, the contents being generally the same as in previous years. The track of the total solar eclipse of August 19 is given in detail for the greater part of the course, and the maximum duration of totality is found to be 3m. 50s., the central eclipse with the sun on the meridian falling in longitude 102° 0′ E. and latitude 53° 47′ N. The Greenwich list includes four occultations of *Aldebaran* during the year and one of *Regulus*.

The average annual sale of the *Nautical Almanac* during the last five years has exceeded 15,500, though many maritime nations have now their nautical ephemeris.

THE PHILOSOPHICAL SOCIETY OF GLASGOW

THE *Proceedings* for 1882-83, pp. 592, 23 plates, and 3 maps, have just been issued, and contain the following papers:—On insensibility arising from a deficiency of oxygen in the air, by Dr. Wallace, president; on technical education, by David Sandeman and E. M. Dixon, B.Sc.; on the decay of building stones, by Dr. Wallace; on some new infusoria, by William Milne, M.A.; note on Lippmann's capillary electrometer, by Dr. McKendrick; on milk and milk pollution, by Dr. John Dougall; on Struther's process for pulverising diamondiferous ore, by Wallace Fairweather, C.E.; on the use of litmus, methyl orange, phenacetolin, and phenolphthalein as indicators, by R. S. Thomson; on approximative photometric measurements of sun, moon, cloudy sky, and electric and other artificial lights, by Sir William Thomson; on the preservation of food by cold, by J. J. Coleman; on the clauses in the Glasgow Police Bill having reference to the prevention and mitigation of disease, by Dr. Ebenezer Duncan; on the ships and shipping trade of Great Britain, by N. Dunlop; on the iron ore industry of the north of Spain, by J. J. Jenkins; on the use of rosolic acid as an indicator, with additional notes on phenolphthalein and methyl orange, by R. S. Thomson; on architecture in Glasgow, by J. Sellars, jun., I.A.; on the water highways of the interior of Africa, with notes on slave hunting and the means of its suppression, by James Stevenson, F.R.G.S.; on a new seismograph, by Thomas Gray, B.Sc.; on the fertilisation of flowers, by Rev. A. S. Wilson, M.A.; on algin, a substance obtained from some of the commoner species of marine algæ, by E. C. C. Stanford; on chemical industries, by R. R. Tatlock; on nitroglycerine, dynamite, and blasting gelatine, by George McRoberts, manager of the Works of Nobel's Explosives Company; on the action of heat and the chlorides of phosphorus upon the water salts of hypophosphorus, phosphorus, and phosphoric acids, by Dr. Otto Richter; on a volumetric process for the estimation of cobalt and nickel, by Dr. John Clark; and, on the development and generic relations of the corals of the carboniferous system of Scotland, by James Thomson, F.G.S.

The society has at present 19 honorary, 10 corresponding, and nearly 700 ordinary members, and is about to enter on its eighty-first session. In addition to the ordinary meetings of the society, held fortnightly, there are sections for architecture, biology, chemistry, sanitary science and social economics, and geography and ethnology.

RESEARCHES ON SPARK SPECTRA

The Disappearance of Short Lines

IT was shown in a former Report of this Committee (Southampton meeting) that the spectra of metallic solutions were the same as those from metallic electrodes line for line, even short and weak lines being reproduced. The principal difference observable in the two spectra was a lengthening of the short lines when spectra were taken from solutions, so that discontinuous lines became long or continuous lines. A few instances of short lines disappearing have also been noticed, but such disappearances occur only when the lines are so short, mere dots, in fact, that no solution can contain a quantity of the metal sufficient to yield an image of them. Certain very short lines in the spectrum of metallic zinc are an example of this. Very short lines in the spectrum of aluminium were not reproduced by solutions of the chlorides except when the solutions were very strong, and then they always appeared. It may thus be seen that the quantity of metal present in the compound determines the presence of these lines.

The Lengthening of Short Lines.—It was remarked that in certain cases metallic electrodes showed a different spectrum according to whether the spark was passed between dry or wet electrodes. Thus it was pointed out that when iridium electrodes are moistened with calcic chloride, discontinuous lines which are very numerous in this spectrum become continuous; and on further examination into this matter it has been found that even moistening with water has the same effect. Hence the supposition, of which there seemed some possibility but no proof, that a chloride of the metal was formed is found to be untenable. The very short lines in the spectrum of zinc were lengthened by the action of water upon the electrodes. It has now been proved beyond doubt that this peculiar variation in the spectra is caused by the cooling action of the water upon the negative electrode, which in effect is the same as a strengthening of the spark, since by heating the electrodes a reverse action is the result.

Alterations in the Spectrum of Carbon.—As already stated in the previous Reports, graphite electrodes have been generally employed for the production of spark spectra from solutions. A portion of the work in connection with this subject included an investigation of the effect of water and of saline solutions in varying the spectrum of carbon. It will of course be readily understood that as carbon is capable of combining with oxygen and nitrogen, that different spectra might be obtained by making one or other of these gases the atmosphere surrounding the electrodes, but it is not so easy to explain why graphite points should give two different spectra in air when dry, and a third spectrum, again different, when moist, the same spark conditions being maintained.

Three such spectra have been photographed, but without the aid of maps their peculiarities are not capable of exact description. The maps which were drawn were presented to the Royal Society, together with a communication on this subject, three months since, so that they are not at present available. It may be said, however, that the difference between the two spectra taken from dry electrodes in air consists of the omission of a certain number of the less refrangible lines, which lines have undoubtedly been identified with carbon.

Spectra of the Non Metallic Constituents of Salts.—A long series of experiments has been made with the object of determining the non-metallic elements which are capable of yielding spark spectra when in combination with the metals. Fluorides, chlorides, bromides, iodides, sulphides, nitrates, sulphates, selenates, phosphates, carbonates, and cyanides yield nothing. On the other hand, hydrochloric acid solutions of arsenites and antimoniates yield the spectra of arsenic and antimony. Borates and silicates in solution yield very characteristic spectra of the non-metallic constituents, but if the solutions be prepared from sodium salts the lines of the metal do not appear in the case of borates, and only the strongest sodium line ($\lambda = 3301$) can be observed in the spectra of silicates, even when concentrated solutions are used.

Line Spectra

BORON Wave-lengths	SILICON Wave lengths
3450·1	2881·0
2497·0	2631·4
2496·2	2541·0
	2528·1
	2523·5
	2518·5
	2515·5
	2513·7
	2506·3
	2435·5

These are the first spectra of boron and silicon obtained from metallic salts.

[1] Report of the Committee on the Comparison of the Spark Spectra of the Elements with Spectra of Solutions of their Compounds, drawn up by Prof. W. N. Hartley.

In Messrs. Liveing and Dewar's map of the carbon spectrum (*Proc. Roy. Soc.* vol. xxxiii. p. 403), and in the list of the carbon lines and in the map of the iron spectrum (*Phil. Trans.* part 1, 1883), a number of lines are given which are absent from the photographs of the spectrum of graphite published in the *Transactions of the Royal Dublin Society* and in the *Journal of the Chemical Society* (vol. xli. p. 90). Many hundreds of spectra taken between graphite poles have failed to show a trace of these lines, and as the spectra have been photographed under very various conditions, it is scarcely likely that the lines in question are really carbon lines. They have now been identified in the spectrum of silicon.

Liveing and Dewar's carbon lines				Silicon lines (Hartley)
Spark [1]		Arc [2]		
—	...	2881·1	..	2881·0
2541·0	...	—	...	2541·0
2528·2	...	2528·1	...	2528·1
2523·6	...	2523·9	...	2523·5
2518·7	...	2518·8	...	2518·5
2515·8	...	2515·8	...	2515·5
2514·0	...	2514·1	...	2513·7
2506·3	...	2506·6	...	2506·3
		2478·3	...	—
		2434·8	...	2435·5

From this it appears that, in the spectrum of the arc, carbon yields but one line in the ultra-violet, wave-length 2478·3. It is perhaps a little doubtful whether the line with wave-length 2434·8 is due to silicon or not.

The Spectrum of Beryllium.—The researches made for the purpose of this report have been useful in furnishing evidence leading to a determination of the probable position of beryllium among the elements. It has been proved that the spectra of metallic solutions are identical with those of the metals themselves, and it is therefore obvious that characteristic spectra may be obtained from concentrated solutions of nitrates or chlorides when metallic electrodes are not procurable.

It was resolved to photograph the spectrum of beryllium, as obtained from its chloride, in order to observe the character of its lines and the manner of their grouping. The following were the lines observed :—

Spectrum of Beryllium

Wave-length		Description
3320·1	... ...	Strong, sharp.
3129·9	... ...	Very strong, extended.
2649·4	... ...	Strong, sharp.
2493·2	... ...	,, ,,
2477·7	... ...	,, ,,

The first two numbers differ slightly from those given in the *Journal of the Chemical Society* (June, 1883), but they are believed to be the more accurate. The previous measurements of the lines of beryllium were two given by Thalén (Watts's "Index of Spectra"), with wave-lengths 4487 and 4575, and two lines very close together given in Cornu's "Map of the Solar Spectrum," wave lengths 3130 and 3130·4. It will be observed that in the spark spectrum only one line corresponding to the first of these is observed, viz. 3129·9. There is probably a difference in this case between the arc and the spark spectra, because there is no difficulty in distinguishing between two lines differing by 0·4 of a tenth-metre, and under various conditions two lines have never been observed at this point in the spark spectrum. On the other hand, such differences are by no means unusual.

Regarding the views held by Emerson Reynolds, Nilson and Pettersson, and Brauner on the subject of beryllium, however wanting in harmony they may be in detail, they at least agree in assigning a value not greater than 13·8 and not less than 9·2 to its atomic weight. The former number implies that the metal is a triad, the latter that it is a dyad. In the former case it must belong either to the series of elements of which aluminium, gallium, and indium are members, or to a sub group of rare earth-metals, to which yttrium and scandium belong. In attempting to accommodate the element with a position in either series we are met by a serious difficulty, namely, that not only is the atomic weight out of keeping with the periodic law (a point which cannot be discussed here), but its spectrum is altogether different from the spectra typical of either class.

There is a periodic variation in the spectra of the elements as well as in their atomic weights and chemical properties, and we cannot put the periodic law out of mind in considering the position of beryllium.

[1] *Proc. Roy. Soc.* [2] *Phil. Trans.*

Now the spectra typical of the triad group, of which aluminium and indium are the first and third terms, consist of three pairs of lines harmonically related, the intervals between the individuals of each pair increasing with increased refrangibility of the rays in each spectrum, while the intervals between the individuals in each pair in different spectra increase with the increase of atomic weight. The interval between each pair of lines contains an isolated ray. As the atomic weight of beryllium is less than that of aluminium, it should have a spectrum in which the same grouping appears, but the intervals between the pairs of lines should be shorter, and the individuals of each pair should be closer together.

The lines of beryllium are not characteristically grouped like those of aluminium and indium ; it cannot therefore belong to this series of elements. If we attempt to classify beryllium in a manner which accords with Nilson and Pettersson's views (*Proc. Roy. Soc.*, 1880, vol. xxxi. p. 37), the elements scandium and yttrium, with atomic weights 44 and 89 respectively, must yield spectra typical of the series, and the similarity between the spectra of the two metals, beryllium and scandium, must be exceedingly close. Now Thalén's spectra of scandium and yttrium, though both totally unlike the spectra of any other element, have many characters in common (*Kongl. Svenska Akademicus Handlingar*, vol. xii. p. 4, and *Comptes Rendus*, vol. xci. p. 45) ; both spectra contain highly characteristic groups of lines in the orange and yellow, the lines or bands degrading towards the red, and the number of lines which have been measured are no fewer than 103 and 90 respectively.

From these two spectra that of beryllium is entirely different, as well in the character and grouping as in the number of the lines. Of the remaining rare earth-metals at present known, cerium is a tetrad, didymium is a pentad, and lanthanum a triad ; their spectra are quite dissimilar from that of beryllium. In consideration of these facts it is impossible to classify the spectrum of beryllium along with the spectra of the rare earth-metals of the triad group.

Let us now consider the question of the dyad groups. On the assumption that beryllium has an atomic weight of 9·2, there is no difficulty in placing it at the head of the second series, in which position it stands in the same relation to the sub-groups Mg, Zn, Cd, and Ca, Sr, Ba, that Li occupies with regard to Na, K, Rb, Cs, and Cu, Ag, Hg. Its position will also be similar to that of B and of C in their relation to the triad and tetrad metals. The spectra belonging to Mg, Zn, Cd, have a very definite constitution ; they consist of (1) a single line, (2) a pair of lines, (3) three to four groups of triplets, (4) a quadruple group, and (5) a quintuple group of lines. The intervals between the individual lines in their different groupings increase with the increase in the atomic weights of the elements. In fact these spectra present a considerable addition to the body of evidence in support of the view that elements whose atomic weights differ by an approximately constant quantity, and whose chemical character is similar, are truly homologous bodies, or, in other words, are the same kind of matter in different states of condensation (*Journal of the Chemical Society*, September, 1883, p. 390, *Trans.*). Their particles are vibrating in the same manner, but with different velocities. In the spectra of the metals Ca, Sr, Ba, successive pairs of lines are a strong feature, in addition to which there are some other groups in the spectrum of barium. The individuals of each pair are separated by smaller intervals the more refrangible the lines, and by larger intervals the higher the atomic weights. It cannot be said that the spectrum of beryllium is precisely similar in constitution to either of these groups of elements.

There is some slight resemblance in character to the spectrum typical of the calcium group, beryllium having two pairs of lines, the individuals of the first or less refrangible pair being separated by a greater interval than those of the second pair. It is a spectrum analogous to that of lithium, hence it was concluded that beryllium is the first member of a dyad series of elements to which probably calcium, strontium, and barium are more strictly homologous than magnesium, &c. It is to be understood that this is a conclusion drawn from one point of view only, and is open to correction or modification when fresh facts shall have been discovered, but so far the classification of beryllium among the dyads is confirmed and maintained by its position being in harmony with these spectrum observations. The metal is shown to be quite out of place among the triad elements.

SPLENIC FEVER IN THE ARGENTINE REPUBLIC[1]

THE author stated that he did not think any one who had worked much on the subject of splenic fever could doubt that the bacilli which caused that disease were capable of considerable variation in their effects on animals and man. Whether this disease, which is without doubt the one which has been most thoroughly investigated of all zymotic affections, gave any support to the views of Dr. Carpenter was another matter, but there could be no doubt that the *Bacillus anthracis* can be so modified by artificial means that the disease which it produces when introduced into animals, such as sheep and cattle, varies considerably as to duration, amount of fever produced, as well as to its mortality.

That, on the other hand, this bacillus has at least a very strong tendency to retain the characters which it at present presents in Europe is shown by the fact that in the Argentine Republic,—into which the affection was introduced at least thirty years ago, and where the conditions are very different from those which exist in Europe,—we find that the minute organism retains its characteristic form and the properties with which we are so well acquainted in Europe, and that the disease which it produces is practically identical with the European disease. That it should vary in some particulars is perhaps only to be expected, but Dr. Roy preferred leaving that point to be treated of elsewhere and occupying the time at his disposal with an account of the observations which he had made as to the means of protecting from the disease by means of inoculation.

Some six months ago he had been requested by a City company who possess a large tract of land in the Argentine Republic, to pay a visit to their property in order to investigate a disease which was causing much mortality amongst the cattle, sheep, and horses, and which was affecting the *employés* as well to a very serious extent. This disease, he found on arriving at the River Plate, was splenic fever, of which the absence of efficient veterinary surgeons and the general apathy of the owners of stock had prevented the recognition. Having spent some time in studying the characters of the disease, he proceeded to make observations on the best means of protecting the stock by means of inoculation, which work was much facilitated by the liberality of the company (the "Las Cabezas Estancia Company") who gave him "carte blanche" as to the number of animals which he might employ for his experiments. Having previously found, in a small series of observations made in this country in conjunction with Dr. E. Klein, that splenic fever virus from white mice was of the proper strength to protect sheep from the disease, he proceeded in the same lines, employing such animals as were available to produce the inoculating fluid. After a number of animals had been tried, he found that the blood of *Biscachas* (prairie dog) which had died of the disease gave satisfactory results when used to inoculate cattle and horses. It was, however, a little two powerful, as 1 or 2 per cent. of the cattle so inoculated died. The pecuniary loss entailed by this was, however, more than counterbalanced by the arrest of the mortality from the natural affection. With regard to sheep, greater difficulties were encountered, and no animals were found giving a virus sufficiently mitigated to cause only a slight form of the disease with subsequent protection. Unfortunately it was impossible to repeat on a large scale the successful experiments which Dr. Roy and Dr. Klein had made with virus from white mice, these animals not being obtainable. Virus from field-mice and rats did not prove satisfactory.

Under these circumstances the speaker then proceeded to investigate the results obtained by artificial mitigation of the bacilli in the laboratory. He first employed the method of Toussaint, which consists in warming the fluid containing the pathogenic organisms to a temperature of 55° C. for a period varying from a half hour to one hour and a half. It was found possible by this means to diminish the strength of the virus so that it took longer to kill, and by graduating the duration of the heating it is not difficult to obtain a virus which will only kill a small percentage of the animals inoculated. But unfortunately, in weakening the virulence of the organised poison, this process weakens also its power of protecting from a second attack, and it was easy to kill the animals so inoculated by subsequently introducing into their system strong virus which had not been subjected to heat. This method having failed, Dr. Roy proceeded to Buenos Ayres, where, in the laboratory of the "Collegia Nacional," which was kindly placed at his disposal, he manipulated the virus by the method of Pasteur, which consists in cultivating the virus in sterilised chicken broth at a temperature of 42°—43° C. At this temperature the bacilli grow much less readily than at one more nearly approaching blood heat. The bacilli so cultivated diminish in virulence day by day, and after being cultivated for six or eight days no longer caused the death of full-grown sheep, although they still killed lambs and prairie dogs.

Careful experiments with inoculating fluid prepared in this manner showed that with it a slight fever could be induced which suffices to protect, at least for some time, from a second attack of the disease. The same objection, however, which characterises the inoculating fluid prepared by Toussaint's method exists, though to a less extent, with regard to Pasteur's fluid; in the case of the latter as well as the first named, the protecting power is seriously diminished at the same time that the virulence of the bacilli (as indicated by the mortality) is lessened. With care it is possible, however, to prepare a liquid which, while its virulence has been brought sufficiently below the lethal limit to insure that none of the inoculated animals succumb to the inoculation, still retains enough protecting power to enable the sheep to resist the effects of strong virus employed some ten to fifteen days after the first inoculation. Dr. Roy was, therefore, able to confirm the assertions of M. Pasteur regarding the attributes of his inoculating fluid in so far that it is possible effectually to protect sheep from anthrax by its use. Still, it was impossible to overlook the fact that its employment necessitated very careful graduation of the strength of the mitigated virus to the resisting power of the animals inoculated. The speaker did not think that the method was one which was likely to be adopted universally, and he rather looked forward to the general acceptation of some inoculating fluid which had been mitigated by cultivation in the bodies of some animal distinct in species from that which it was desired to protect. In the case of cattle the virus taken from *Biscachas* seemed to protect in all cases, whether the illness produced by the inoculation was mild or severe. It was to be hoped that more extended inquiries would confirm the favourable results obtained by employing the virus from white mice to protect sheep. The speaker stated that he proposed communicating the results of his observations on this subject to the Royal Society at an early date.

[1] Abstract of a paper read at the British Association by Dr. C. S. Roy.

SUGGESTIONS FOR FACILITATING THE USE OF A DELICATE BALANCE[1]

IN some experiments with which I have lately been occupied, a coil of insulated wire, traversed by an electric current, was suspended in the balance, and it was a matter of necessity to be able quickly to check the oscillations of the beam, so as to bring the coil into a standard position corresponding to the zero of the pointer. A very simple addition to the apparatus allowed this to be done. The current from a Leclanché cell is led into an auxiliary coil of wire coaxial with the other, and is controlled by a key. When the contact is made, a vertical force acts upon the suspended coil, but ceases as soon as the contact is broken. After a little practice, the beam may be brought to rest at zero at the first or second application of the retarding force.

This control over the oscillations has been found so convenient that I have applied a similar contrivance in the case of ordinary weighings, and my object in the present note is to induce chemists and others experienced in such operations to give it a trial. Two magnets of steel wire, three or four inches long, are attached vertically to the scale pans, and underneath one of them is fixed a coil of insulated wire of perhaps fifty or one hundred turns, and of four or five inches in diameter. The best place for the coil is immediately underneath the bottom of the balance case. It is then pretty near the lower pole of the magnet, and is yet out of the way. The circuit is completed through a Leclanché cell and a common spring contact key, placed in any convenient position. The only precaution required is not to bring other magnets into the neighbourhood of the balance, or, at any rate, not to move them during a set of weighings.

The other point as to which I wish to make a suggestion relates to the time of vibration of the beam. I think that with the view of obtaining a high degree of sensitiveness the vibrations are often made too slow. Now the limit of accuracy depends more upon the smallness of the force which can be relied upon

[1] Paper read at the British Association by Lord Rayleigh, F.R.S.

to displace the beam in a definite manner, than upon the magnitude of the displacement so produced. As in other instruments whose operation depends upon similar principles, *e.g.* galvanometers, it is useless to endeavour to increase the sensitiveness by too near an approach to instability, because the effect of casual disturbances is augmented in the same proportion as that of the forces to be estimated. If the time of vibration be halved, the displacement due to a small excess of weight is indeed reduced in the ratio of four to one, but it is not necessarily rendered any more uncertain. The mere diminution in the amount of displacement may be compensated by lengthening the pointer, or by optical magnification of its motions. By the method of mirror reading such magnification may be pushed to almost any extent, but I am dealing at present only with arrangements adapted for ordinary use.

In the balance (by Oertling) that I am now using, the scale divisions are finer than usual, and the motion of the pointer is magnified four or five times without the slightest inconvenience by a lens fixed in the proper position. The pointer being in the same plane as the scale divisions, there is no sensible parallax. In this way the advantage of quick vibrations is combined with easy visibility of the motion due to the smallest weights appreciable by the balance.

To illuminate the scale, the image of a small and distant gas flame is thrown upon it by means of a large plate-glass lens. This artificial illumination is found to be very convenient, as the instrument stands at some distance from a window, but it is not at all called for in consequence of the use of the magnifying lens.

ON THE DEVELOPMENT OF PERIPATUS[1]

AMONG the acquisitions I made during my journey to the West India Island of Trinidad, a rich collection of Peripatus stands in the first rank. This has put me in a position to correct many mistakes, and to contribute a good deal to the knowledge of the histological anatomy of this interesting animal form, as well as especially to follow the process of development from beginning to end. Postponing for the present the anatomy of the adult animal, inasmuch as we have on this subject a good many studies, some of which are very good (for instance, that of Gaffron in *Zool. Beiträge*, edited by Dr. A. Schneider), I shall confine myself to a preliminary notice of the earliest stages of the development of Peripatus, although my investigations have not as yet been brought to a conclusion, nor have I been able to devote any attention to the development of the organs. I do this chiefly because the treatise published by Moseley and Sedgwick from the posthumous notes of Balfour contains some representations of embryos and cross-sections of the same, upon whose accuracy in details I, with my rich and well preserved collection of specimens, and observations on fresh objects, must cast some doubt, and the interpretation of which does not bear investigation. And yet these already serve as evidence for some theoretical explanations of embryonic processes in other groups of animals, which it would be well to avoid in such a case.

I collected in Trinidad over a hundred specimens of *Peripatus Edwardsii*, and a small number of a new species which is distinguished by its size from all those hitherto known, and which may briefly be thus characterised: The females, which are considerably larger than the males, attain a length of 15 cm. and a diameter of 8 mm.; the males grow to a size of about 10 cm. Their colour is a plain reddish brown above, darkening a little towards the middle line of the back, and growing pale a little towards the sides. The head, or, more correctly, the forehead, as well as the antennæ, is black, and marked off on the dorsal side by a light yellow necklace, which is often slightly interrupted in the middle, from the rest of the body. The under side is of a dark flesh colour. This species is especially characterised by possessing forty-one to forty-two pairs of feet, which is the highest recorded number, and a number which differs greatly from that of all other species. I call this new species *Peripatus torquatus*.

The ovaries are two small, elongated bodies, which are generally united along their whole length, and so appear as a narrow, spindle-shaped body, which is connected by one or often by two delicate muscular threads to the body wall. The ovaries are prolonged into the two horns of the uterus, which, each forming a bow with several curves, unite immediately before reaching the genital pore to form a very short vagina. At the point where the ovaries pass over into the uterus is situated a small, nipple-shaped gland and a spherical receptaculum seminis, the orifice of which every egg has to pass before it can enter the uterus. Now as a large number of embryos, from the "just furrowed" egg to the matured young, are always found in the uterus, it is very probable that each female Peripatus is only fertilised once.

The eggs of Peripatus contain no yolk, and seeing that in spite of this an animal of half the length that it attains when adult develops itself in the uterus out of a small egg whose diameter is about 0·04 mm., there must be some quite peculiar means for its nutrition, and this is the case to the most astonishing extent and in the most surprising manner.

As soon as the fertilised egg enters the thin portion of the uterus, a small enlargement takes place in its lumen, which is very narrow and is surrounded with very deep cylinder epithelia. Simultaneously with this the epithelium cells mass themselves a little together; the furrowed egg settles upon the epithelium, and immediately the lumen widens a good deal by the epithelial cells of the uterus becoming very depressed at that spot; so flattened do they become that they form a very thin pavement-epithelium, whereas before and behind the "breeding-nidus" (*Bruthöle*) an embankment is formed by the thickening of the connective tissue of the uterine walls, so as nearly to fill up the uterine canal.

In this stage we find a hemispherical mass of homologous cells attached by a broad basis to the extraordinarily thin lining of the uterine cavity, a lining which has been formed out of the two cells that originally surrounded the egg. Presently a small depression develops in this hemispherical mass, and now the embryo forms something like the half of a hollow sphere, still consisting of but a few cells. Through the multiplication of these the hemisphere and the cavity in it become a little larger, and now a difference is perceptible between the cells of the embryo which are situated immediately upon the uterine epithelium and the rest. The former, which I shall for brevity's sake here call basal cells, have a long, narrow, and very compact nucleus, whereas the others have a large, circular, granular nucleus. The basal cells multiply, and in doing so close the opening of the hemisphere, and form a layer which, lying between the embryo and the uterine epithelium, fastens the former to the latter. In the meantime the cells of the hemispherical mass have also multiplied to such a degree that the side looking towards the lumen of the uterus appears thickened by the cells mutually displacing each other.

In this stage the whole condition of the embryo resembles that of a flattened hollow sphere whose free wall has been thickened; the longer diameter is 0·09 mm., and the lesser 0·07mm. The basal cells of the embryo now spread themselves out a little, a few isolated ones come out from under the embryo, and thus enlarge the basis of attachment—they form an *embryonic placenta*. From them is also developed a very delicate membrane, which becomes closely applied to the uterine epithelium, and envelops the embryo—it may be shortly designated as *amnion*.

In the meanwhile changes are also going on in the uterus; the epithelium of the "breeding-nidus" has become a little thicker, the nuclei have increased in number, and a number of small dark brown pigment granules have developed and collected in the protoplasm of the flat cells, which for a long time mark off sharply the uterine epithelium from the embryonic portions.

The basal cells now multiply to a remarkable extent, partly so as to increase the size of the placenta, and partly in a direction perpendicular to it, forming a solid stalk upon which the embryo is pushed out free into the lumen of the "breeding-nidus." The whole now forms a pyriform mass; the little head of the pear, the actual embryo, is, however, now no longer hollow; cells have been thrust in from the side furthest away from the stalk, which have filled up the whole "furrow cavity"; a sharp limit, however, is visible between them and the ectoderm at every point except the place where they have been invaginated; this point, which is comparable to the blastopore of other embryos, persists for a long time as the spot where material for the inner germinal layers is being continually provided by invagination, and is still demonstrable in embryos in which the form of Peripatus has long since been recognisable.

As soon as the "furrow cavity" has been filled up in the manner that has been described, a new cavity develops by fission in the central mass of cells. This is the definite visceral cavity. It develops by the embryo becoming composed of two layers (ectoderm and entoderm) in the half that is nearest to the

[1] Translated from a notice, by Dr. J. von Kennel of Würzburg, in the *Zoologischer Anzeiger* for October 8, 1883.

stalk, whereas a thick prominence in which no differentiation can be made out, lies on the side furthest from the stalk. One must, however, regard its innermost cell layer as belonging to the entoderm, which also is continued into it.

While these changes have been taking place in the embryo, the "breeding-nidus" has increased considerably in size, the uterine epithelium has become thicker, and consists of a finely granular mass of protoplasm in which large round nuclei are found, and often lie in several layers one on top of another; cell boundaries are no longer recognisable, and the pigment granules, which are disappearing, still form a narrow border towards the lumen of the uterus. Before and behind the breeding-nidus is almost altogether closed by great thickenings of the uterine walls. In the region of the breeding-nidus, however, there is a fissure in the connective tissue wall of the uterus which is probably a blood space.

The next stage in the development of the embryo may be shortly characterised as the mushroom form; the embryo becomes more clearly marked off from its stalk, and expands in all directions, but most of all in the direction of the longitudinal axis of the uterus, and now for the first time a bilateral symmetry can with certainty be made out; the whole embryo resembles a mushroom with a thick stalk; the pileus is oval, as seen from above, and is a little broader at one end than at the other, and on the surface, towards the narrower end, is to be seen a shallow depression, which is limited towards the broader end by a slight prominence. This depression corresponds to the spot where the meso- and entoderms have been invaginated. There is as yet no opening to connect the visceral cavity with the outer world. The broader end of the embryo is the head end, the stalk side the back, the surface that projects into the lumen of the uterus the future ventral surface. In this stage a multiple layer of cells has already freed itself from the ectoderm, in front of the place where the invagination took place, and it lies, passing over behind into the undifferentiated cell-mass, between the ecto- and entoderm, but is marked off from both of them by a distinct boundary.

Now while the embryo increases in length, more and more cells press in from the ectoderm at the spot that has been indicated, and specialise themselves towards the front into a real mesoderm, which, however, at first, and for a long time afterwards, occupies only the ventral aspect and also the lateral regions between ectoderm and entoderm, where it of course multiplies independently.

In the meanwhile the thickening of the uterine epithelium has gone on; it now forms a ring, which surrounds three-quarters of the circumference of the breeding-nidus, and which as a broad zone divides the breeding-nidus into two halves, where, by the way, the epithelium has been thickened to a considerable though a less degree; the pigment granules have now disappeared, the placenta has become very large, and the amnion, which has attained a high degree of development, and which consists of numerous large cells with large nuclei, lies closely applied to the uterine epithelium.

It is only when the embryo has still further increased in length, the part posterior to the stalk increasing very quickly in size, that the anus and mouth are formed, but not from a common opening, the blastopore of Balfour. The anus develops as a small fissure in the median line upon the prominence in front of the spot where the invagination has taken place; but the mouth develops far further forwards as an invagination of the ectoderm, consisting of only very few cells. This invagination has an inclination obliquely from behind forwards as it proceeds, and reaches the intestine, dividing its epithelium at the point of junction. This mouth invagination has as yet no lumen; this makes its appearance later, when the embryo already shows its segmentation plainly.

The first trace of this segmentation is the appearance of a cavity on each side in the oldest portions of the mesoderm, *i.e.* in the anterior extremity of the embryo, which splits the mesoderm plates into an inner membrane adjoining the intestine, and an outer one adjoining the ectoderm. These, however, are still connected to each other dorsally and ventrally. Soon afterwards a second pair of similar cavities develops behind, and so on from before backwards. These cavities that appear in segments, and which in their appearance closely resemble the original segmental formation of a vertebrate animal, are the first rudiments of the body cavity. The different structures that develop out of its walls cannot be made out till later. With the exception of the further growth of the posterior end of the embryo, which soon curves itself, rolls itself up spirally, and finally forms manifold loops, and of the progress of the segmentation, and of the corresponding formation of cavities in the mesoderm, no changes take place in the interior of the embryo. Embryos of *P. Edwardsii* of 1–1·5 mm. length always present the same appearance on cross-section: an ectoderm slightly thickened on the ventral aspect, an extraordinarily thin entoderm, and between them on each side a pocket of mesoderm, whose walls touch each other in the ventral median line, and which in well-preserved embryos always are closely applied to the ectoderm, as well as to the entoderm, but which always present a sharply-defined boundary line. The anus is still nothing more than a narrow longitudinal fissure; the mouth has at last opened. Behind the anus is situated the depression, with the place where invagination has taken place.

Externally, on the other hand, a distinct segmentation of the body has taken place corresponding to the cavities in the mesoderm; the anterior segment (head segment) exceeds all the others in size; it consists of two symmetrical, spherical halves, to which the other segments are connected posteriorly; the ventral aspect of the head segment contains the mouth opening. I remark here that the mouth and anal opening that have been mentioned must be regarded as primary in Peripatus; the latter closes at a later stage to make room for a later-developing structure, and the former is thrust in further by a new invagination of the ectoderm, and becomes converted into the œsophageal opening of the intestine. (These two observations require to be checked, and I shall have to do so by examining other embryos.) Each segment carries on each side a prominence which is the rudiment of the limbs that are developed later. The first pair of limbs is surrounded by a number of secondary papillæ, and is drawn into a wide mouth cavity to be utilised as a jaw; the second pair gives the papillæ on whose apices the large slime glands afterwards have their orifices. The tentacles are simply dorsal continuations or prolongations of both head cavities. Now at last, after the embryo has attained its full complement of segments, the first appearance of the nervous system can be made out as a paired ventral thickening of the ectoderm, which, soon separating itself from the ectoderm, extends in two separate threads from one end of the body to the other, only united by the brain, which has been developed in a similar manner in the head. The embryo itself, until it develops a definite gullet, is intimately connected by its ectoderm, by means of the placenta with the maternal organism, and receives its nutriment through its dorsal stalk, which can be quite properly characterised as a navel-string, and which belongs to the first body segment. As soon, however, as it can swallow by help of its gullet, this connection is loosened, and the embryo now eats the food that is provided by the extraordinarily thickened uterine epithelium, which is rich in protoplasmic materials. At any rate, from that time forward coagulated protoplasm is always to be found in the intestine of the embryo, which was previously always empty.

This is, in a few words, an abstract of the most important results of my investigations up to date, which have been made upon something like a hundred young embryos. I here abstain for the sake of brevity from all discussion, but must, however, call attention to the fact how little Balfour's illustrations and the descriptions of the editors agree with the facts as they are here given. I hope it will not be long before I shall be able to lay before my fellow-workers my investigations, which I hope soon to complete, of these interesting and exceedingly anomalous phenomena of embryonic development, accompanied by numerous illustrations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—By a mistake last week the stipend of the Professorship of Botany was given as 500*l.* instead of 700*l.* with a residence rent free. An election will take place in the course of Hilary term. The duty of the professor is to lecture and give instruction in botany. He will also have charge and supervision of the Botanical Garden and of the botanical collections belonging to the University; and it will be part of his duty to make such gardens and collections accessible to and available for the instruction of students attending his lectures. Candidates are requested to send to the

Registrar of the University their application, and also any documents which they may wish to submit to the electors, on or before Saturday, January 26, 1884.

The Professorship of Rural Economy—now separated from that of Botany—will be filled up in December. Candidates are requested to send to the Registrar of the University their applications, and any documents they may wish to submit to the electors, on or before Monday, December 10, 1883. According to the regulations sanctioned by the Court of Chancery, the Sibthorpian Professor of Rural Economy shall lecture and give instruction on the scientific principles of agriculture and forestry. He shall be entitled to the emolument of 200*l.* derived from the benefaction of Dr. John Sibthorp, Doctor of Medicine, and assigned to the professorship. The professor holds his office for a period of three years from election, and no longer. He may be re-elected for a second period of three years, and no longer; but no professor shall hold the professorship for more than six years consecutively. The professor will have the use of the garden appropriated for making experiments on the subjects of his professorship. The professor shall give not less than twelve lectures in the course of the academical year, in full term, and not more than two in any one week.

CAMBRIDGE.—The following are the speeches made to the Senate of the University by the Public Orator (Mr. J. E. Sandys) in presenting Professors Foster and Macalister for the complete degree of M.A. *honoris causâ*, on November 8:—

"Dignissime domine, domine procancellarie et tota Academia: In hoc ipso loco, duodecim abhinc annos, unum e Collegii maximi Prælectoribus auspiciis optimis titulo vestro honorifico exornastis. Hodie eundem, tot annorum usu et experientia spectatum probatumque, et Academiæ totius Professoribus merito adscriptum, senatus nostri in ordinem honoris causa adsciscimus. Quantum interim, hujus præsertim laboribus, inter alumnos nostros creverit vigueritque physiologiæ studium, vosmet ipsi omnes animo grato recordamini. Ut animantium in corporibus ex ipso corde, velut e fonte quodam, salutares illi sanguinis rivi per membra omnia fluunt refluuntque; non aliter corporis Academici in partes quam plurimas ex hoc fonte scientiæ flumina effluxisse atque inde rursus redundasse dixerim. Tali e fonte quot alumnis vires novæ redditæ sunt: quotiens ex alumnis rivuli fontem ipsum denuo auxerunt! E discipulis vero tam multis cum magistro tanto feliciter consociatis, plurimos adhuc superesse, nonnullos etiam adesse hodie gaudemus; unum illum non sine lacrimis desideramus qui nascentis vitæ primordiis hujus auxilio sagacissime investigatis, nuper inter Alpium culmina, in ipso ætatis flore, morte immatura e nobis est abreptus. Talium filiorum progenies Matri Almæ indies nova succrescat: magistrorum talium accessionibus et Professorem et Senatorum ordo identidem nobis augeatur!

"Vobis præsento Collegii sacrosanctæ Trinitatis socium, Physiologiæ Professorem illustrem, MICHAELEM FOSTER."

"In Professoribus novis vestro omnium nomine salutandis, fato quodam iniquo successoris laudes decessoris desideria nonnunquam aliquatenus imminui videntur. Hodie vero ornat adhuc Professorum ordinem eloquentissimus ille Anatomiæ Professor quem diu sumus admirati. Integro igitur sinceroque gaudio Professorem illum salvere jubemus, quem Caledonia Hiberniæ quondam donavit, Hibernia Britanniæ nuper reddidit. Salutamus virum qui corporis humani scientiam interiorem, antiquissimum illud atque regium (uti nuper audivimus) scribendi argumentum, quasi propriam provinciam penitus exploravit; qui ne his quidem finibus contentus, sed etiam in alias rerum naturæ regiones egressus, non modo de zoologia et de comparativa quæ dicitur anatomia egregie meritus est, sed geologiæ quoque operam singularem impendit, petrographiæ præsertim recentiores, progressus curiositate minuta perscrutatus. Idem et litterarum amore et linguarum peritia insignis, inter rerum antiquarum monumenta ne hieroglyphica neglexit, neque historiam ecclesiasticam intactam reliquit. Ergo non uni tantum Collegio sed toti Academiæ gratum est, virum tot tantisque animi dotibus instructum, societati illi tam cito esse adscriptum, cui medicinæ studia commendavit olim vir et de litteris antiquis et de scientiis recentioribus præclare meritus, Thomas Linacre.

"Vobis præsento Collegii Divi Johannis socium, Anatomiæ Professorem insignem, ALEXANDRUM MACALISTER."

The allusions to the growth of the physiological school, to the loss of Prof. F. M. Balfour, to Prof. Macalister's inaugural lecture with its happy antiquarian illustrations, and his speedy enrolment as a Fellow of St. John's, were heartily taken up by the members of the Senate and the undergraduates present.

The Special Board for Medicine publish for the guidance of students proceeding to medical and surgical degrees the following schedule defining the range of the examination in elementary biology under the regulations which come into effect on the first day of January, 1884 (Grace, November 15, 1883). The examination in elementary biology will have reference to (1) the fundamental facts and laws of the morphology, histology, physiology, and life-history of plants as illustrated by the following types: *Saccharomyces*, *Protococcus*, *Mucor*, *Spirogyra*, *Chara* or *Nitella*, a fern, *Pinus*, and an angiospermous flowering plant; (2) the fundamental facts and laws of animal morphology, as illustrated by the following types: *Amœba*, *Paramæcium* or *Vorticella*, *Hydra*, *Lumbricus*, *Astacus*, *Anodon*, *Amphioxus*, *Scyllium*, *Rana*, *Lepus*. Under the head of vegetable physiology the student will not be expected to deal with special questions relating to the more highly differentiated flowering plants. He will be expected to show a practical knowledge of the general structure of each of the animal types above specified, and an elementary knowledge of the chief biological laws which the structural phenomena illustrate. He will also be expected to show an elementary knowledge of the general developmental history of *Amphioxus* and of *Rana*. He will not be expected to deal with purely physiological details.

The subject announced for the next Adams Prize to be adjudged in 1885, is as follows: Investigate the laws governing the interaction of cyclones and anticyclones on the earth's surface. In order to give precision to this, the following suggestions are given to the examiners:—An infinite plane has surface density $\frac{g}{2\pi}$ (where g is gravity); on one side of it is air in equilibrium, the density of which must diminish according to the barometric law as we recede from the plane. The system revolves as a rigid body, about an axis perpendicular to the plane, with a constant angular velocity ω. If one or more vortices, with a revolution either consentaneous with ω (cyclones), or adverse thereto (anticyclones), be established in the air, investigate their motions. It may be well to consider the axes of the vortices as either straight or curved, and perpendicular or inclined to the plane. If possible, pass to the case in which the vortices exist in the atmosphere surrounding a rotating globe.

The Rev. H. W. Watson has been approved for the degree of Sc.D.—Prof. Darwin is arranging to give a course of practical teaching in astronomy with the instruments under his charge. Next term Mr. H. H. Turner of Trinity College will undertake this course.—The General Board of Studies, in re-issuing its recommendations as to Readers, Demonstrators, &c., has asked that power be given to the Museums and Lecture Rooms Syndicate to obtain plans for a foundry for the Department of Mechanism, for buildings for Botany, and for additional buildings for Comparative Anatomy and Physiology.—It is recommended that a Curator of the Museum of General and Local Archæology be appointed, at a salary of 100*l.* per annum.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, vol. cxvi. No. 694, October, 1883.—The commercial and dynamic efficiencies of steam-engines, by Prof. R. H. Thurston. In this paper there are calculated the ratio of expansion to furnish power most economically, the maximum efficiency of a given plant, and maximum efficiency of fluid, when such data are taken into account, as total annual cost of steam, and total annual cost of all items variable with size of steam-cylinder.—Mr. R. Grimshaw, in a paper on the steam-engine indicator as a detector of lost motion, describes the use of the indicator to pick out defective setting of cranks, cross-heads, &c.—The next three articles are on the water supply of cities in ancient times, on oil-dressed belting, and a report on the pressure-governed gas-meter and burner.—The address by Prof. Rowland, entitled "A Plea for Pure Science," lately reprinted in NATURE, is also reproduced *in extenso*.

Annalen der Physik und Chemie, xxii. No. 10, contains a long memoir by Professors Sohncke and Wangerin on interference phenomena obtained with thin and especially with wedge-shaped laminæ. The article will be continued in the next number.—On the changes of volume of metals and alloys on melting, by Prof. Eilhard Wiedemann. The metals were cast in thin rods, then dropped into a nearly-fitting glass tube, ending into a capillary. The wide end was sealed, and a dilatometric fluid such as oil introduced. The conclusions arrived at are that tin, soft solder, and probably also lead, expand on melting; but bismuth contracts. Many observations were made on alloys of bismuth and lead.—On the liquefaction of oxygen, nitrogen, and carbonic oxide, by S. von Wroblewski and C. Olszewski. Intense cold was obtained by evaporation, under reduced pressure, of liquefied ethylene in an apparatus modified from that of Cailletet. Temperatures were measured by a hydrogen pressure-thermometer. Oxygen proved to be liquefiable at temperatures varying from $-129°\cdot 6$ to $-135°\cdot 8$ C., under pressures varying from 27·02 to 22·2 atmospheres. The liquefaction of nitrogen and of carbonic oxide proved more difficult, and was not accomplished at a temperature of $-136°$ C., even under a pressure of 150 atmospheres, though a sudden release of pressure produced a temporary mist of condensed spherules, and a slower release of pressure yielded a deposit of liquid with a distinct meniscus. Liquefied nitrogen and liquefied carbonic oxide are both colourless and transparent.—On the internal friction of certain solutions, and on the viscosity of water at different temperatures, by K. F. Slotte. The results confirm those previously obtained by Rosencrantz and Poiseulle.—On a lecture apparatus for demonstrating Poiseulle's law, by W. C. Röntgen.—On the deduction of the crystal systems from the theory of elasticity, by H. Aron; a mathematical discussion of the possible cases arising from the position of planes of symmetry, proving that no others than the recognised six systems of crystals can exist.—On the properties of benzine as an insulator and as a substance exhibiting electric reaction, by H. Hertz. *Pure* benzine appears to be remarkably good as an insulator and remarkably free from reaction effects.—On the influence of galvanic polarisation on friction, by K. Waitz. Treats of the phenomenon discovered by Edison, and recently examined by K. R. Koch.—On the properties of calc-spar in the homogeneous magnetic field, by Fr. Stenger.—Notes on a photometric apparatus, by Leonhard Weber.—On "the Exhibition of the Treatise on Light" of Ibn al Haitam, by E. Wiedemann.—On the Cologne air-pump of the year 1641, a historical notice by Dr. G. Berthold.—Remarks on the memoir of Herr Christiansen, "Researches on Heat-Conductivity," by A. Winkelmann.

Atti of the Royal Academy dei Lincei, July 12-15, 1883.—Obituary notice of William Spottiswoode.—Two communications from Signor Tacchini on the observations made by him at Caroline Island during the solar eclipse of May 6, 1883.—On the average variation in tension of the atmospheric aqueous vapour according to latitude and elevation in Italy, by A. Lugli.—Meteorological observations at the Royal Observatory of the Campidoglio for the months of June and July.—Most of the present number is occupied with the new reforms and statutes of the Academy, whose constitution has recently been remodelled. There are also long inventories of the works of art, furniture, and fixtures of the Palazzo Corsini, which has been purchased as the future home of the Academy.

Rivista Scientifico Industriale, Florence, September 15-30.—The total eclipse of May 6. Results of the observations of Tacchini, Janssen, and others, in Caroline Island.—Eclipses and terrestrial magnetism, by P. Denza. All connection is denied between eclipses and magnetic phenomena.—On the compressibility of water, by S. Pagliani and G. Vicentini.—A new electrodynamometer, by Prof. Bellati.—On the deformation detected by Gouy in polarised electrodes, by A. Volta.—An improved reversible magnetico-electric machine, by M. Delaurier.—Anatomical description of two extremely rare birds (*Somateria mollissima* and *Phalaropus fulicarius*) preserved in the Civic Museum of Venice, by P. A. Ninni.—On the fossil vertebrates of the Miocene formations in the Venetian Alps, by Baron Achille de Zigno.—On the fossil gastropods, cephalopods, and corals of the lower titonic formations of Sicily, by Dr. G. de Stefano.

SOCIETIES AND ACADEMIES

London

Chemical Society, November 15.—Dr. Perkin, F.R.S., president, in the chair.—It was announced that a ballot would take place at the next meeting (Dec. 6).—The following papers were read:—On the estimation of starch, by C. O'Sullivan. The method may be briefly described as follows:—About five grms. of the finely ground grain are successively extracted with ether, alcohol (sp. gr. 0·90), and water at 35° to 38°. Fat, sugar, albuminoids, amylams, &c., are thus got rid of. The starch in the washed residue is gelatinised by boiling with water, cooled to 62°, about 0·03 grm. diatase (prepared by precipitating a cold, aqueous extract of malt with alcohol) added; the starch is thus converted entirely into maltose and dextrin, and by a quantitative determination of these two products the starch originally present can be calculated. The author states, as the result of his experience with the method, that the difference in results obtained by any two observers need not exceed 0·5 per cent. of the total starch.—On the illuminating power of ethylene when burnt with non-luminous combustible gases, by P. F. Frankland. The author summarises his results as follows:—Pure ethylene burnt at the rate of five cubic feet per hour from a Referees Argand burner, emits a light of 68·5 standard candles; the illuminating power of equal volumes of mixtures of ethylene with either hydrogen, carbon monoxide, or marsh gas is less than that of pure ethylene; when such mixtures contain 60 per cent. of ethylene or more, the illuminating power of the mixture is but slightly affected by the nature of the diluent; in mixtures containing less than 60 per cent. of ethylene, the illuminating power is the highest when marsh gas, and lowest when carbon monoxide, is the diluent.—On the products of decomposition of aqueous solutions of ammonium nitrite, by G. S. Johnson. The nitrogen evolved from alkaline solutions of ammonium nitrite contains no oxides of nitrogen; nitrogen is evolved from aqueous solutions below 100°; by adding crystallised cupric chloride, a continuous evolution of pure nitrogen takes place in the cold. When solutions are acid, the nitrogen may contain 4 per cent. of nitric oxide. About 2 per cent. of the nitrogen evolved by the cupric chloride is stated by the author to possess peculiarly active properties, and forms ammonia when passed with hydrogen over spongy platinum.—On the estimation of iron by standard potassium bichromate, by E. B. Schmidt. The author recommends the above process, but states that zinc should not be used to reduce the iron, as it interferes with the end reaction with potassium ferricyanide. He prefers Kessler's method of reduction with stannous chloride.

Western Microscopical Club, November 5.—Mr. W. Crookes gave a lecture on "Recent Discoveries in High Vacua." He illustrated his theme with a series of brilliant and interesting experiments. The effects were produced by a large electric coil, having sixty miles of secondary wire, and worked by two cells of a storage-battery. The coil, when attached to its full complement of thirty cells, would give a spark in air of twenty-four inches. "High vacua" were defined as those ranging from above the 1/1000 to the 1/100,000,000 of an atmosphere. Air and all gases are conceived to consist of myriads of excessively minute molecules, which in the ordinary state vibrate with enormous velocity; but being crowded together in that condition their extent of vibration is impeded by each other, and is, in fact, limited to a path of only 1/10,000 of a millimetre. When, as in a partial vacuum, there are fewer of these molecules, they have more room in which to vibrate, and hence their "mean length of path" is increased. Under the influence of electricity these molecules are driven in straight lines from the negative pole. In a comparatively low vacuum, on the passage of an electric current, the residual air assumes a stratified condition, showing alternate light and dark bands. The width of the dark bands marks the length of the excursions of the molecules. Further exhaustion increases the width of these bands, so that in a vacuum of 1/1,000,000 of an atmosphere the free path of the molecules was seen to extend to about four inches. By means of an exhausted V-shaped tube it was shown that these molecules are driven from the negative pole in straight lines, and hence cannot turn a corner. First one limb of the V, then the other, was connected with the negative pole of the coil, with the result that each in turn was in darkness. In another vacuum-tube a concave negative pole was fixed; the molecules were driven normally from this concave surface, and, meeting the cylindrical surface of the glass inclosure, were thrown into beautiful caustic curves. That these molecules, under the influence of electricity, possessed mechanical force was shown by causing them to impinge on the vanes of a radiometer, when a rapid rotation took place. On reversing the current, the direction of rotation was also reversed. That this was not due merely to the passage of an electric current was shown by a vacuum-tube containing a small, horizontal "water-wheel." Its upper and lower floats being struck equally by the radiant matter, no motion took place; but on diverting the flow of radiant molecules by means of the external application of a magnet, the molecules were caused to strike the upper floats only, when revolution took place. By reversing the magnet, the path of the molecules was diverted so as to strike the lower floats, and thus to reverse the rotation. Radiant molecules are not attracted by one pole of a magnet and repelled by the other, but tend to rotate round the north pole in one direction and round the south pole in the opposite direction. Hence, with a horseshoe magnet, they are deflected in a line at right angles to the line that joins the two poles. The mechanical effect of the impact of these radiant molecules was further shown by converging them by means of a concave negative pole to a focus in which was a small bundle of platinum wires. These wires were rapidly raised to a white heat by the vigorous though inaudible bombardment. Further, the impact of radiant molecules on certain bodies produces phosphorescent light; thus they give to potash-glass a green and to lead-glass a blue tinge. If in an exhausted tube an obstacle, such as a piece of mica in the shape of a cross, be set up, a dark shadow of it is thrown on the positive end of the tube, the part surrounding the shadow being rendered phosphorescent by the impact of the molecules. On suddenly removing the obstacle, the part that was in shadow glows brighter than in surrounding luminous space. This effect is due to the molecules acting suddenly on a new and, as it were, untired surface.

CAMBRIDGE

Philosophical Society, October 29.—The following officers for the ensuing year were elected:—President, Mr. Glaisher; Vice-Presidents: Prof. Cayley, Prof. Stokes, Lord Rayleigh; Treasurer, Mr. J. W. Clark; Secretaries: Mr. Trotter, Mr. Glazebrook, Mr. Vines; New Members of Council: Prof Humphry, Prof. Babington, Prof. Adams, Prof. Newton, Mr. F. Darwin, Mr. Shaw, Mr. Sedgwick.—The following papers were communicated to the Society:—On the effect of viscosity upon the tides, by Rev. Osmond Fisher.—Note on Mr. Larmor's communication on "Critical Equilibrium," by Mr. Greenhill.—On some general equations which include the equations of hydrodynamics, by Mr. M. J. M. Hill.

EDINBURGH

Mathematical Society, November 9.—Mr. J. S. Mackay, F.R.S.E., in the chair.—The opening address of the session was delivered by Prof. Tait, who chose for his subject "Listing's Topologie."—The office-bearers elected were:—President, Thomas Muir, F.R.S.E.; Vice-President, A. J. G. Barclay; Secretary and Treasurer, A. Y. Fraser; Committee: R. E. Allardice, William Peddie, Robert Robertson, David Traill, B.Sc.

PARIS

Academy of Sciences, November 12.—M. Blanchard, president, in the chair.—On the velocities acquired in the interior of a vessel by the diverse elements of a fluid during its discharge through a lower orifice, and on the simple means possible to be employed in determining very approximately the numerical residuums of slightly converging double series, by MM. de Saint-Venant and Flamant.—Extract from a letter addressed to M. Daubrée by M. Nordenskjöld on the results of his recent expedition to Greenland.—On a tribasic oxalate of alumina, by M. Mathieu-Plessy.—Note on the letter communicated to the Academy by M. Martial, Captain of the *Romanche*, on his return from Tierra del Fuego and neighbouring waters, by M. Alph. Milne-Edwards. Soundings and dredgings were taken at depths of 600 metres; a careful study was made of the fauna and flora on the mainland, as well as of the Fuegian aborigines, and 167 cases of collections were brought back, including two skeletons of whales, and several living specimens of animals and plants. On his return M. Martial determined the presence of a deep trough about the twentieth meridian south of the equator, 7370 metres deep, near the ridge of submarine banks discovered by the *Challenger* and *Gazelle*.—Observations on the Pons-Brooks comet made at the Observatory of Nice (Gautier-Eichens equatorial), and comparison with MM. Schulhof and Bossert's ephemerides, by M. Perrotin.—On certain astronomical formulas of Hansen and Tisserand, by M. P. Appell.—On the asymptotic lines of wave surfaces, by M. G. Darboux.—On the functions of two independent variables rendered invariable by the substitutions of a discontinued group, by M. E. Picard.—Note on the nature of an algebraic relation between two uniform functions of an analytical point (x, y), by M. E. Goursat.—On an algebraic problem in the theory of elimination, by M. Cyparissos Stéphanos.—A description of the differential pyrometer patented in February, 1882, by M. E. H. Amagat.—On an optical photometer, by M. L. Simonoff.—On the measurement of electromotor forces (two illustrations), by M. E. Reynier.—On an electric sounding apparatus for great depths (four illustrations), by M. E. de la Croix.—On a rapid method for determining the work absorbed or produced by a dynamo-electric machine, by M. Pierre Picard.—On a new series of combinations of titanium, by M. A. Piccini.—Qualitative research and quantitative analysis of zinc and lead in iron ores, by M. A. Deros.—On the formation of considerable quantities of alcohol in the fermentation of bread stuffs, by M. V. Marcano.—Determination of the causes tending to diminish the susceptibility of certain regions of the organism to the virus of bacterian or symptomatic charbon, transforming a fatal into a prophylactic inoculation, by MM. Arloing, Cornevin, and Thomas.—On the source of the imperfectly-oxydised sulphur present in urine, by MM. R. Lépine and G. Guérin.—On the development of the branchia of cephalopods, by M. L. Joubin.—On the functions of the renal sac in heteropods, by M. L. Joliet.—Remarks on the *Crocodilus robustus*, Vaill. and Grand., of Madagascar, by M. L. Vaillant.—On the osmotic force of diluted solutions, by M. Hugo de Vries.—On the interpretation of an experiment by Hales touching the function of vegetable vessels, by M. J. Vesque.—Note on the direct observation of the movement of water in plants, by M. G. Capus.—Remarks on the saccharoid and serpentine limestones of the northern slopes of the Pyrenees, by M. Dieulafait.—On the causes of abnormal winters (five illustrations), by M. L. Teisserenc de Bort.—The election was reported of M. Charcot in place of M. Cloquet in the Section of Medicine and Surgery.

CONTENTS

THURSDAY, NOVEMBER 29, 1883

SCIENTIFIC WORTHIES

XXIII.—Sir Charles William Siemens,[1] Born April 4, 1823; Died November 19, 1883

THE death of Sir William Siemens, coming as it did so suddenly and unexpectedly, has been felt as a severe blow and grief through a far wider circle than that of his personal friends. His work for the last five or six years has interested the general public to a degree that has perhaps never before been the lot of any man devoted to science as he has been. Not only the people of his adopted country, England, but the larger public of the whole civilised world, have been deeply interested in the electric lighting, the electric transmission of power, the electric railways, the regenerative gas furnaces, and the conversion of fuel into gas to feed them, and the prospect of smoke abatement by this mode of dealing with coal, and the improvements it has helped to make in the manufacture of steel, in all of which they have recognised Sir William Siemens as an originator, a devoted worker, and a friend. The Portrush and Bushmills electric tramway in the north of Ireland, one of the most splendid and interesting of his achievements, now carries passengers on a six and a half miles line of steep gradients and sharp curves, at a good ten miles an hour, solely by water power of the River Bush, driving, through turbines, a 250 volt Siemens dynamo at a distance of seven and a half miles from the Portrush end of the line. Just two months before his death he was present, and the writer of this article had the great pleasure of being present with him, at the formal opening to the public by the Lord-Lieutenant of Ireland, Earl Spencer, of this transcendent gift of science to mankind. His death is mourned as an irreparable loss, and the thought that advances in so many lines of beneficent progress, carried on by his untiring activity and his splendid zeal, are so suddenly stopped has caused most grievous disappointment.

William Siemens had the great characteristic common to all men who have left their mark on the world, the *perfervidum ingenium*, in which thought leads to instant action. When he was only twenty years old he came to England with his brother Werner, to realise an invention for electro-gilding; and, persevering through the complication of difficulties naturally met with by young men in a strange land, with little knowledge of its language, they succeeded in proving the usefulness of their invention, and getting it carried into practical effect through the wise and kindly appreciation of Mr. Elkington. Encouraged by this success, William Siemens returned a year later with his chronometric governor, an invention of remarkable beauty and ingenuity, in which, by the motion of a pivoted framework carrying an idle wheel geared to bevel wheels on two shafts in line, or geared to the outer and inner circumferences of concentric wheels, rotating in opposite directions on coaxial shafts, the movement of one wheel is caused to keep time with that of the other. We believe that although the invention was not a commercial success, and is not generally known in this country as practically realised except in its application to regulate the motions of chronoscopic instruments in the Royal Observatory of Greenwich, it may yet be destined to have large practical applications in engineering.

One of William Siemens's early inventions was his water-meter, which exactly met an important practical requirement, and has had a splendid thirty years' success. It realised curiously subtle hydraulic principles, which, even irrespectively of the practical value of the instrument, may interest readers of NATURE. Imagine a Barker's mill running absolutely unresisted. The discharged water must have approximately zero absolute velocity on leaving the nozzles; in other words, its velocity relatively to the nozzles must be approximately equal to the contrary absolute velocity of the nozzles. Hence the machine will rotate in simple proportion to the quantity of water passing through it. By an extension of similar considerations it is easy to prove that if the wheel, instead of being unresisted, is resisted by a force exactly proportional to the square of its angular velocity, its velocity must still be proportional to the quantity of water passing through it per unit of time. Thus, provided this law of resistance is maintained, the whole angle turned through by the wheel measures the whole quantity of water that has passed. Now think of the difficulties which Siemens had to overcome to realise this principle. What we have roughly called a Barker's mill must be completely inclosed in the supply water-pipes, its nozzles discharging into water, not into air. It must be of very small dimensions to be convenient for practice, and its bearings must be kept oiled to secure, not only that it may not be injured by the wear of running for years, but also that the constant frictional force of solid rubbing on solid may be as nothing compared to the resistance, proportional to the square of the velocity, exerted by the circumambient liquid upon a wheel with sharp edged vanes rotating in it. After a few years of trials, difficulty after difficulty was overcome, and the instrument did its work with the accuracy and convenience which met practical requirements. It was we believe the protection offered by the British Patent Law, which, in the case of this very instrument, allowed Siemens to work it out in England, and so helped him eventually to find his home among us, and to give us primarily the benefit of his great inventiveness in all directions; while the want of similar protection under German law at that time rendered it practically impossible for him to work out so difficult an invention in his own country.

In electric invention William Siemens has been associated with his brother Werner, and the world has profited largely by this brotherly cooperation of genius. More than a quarter of a century ago, they brought out what is now known as the Siemens armature. The writer well remembers admiring it greatly when he first saw it (he believes at the London Exhibition of 1862), mounted between the poles of a multiple steel horseshoe magnet and serving for the transmitter in an electric telegraph. That was what we may now call the one-coil Siemens armature. It suggested inevitably the mounting of two or more coils on the same iron core, in meridional planes at equal angles round the axis, and as nearly equal and similar in all respects as is allowed by the exigencies of

[1] The Steel Engraving, which was put in hand some time ago while the life which has now passed away was rich in promise as well as achievement, is not yet finished. It will be issued with a future number.—Ed.

completing the circuits with the different portions of wire laid over one another, and bent to one side or the other, to avoid passing through the space occupied by the bearing shaft. The principle of electro-magnetic augmentation and maintenance of a current without the aid of steel or other permanent magnets, invented by Werner Siemens, and also independently by Wheatstone and S. A. Varley, was communicated to the Royal Society by William Siemens on February 14, 1867, in his celebrated paper "On the conversion of dynamical into electric force without the aid of permanent magnets." This paper is peculiarly interesting, as being the first scientific enunciation of that wonderful electro-magnetic principle, on which are founded the dynamo-electric machines of the present day. Soon after came the Paccinotti-Gramme ring, from which followed naturally the suggestion of the mode of connection between the coils of a multiple-coil Siemens armature, described in the Siemens-Alteneck patent of 1873, and made the foundation of the Siemens dynamo as we now have it, whether as given from the Siemens firm, or with the modifications of details and proportions, valuable for many practical purposes, which have been contributed by Edison and Hopkinson. The evolution of the Siemens armature, as we now have it, in this splendid machine, from the rudimentary type which the writer saw a quarter of a century ago, is one of the most beautiful products of inventive genius, and is more like to the growth of a flower than to almost anything else in the way of mechanism made by man.

Space prevents us from more than mentioning the works of William Siemens and his brothers, Werner and Carl, in land and sea telegraphic engineering, and their great achievements in Atlantic cable-laying. The *Faraday* bore particularly the impress of William Siemens's practical genius. It is remarkable that a ship capable of doing what no other ship afloat can do in the way of manœuvre, as has been proved by her success in the difficult and delicate operations of laying and lifting cables in depths of 2500 fathoms, and of cable repairing in all seasons and all weathers, should have been the work of a landsman, born in the middle of Europe, who early made himself a sailor in cable-laying expeditions in the Mediterranean and the Black Sea, but whose life has been chiefly devoted to land engineering and science.

On the 19th of this November the writer of the present article was accosted in a manner of which most persons occupied with science have not infrequent experience:—"Can you scientific people not save us from those black and yellow city fogs?" The instant answer was—"Sir William Siemens is going to do it; and I hope if we live a few years longer we shall have seen almost the last of them." How little we thought that we were that very evening to lose the valuable life from which we were promising ourselves such great benefits. May we not hope that, after all, the promise was not vain, and that, although Sir William Siemens is gone from among us, the great movement for smoke abatement, in which he has so earnestly laboured during the last three years of his life, may have full effect.

Just nine days previously, the writer had received a letter from Sir William Siemens, saying nothing of illness, but full of plans for the immediate future: chiefly an address to the Society of Arts, and the realisation at Sherwood of his method for the smokeless supply of heat to a steam boiler, by the combustion of hydrogen, carburetted hydrogen, and carbonic oxide, obtained from the conversion into these gases of the whole combustible material of the coal, together with some hydrogen and oxygen from water, and oxygen from air, in his gas-producing kiln. "The producer will be in full operation at Sherwood by that time" were almost the last words received by the writer from his friend, kindly inviting him to come and see the new method in operation at the end of the present month. A short time before, in travelling home from Vienna, where they had been associated in the British Commission for the Electrical Exhibition, Sir William Siemens had told the writer that without waiting for a perfected gas-engine to use the products of combustion as direct motive agent, and so give the very highest attainable economy, he expected by using the gas from his producer as fuel for the fire of a steam-boiler, even on a comparatively small scale, like that of his appliances at Sherwood for electric lighting and the electric transmission of power, to be able to obtain better economy of coal for motive power than by burning the coal directly in the usual manner in a furnace under the boiler. And further, what is specially interesting to persons planning isolated installations for electric light, he believed that the labour of tending the producer and boiler and steam-engine would be on the whole considerably less than that which is required on the ordinary plan, with its incessant stoking of coal into the furnace under the boiler, as long as steam is to be kept up. There is something inexpressibly sad, even in respect to a comparatively small matter like this, to see the active prosecution of an experiment so full of interest and so near to a practical solution, suddenly cut short by death. But the great things done by Siemens with gas produced in the manner referred to above, first in the gas glass furnace, described with glowing admiration by Faraday on Friday evening, June 20, 1862, in his last Royal Institution lecture, and more recently in connection with another great and exceedingly valuable invention, the Siemens process for making steel, by using the oxygen of iron ore to burn out part of the carbon from cast iron, and still more recently in the heating of the retorts for the production of ordinary lighting gas, by which a large increase has been obtained in the yield of gas per ton of coal used, are achieved results which live after the inventor has gone, and which, it is to be hoped, will give encouragement to push farther and farther on in practical realisation of the benefits to the world from the legacy of his great inventions.

A most interesting article on the life and work of Sir William Siemens in the *Times* of November 21 concludes with the following words, in which we fully sympathise:—"Those who knew him may mourn the kindly heart, the generous noble nature, so tolerant of imperfect knowledge, so impatient only at charlatanism and dishonesty; the nation at large has lost a faithful servant, chief among those who live only to better the life of their fellow-men by subduing the forces of nature to their use. Looking back along the line of England's scientific worthies, there are few who have served the people better than this her adopted son, few, if any, whose life's record will show so long a list of useful labours."

In private life Sir William Siemens, with his lively bright intelligence always present and eager to give pleasure and benefit to those around him, was a most lovable man, singularly unselfish and full of kind thought and care for others. The writer of the present article has for nearly a quarter of a century had the happiness of personal friendship with him. The occasions of meeting him, more frequent of late years, and more and more frequent to the very end, are among the happiest of recollections. The thought that they can now live only in memory is too full of grief to find expression in words.

WILLIAM THOMSON

In addition to the above notice by a master-hand we give the following details of Sir William Siemens's life and of the sad and solemn closing scene.

CHARLES WILLIAM SIEMENS was born at Lenthe, in Hanover, on April 4, 1823; he was educated at Lübeck, the Polytechnic School of Magdeburg, and had the advantage of sitting for a couple of sessions under Professors Wöhler and Himly at the Univerity of Göttingen, finishing his academical career at the age of nineteen. He stayed one year at the engine works of Count Stolberg, and when twenty years of age landed in England to introduce a new process of electro deposition, and, as stated above, was so successful that he made England his home. Another early invention of the two brothers was one which Faraday lectured upon at the Royal Institution one Friday evening under the title of the "Anastatic Printing Process of the Brothers Siemens."

Between his twentieth and thirtieth years he was mainly engaged in problems connected with mechanical engineering, improving the chronometric governor, bringing out a double-cylinder air-pump and a simple water-meter which has been extensively used both in this country and on the Continent. When twenty-four years of age he constructed a four horse-power steam-engine, with regenerative condensers, in the factory of Mr. John Hicks, of Bolton, and the Society of Arts acknowledged the value of the principle by giving him their gold medal in 1850. At this time also he made a modification of Grove's secondary battery, to which he referred two years ago at the Jubilee Meeting of the British Association. When just over thirty years of age he received the Telford prize and premium of the Institution of Mechanical Engineers for his paper "On the Conversion of Heat into Mechanical Effect," in which he defined a perfect engine as one in which all the heat applied to the elastic medium was consumed in its expansion behind a working piston, leaving no portion to be thrown into a condenser or into the atmosphere, and advised that expansion should be carried to the utmost possible limit. In taking up the question of heat he adopted the dynamical theory as the result of a study of the works of Joule, Mayer, and others, and we find him when thirty-two years of age exhibiting two steam-engines with regenerative condensers, the one of twenty and the other of seven horse-power at the Paris Exhibition of 1855.

Between his thirtieth and fortieth years he read several papers before the Institution of Civil Engineers on electrical subjects, and before the Institution of Mechanical Engineers upon the various inventions which he had already brought out. During this period also was established the firm of Siemens Brothers, which has become so famous for their machines, and submarine and land lines, four Transatlantic cables, the Indo-European line, the North China cable, the Platino-Braziliera cable, and others. In 1860, when engaged in superintending the electrical examination of the Malta and Alexandria telegraph cable, he thought of using the increased resistance of metallic conductors due to rise of temperature as a means for measuring temperature, and brought out next year a pyrometer based upon this principle.

He was now also engaged with his brother, Mr. Frederick Siemens, upon that invention with which his name has since been mainly connected—the regenerative gas furnace. By means of this furnace, which is now used all over the world, two evils which formerly appertained to heat furnaces are cured, viz. the discharge of the products of combustion at a very high temperature and in an incompletely combined state. Another advantage of this furnace is the very high temperature that could be attained by its use, and from the very first its author looked upon it as capable of accomplishing what Reaumur, and after him Heath, had proposed, namely, to produce steel on the open hearth. It was in 1862 that Mr. Charles Atwood made the first attempt to produce steel in this manner at Tow Law under a license from Mr. Siemens; but, though partially successful, it was afterwards abandoned; after one or two other disappointments, Mr. Siemens had to take the matter into his own hands, and having matured the process at his experimental works at Birmingham, he laid the foundation of an industry which now employs thousands of workmen at the works of the Landore Company, Vickers and Co. of Sheffield, the Steel Company of Scotland, and others, about half a million tons of mild steel having been produced last year in Great Britain alone. This steel is now used almost exclusively in Her Majesty's dockyards in the construction of the boilers and hulls of ships, and its use in private yards is extending rapidly.

On February 14, 1867, he brought before the Royal Society the paper on the conversion of dynamical into electrical force referred to by Sir William Thomson.

Not only to these large applications of electricity did Sir William Siemens direct his attention but to electro-metallurgy and horticulture. Those who were present at his lecture to the Royal Institution on March 12, 1880, will remember the stream of light which poured forth from his electric furnace when the lid was taken off the crucible to pour the fused steel into the mould, and the result of his experiments on the influence of electric light upon plant growth in the exhibition of peas, roses, lilies, and strawberries at this early season with the fruit partially developed. But the space at our disposal will only allow us to remind our readers of others of his inventions, his bathometer for measuring the depth of the sea, and his attraction meter (*Phil. Trans.*, 1876); the selenium eye, which was sensitive to variation of colour; the regeneracareous organisms in the surface waters and of the comparative rapidity with which these remains might be accumulated on the sea-bottom.

Reef-builders starting on a submarine bank, whether prepared for them by erosion, by subsidence, or by the upward growth of organic deposits, would form reefs that must necessarily tend to assume the atoll form The central portions of the colony or clump of coral will gradually be placed at a disadvantage as compared with the peripheral parts of the mass in being further removed from the food-supply, and will consequently dwindle and die. In proportion as the reef approaches the sea-level these central parts are brought into increasingly uncongenial conditions, until at last an outer ring of vigorous, growing coral-reef encircles an inside lagoon overlying the central stunted and dead portions. The possibility of such a sequence of events was likewise recognised by Darwin. "If a bank, either of rock or of hardened sediment," he says, "lay a few fathoms submerged, the simple growth of the coral, without the aid of subsidence, would produce a structure scarcely to be distinguished from a true atoll."[1]

As the atoll increases in size the lagoon becomes proportionately larger, partly from its waters being less supplied with pelagic food and therefore less favourable to the growth of the more massive kinds of coral, partly from the injurious effects of calcareous sediment upon coral-growth there, and partly also from the solvent action of the carbonic acid of the sea-water upon the dead coral. The solution of dead calcareous organisms by sea-water is undoubtedly one of the most interesting facts brought to light by the naturalists of the *Challenger* Expedition.

Moreover, a connected chain of atolls might be formed on a long, submarine bank, and similar conditions of growth would then be displayed as in the case of a single atoll. The marginal atolls having a better supply of food would grow more vigorously than those towards the centre, and would tend to assume elongated forms, according to the shape of the bank beneath them. Many of them might coalesce, and might even ultimately give rise to one large atoll. Such a chain of atolls as that of the great Maldive group may be thus explained without the necessity for any disseverment by oceanic currents as Darwin supposed. On the other hand, the submerged coral-banks of the Lakadivh, Caroline, and Chagos archipelagos may be regarded as representing various stages in the growth of coral-reefs, some of them being still too deep for reef-builders, others with coral-reefs which have not yet quite grown up to the surface. But scattered among these banks are some of the most completely formed atolls. Mr. Murray contends that it is difficult to conceive how such banks can have been due to subsidence, when their situation with respect to each other and to the perfect atolls is considered. He reverses the order of growth as given by Darwin, who cited the great Chagos bank as probably an example of an atoll which had been carried down by a subsidence more rapid than the rate at which the corals could build upwards.

From a careful study of barrier-reefs Mr. Murray concludes that, in their case also, all the phenomena can be explained without having recourse to subsidence. He found from personal observation and a comparison of the Admiralty charts that most exaggerated notions prevail regarding the depth of water immediately outside the reef, which is usually supposed to be very great. After minutely exploring the barrier-reef of Tahiti, and sounding the water both inside and outside the reefs, he found that the slopes are just such as might be looked for on the supposition that the corals have grown up without any sinking of the bottom. The accompanying section (Fig. 1), drawn to a true scale will show that there is nothing abnormal in the declivities. Beginning near the shore or wherever the bottom whether of rock or sediment comes within the range of the reef-builders, a barrier-reef grows vigorously along its outer face, while its inner parts, as in the case of an atoll and for the same reason, are enfeebled and die. The force of the breakers tears off huge masses, sometimes 20 or 30 feet long, from the face of the reef, especially where from the borings of mollusks, sponges, &c., the coral-rock has been weakened. These blocks tumble down the seaward face of the reef, forming a remarkably steep talus. It is this precipitous part of the reef which has probably given rise to the notion that the water outside suddenly descends to a profound depth. The steep front of fallen blocks is succeeded by a declivity covered with coral sand, beyond which the bottom slopes away at an angle of no more than 6°, and is covered chiefly with volcanic detritus. Mr. Murray insists that any seaward extension of the reef must be on the summit of the talus of broken coral. The reef will gradually recede from the shore of the island or continent, and will leave behind here and there a remnant to form an island in the slowly broadening lagoon-channel.

[1] *Op. cit.* p. 134.

The very general occurrence of proofs of elevation among the regions of barrier-reefs and atolls is in harmony with the volcanic origin of the ground on which these coral-formations have grown, but is, as Mr. Murray contends, most difficult of explanation on the theory of widespread subsidence. He affirms that all the chief features of coral-reefs and islands not only do not necessarily demand the hypothesis of subsidence, but may be satisfactorily accounted for, even in areas where the movement is an upward one, by the vigorous outward growth of the corals on the external faces of the reef in presence of abundant food, by their death, disintegration, and removal by the mechanical and chemical action of the sea in the inner parts, and by the influence of subaërial agencies and breaker-action in lowering the level of the upraised areas of coral-rock. ARCH. GEIKIE

(To be continued.)

NOTES

It will be seen from our Diary that the meeting of the Linnean Society on December 6 is to be exclusively devoted to the reading of a posthumous essay on Instinct by the late Mr. Darwin. We are informed that this essay is full of important and hitherto unpublished matter with regard to the facts of animal instinct considered in the light of the theory of natural selection; and as the existence of the essay has only now been divulged, we doubt not that the next meeting of the Linnean Society will be of an unusually interesting character.

The death is announced, at the age of seventy-six, of Mr. John Eliot Howard, F.R.S., well known as a chemist and quinologist. He was the son of Mr. Luke Howard, F.R.S., a well-known meteorologist in his day.

We announced some time ago that the Finnish Senate had voted a sum of 37,000 marks to Prof. Lemström for the continuation of his experiments with the aurora borealis at Sodankylä in the Finnish Lappmark during 1882-83, of which he gave an account in NATURE (vol. xxvii. p. 389). The plan to be followed during the present winter at this station is to make observations three times in every twenty-four hours, with the exception only of the first and fifteenth of every month, when they are made every five minutes throughout the twenty-four hours, and three days of the month when they will be effected every half minute during two hours. In order partly to obtain the necessary data for the control of the variation of the current from the atmosphere with the latitude, and partly to reduce the effect of probable influences, a branch station will be temporarily established during the months of November, December, January, February, and part of March at the buildings of the Kultala gold works, some distance from the principal station at Sodankylä. At Kultala exhaustive experiments will be made as to the effect which the increase of the area of the "utströmnings" apparatus, invented by Prof. Lemström for producing the aurora borealis, has on the intensity of the current. The observations will in other respects be the same at both stations. At Sodankylä they will be continued until September 1, 1884.

THE Report by the Board of Trade on their Proceedings and Business under the Weights and Measures Act, 1878, for the past year has been issued. The following are some of the leading points in the Report: During the past year the Standards Department has had the opportunity of assisting the United States Government in a comparison of their standard of length (Yard No. 57), with the standards at this office. Prof. C. S. Peirce, of the United States Coast and Geodetic Survey, came to London for this purpose in June last, on behalf of Prof. J. E. Hilgard, who has charge of the Bureau of Weights and Measures at Washington. A large number of comparisons of these measures was made with all possible care, and it was found that at 62° F., Yard No. 57 was 0·000022 inch longer than the Yard No. 1 deposited at this office. The results of these comparisons, as calculated by Prof. Peirce, will be referred to in a printed memorandum which will be separately drawn up. It was found necessary to test the accuracy of the standard kilogram, and the only resource was to apply to the Comité International des Poids et Mesures for permission to compare the British standard kilogram with that deposited at their bureau near Paris. By the report of this comparison, it is seen that our standard kilogram is now 2·0178 milligrams too light. The Report rather naively points out that, but for the courtesy of the Comité, the Standards Department would have been unable to re-verify our unit of metric weight, as this country is not represented on the Comité, and consequently does not contribute towards its expenses. In a previous Report it is also pointed out that the Board of Trade had been then able to avail itself of the results of the scientific researches which had been carried out under the directions of the Bureau. A note on the instrumental equipment of the Bureau of the Comité International is attached to the Report; of the equipment of this Bureau we recently gave a detailed description. The tables of densities and expansions hitherto in use at the Standards Office not having been found entirely in accord with the most recent scientific research, new tables have been drawn up for future use in the accurate comparisons of standards of measure and weight, and these are given in the Appendix. At the last annual trial of the pyx, the Report states, the differences in weight and fineness of the new coins then submitted for testing were again found to be far within the legal amounts allowed, *particularly on those allowed in the fineness of the gold coin.* With reference to the Electric Lighting Act, the Report remarks that with the advance of science there arise from time to time measures and weights of new forms and denominations which, in their application to commercial purposes, subsequently receive the sanction and force of legislative enactment. Among the most important of such new measures are those for the measurement of mechanical and of electrical energy, as applied to the measurement of electricity under the Electric Lighting Act of last year. A present unit of measurement has been taken in Provisional Orders under this Act, which is equivalent to "the energy contained in a current of 1000 amperes flowing under an electromotive force of one volt during one hour." No practical meter of electricity capable of use in commerce and daily life has yet received official sanction. The Report and Appendices show that Mr. Chaney continues the work of his office as efficiently as his means will permit.

AT the last sitting of the Academy of Sciences M. Pasteur read and commented on a posthumous paper by Dr. Thuilier his pupil, who died in Alexandria, where he was sent in August, in order to make observations on cholera. The late Dr. Thuilier takes an intermediate position between M. Pasteur and M. Bouchardat. M. Pasteur seems not to be quite opposed to the views of his pupil.

THE German Cholera Commission are going, not, as they originally intended, to Bombay, but to Calcutta, as they consider the latter place more suitable for their investigations.

IN an official pamphlet published at Washington there is an interesting sketch of the work and history of the United States Bureau of Education. Not only does the Bureau publish reports on education in the United States, but at frequent intervals issues "Circulars of Information" containing data of great value, and in many cases not otherwise accessible. Among other things these circulars contain information on the systems of education in nearly every civilised country, including China; the pamphlet referred to contains a useful list of all the circulars issued, with their contents.

IN the report by Dr. Daniel Draper on the New York Meteorological Observatory for 1882, it is shown that the actual hours of sunshine at Greenwich Observatory were 1245 in 1878 and 977 in 1879, when the possible hours were 4447; whereas at New York in the former year the actual hours were 2936, and in the latter 3101, when the possible hours were 4449.

THE "Howard" Medal of the Statistical Society for 1883, with a prize of 20*l*., has been awarded to Dr. R. D. R. Sweeting, S.Sc. Cert. Camb., Medical Superintendent of the Western District Fever Hospital, Fulham, for the best essay on "The experiences and opinions of John Howard on the preservation and improvement of the health of the inmates of schools, prisons, workhouses, hospitals, and other public institutions, as far as health is affected by structural arrangements relating to supplies of air and water, drainage," &c.

THE cultivation of Sorghum (*S. saccharatum*) and the manufacture of sugar from its stems has of late occupied a large share of attention by the Government in America, reports on which have been issued at different times. The most recent of these is an "Investigation of the Scientific and Economic Relations of the Sorghum Sugar Industry." This is in the form of a report drawn up by the committee of the National Academy of Sciences, in which the subject of the cultivation, production, and manufacture of the sugar is treated in considerable detail. The report is one of considerable value, especially to those interested in the progress of this industry.

FROM Dr. King's Annual Report of the Royal Botanic Garden, Calcutta, for the year 1882-83, and Mr. J. F. Duthie's Report of the Government Botanical Gardens at Saharunpur and Mussoorie for the year ending March 31, 1883, both of which have recently reached us, we learn something of the progress of botany at these botanical centres in India. It is satisfactory to note that at Calcutta considerable improvements have been effected during the year, not only in the general arrangements of the garden itself but also in the scientific department, for Dr. King informs us that "the bamboo and mat erections which used to do duty as conservatories have been replaced by three large, handsome, and efficient structures of iron, on which a thin thatch of grass is spread, and under shelter of which tropical plants thrive admirably." As usual at Calcutta considerable attention has been given to various economic plants, notably those which produce the valuable article indiarubber, and which have occupied so much attention of late. Dr. King says the cultivation of the soy bean of Japan (*Glycine soja*) has of late been pressed on the people of India, and "more in obedience to the loudness of this clamour than from a belief in its soundness" he has arranged that is, the practice of setting fire to the trees in order to clear the ground, is still carried on extensively. The clearing away of the woods is to prepare the ground for agriculture, but as much or more by the preparation of the soil as by obtaining space for the cultivation contemplated, and this is the peculiarity of the usage. The trees growing on the spot selected are burned, and the seed is sown on the soil thus manured with the ashes of the trees. The effects of *sartage* in other European countries, in India, and in North America, are brought under notice and discussed at some length. In France it is a practice recognised both in forest science and in forest management, but whereas it was formerly resorted to largely it is now adopted only in special circumstances. It is there found that the oak, particularly a hardy variety known as the *rouvre*, of all forest trees sustains best the treatment of *sartage*. In the Ardennes the coppice woods of *rouvre*, which are so treated, yield excellent firewood and charcoal. The burning is carried out in August and September, and, at the proper time for sowing cereals, rye or buckwheat is scattered over the ground and covered with a light hoe. After the crop is reaped the young tree-shoots begin to grow rapidly, but it is often necessary in order to insure perpetuity of good growths to plant out seedlings, and this is especially the case with the oak.

At the present time there are in Finland districts in which *sartage* is now prohibited, others in which it is carried on under restrictions, and others in which it is tolerated and apparently freely practised. Should the cleared ground not be retained permanently under agriculture, it is likely to become covered again with a crop of self-sown trees, of the same kind as those destroyed, or of a kind of higher pecuniary value. On the banks of the Saima See, for example, fir trees have been replaced either by firs or by birch. The fir or pine may be of more value for building purposes, but the birch supplies a better firewood, and for this there is and probably will long continue an ever-increasing demand in St. Petersburg, to which it can be sent from most places in Finland by water.

When a crop of trees after destruction is not replaced by another crop, the proximate effect upon the climate is generally considered to be beneficial to agriculture. But in Sweden in many districts in which the forests have been cleared away it is remarked that spring now begins a fortnight later than it did in the last century, and this is attributed to protracted frost due to diminished humidity of the atmosphere.

The improved forest economy of France dates from the issue of the celebrated Forest Ordinance of 1669, if not from a much earlier period. But in Finland all improvements in forest economy have been effected since 1809, and particularly during the last twenty-five years. Though formerly an independent country, Finland was for a long time a province of Sweden, and in 1809 it was annexed to the dominions of Russia as a Grand Duchy, with the enjoyment of pre-existing privileges and of government under its own laws issued in accordance with its Constitution. In 1848 were sent out Imperial Instructions relative to the management of the Crown forests, along with regulations respecting projected surveys, and in 1858 new arrangements for the management of these forests were made.

The forest administration of Finland is now in the hands of well-trained officers, and much of the lavish waste of former days has ceased. By giving more attention to considerate thinning, by more skilful conservation and more scientific exploitation, it was felt that the "produce and the products of the forests might be equalised approximately, if not perfectly," and one object aimed at in the inspection of forests is to prevent the removal of trees being effected more rapidly than the re-growth. As has been remarked, Finland has a constant market for firewood and timber in St. Petersburg, where firewood is now more expensive than coal brought from Britain.

It is to its School of Forestry at Evois that Finland looks for its supply of trained forest conservators. This school was opened in 1859, and intending students were required to produce before admission a university diploma, or a first class certificate of the completion of the course of study at a gymnasium. Closed after a time from lack of students, it was reorganised and reopened in 1874. The course of study occupies two years, and the subjects are forest science, surveying, engineering, rural economy, legal economy, and drawing. In July and August the pupils are required, for the sake of practice, to measure fields and woods, and to estimate the quantities of standing timber. We observe that under forest science is included "the science of hunting," whereat many an English youth would no doubt be inclined to say "Happy Finlanders!" Officered by men trained in this school, the Finnish forest administration is now in a position to attain objects identical with those of the advanced forest economy of Europe: first, to secure a sustained production from the forests; secondly, to secure along with this an amelioration of their condition; and thirdly, a reproduction of them by self-sown seed when felled.

Readers who are interested in forest conservancy will find much valuable information in the middle section of Dr. Brown's work. The subject is one which must ere long force itself on the attention of political economists. The reckless clearances that have been effected in our Canadian territories are approaching a limit; the most cautious estimates do not allow a longer period than fifteen years for the exhaustion of our Canadian timber lands at the present rate of consumption, and one very trustworthy and experienced authority limits it to seven years.

W. FREAM

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Optical Phenomena

THE phenomenon described as "Cloud-Glow" by your correspondent, Mr. F. A. R. Russell, in NATURE of the 15th inst. (p. 55), and by Mr. J. J. Walker in your last issue (p. 77), was observed here by me; as, however, the time my observation commenced (5 p.m.) was three-quarters of an hour later than the time given by Mr. Russell (4.18 p.m.) it is probable that many of the features described by him had faded before the phenomenon came under my notice. As seen by me, the appearance consisted of an arc-like mass of glowing vapour of a ruddy hue, in the case of London, and less but perceptibly so in that of Brighton, the light has become of a more silvery hue, due doubtless to the extensive use of the electric light. The distance between this place (lat. 51°, long. 0) and London is about thirty-five miles in a direct line, and there is no place of any size between these points, so there can be no mistake about it; and that the reflection of light at such a distance should be visible seems worthy of notice. It would be interesting to know how far, under favourable atmospheric conditions, the reflection of the London lights can really be seen. W. J. TRENTLER

Fletching, Sussex, November 22

A Lunar Rainbow

ANY of your readers who happened to observe the heavens on Saturday night, the 17th inst., at about 11.15 to 11.30, could not fail to notice the beautiful lunar rainbow which was then visible. Though the moon had slightly passed its perigee, it was shining with such dazzling brilliance that the marbled shadows on its surface were almost effaced, and it hung in the heavens like a spotless crystal sun. The very stars seemed farther away, as though they had shrunk back, ashamed and frighted by the silver glory. Jupiter and Sirius alone stood fearless and undaunted—the former, below her to the left, as if in attendance, the latter far away in the starless south. A few featherlike clouds which the moon illumined with a splendour of her own, now and again sailed in stately silence across her path, but that portion which spread directly over her face, seemed to melt and become invisible like a snow flake on a warm hand, so that the cloud floated around her as a veil, fringing but not covering her face. It was when surrounded by one of these clouds that the rainbow became visible. I had never seen one before, so cannot say whether it was more distinct and bright than is usually the case, but I could see most vividly the red, yellow, green, and violet bands with their intermediate shades. The bow seemed formed on the cloud that shaded the moon at the time, and lay round her in a perfect, though comparatively small circle. It remained so for some nine or ten minutes, and then faded gradually away into a luminous halo of golden brown. Those of your readers who were fortunate enough to behold this beautiful phenomenon will, I am sure, agree with me that it was a sight not to be forgotten. J. C. KERNAHAN

The London Institution, November 24

Sudden Stoppage of Clocks

I HAVE four clocks in my house; one is on a wall that bears north-east and south-west, while the other three ranged nearly at right angles about north-west and south-east. The times of these clocks were not exactly together, there being from five to fifteen minutes between the times; but all of them stopped on the morning of November 18 at times as recorded by each between 3.25 a.m. and 3.40 a.m. Have any other clocks stopped on the same night? This place—Lurgybrack, Letterkenny, Co. Donegal, is in lat. 54° 56″ and W. long. 7° 41′ 52″.

Letterkenny, November 19 G. HENRY KINAHAN

Fog Bows

ON November 14, when driving about half way between Convoy and Letterkenny, Co. Donegal, I observed a very complete bow at about 1 p.m., due solely to a fog. For the most part it was quite white, but at the springing there were slight traces of prismatic colours. On November 15 at 7 a.m. at Letterkenny there was also a fog bow; this, however, had all through well developed prismatic colours. The 15th afterwards came on a heavy wet day; the 16th was fine; but since then there have been severe winds accompanied with sleet, snow, and rain. G. H. KINAHAN

Letterkenny, November 19

THE EARLY HISTORY OF THE HERRING[1]

THE Admiralty having intimated on July 31 that they were prepared to grant the use of a gunboat to enable the Board to undertake some investigations into the early history of the herring, the convener of the Committee appointed to carry on these inquiries made as complete arrangements as was possible in the limited time, and, along with Sir James R. Gibson-Maitland, proceeded to join Her Majesty's gunboat *Jackal* at Invergordon on August 6. Besides making preparations to collect material to illustrate the growth of the herring during the early stages of its development, it was thought desirable to make arrangements for the examination of the spawning grounds, in order to ascertain under what conditions the spawn was deposited. To assist in the work Mr. J. Gibson, D.Sc., of the Edinburgh University Chemical Laboratory, and Mr. J. T. Cunningham, B.A., of the Zoological Laboratory, were invited to join the expedition.

The trawls, dredges, and other appliances were taken on board on August 6, and on the following day the *Jackal* left Invergordon for the Moray Firth, and began the work of investigating the inshore spawning grounds lying between Wick and Fraserburgh. Each place examined was indicated by a number on the chart, and will be spoken of in the Report as a "station." During the month the *Jackal* was at our disposal sixty stations were made, and nearly as many by the *Vigilant* from the time she relieved the *Jackal* to her return to Granton on Oct ber 6. The plan generally adopted at the various stations consisted in (1) taking the depth and the surface and bottom temperatures; (2) collecting samples of water from the bottom, and of the mud, sand, &c., brought up by the sounding apparatus; (3) noting the nature of the surface fauna taken in the tow-net; and (4) examining and, when necessary, preserving the animal and vegetable forms brought up by the trawl, dredges, and tangles. In this way there has been collected a considerable amount of raw material, from which important results will in due time be obtained.

Not the least interesting part of the work consisted in experimenting with herring ova which were successfully artificially impregnated and developed. At first experiments were made with spawn obtained at Helmsdale on August 7, from herring which had been several hours out of the water; but the results being unsatisfactory, it was determined to obtain, if possible, the roe and milt from living fish. We, therefore, frequently remained during the night on the fishing ground, and boarded the herring boats when the nets were being hauled. The fishermen, always pleased to see us, rendered every assistance in their power. Selecting ripe fish, we expressed the roe and milt on squares of glass, which were then placed in carrying boxes specially designed for the purpose. The boxes were conveyed by the *Jackal* to a small laboratory near Geanies, which had been kindly placed at the disposal of the Committee. Once at the laboratory, the glass plates, with the developing eggs firmly adhering to them, were transferred to hatching boxes, through which a constant current of water flowed from a large tank. In from three to five days well formed active embryos were visible through the thin transparent egg membrane, and in ten days we successfully hatched fry from the artificially impregnated ova. We soon discovered that success depended on having an abundant supply of pure sea-water at an equable temperature. Unfortunately, just as our arrangements for experimenting on a large scale were completed, the herring fishing in the Moray Firth came suddenly to an end, and it was impossible to obtain further supplies of eggs.

We next directed our attention to the nature of the surface forms, which are believed to supply the principal food for the herring fry, and when this, on account of the weather, was no longer possible, we proceeded to examine the mussel scalps in the Dornoch, Cromarty, and Inverness Firths.

As a full account of the autumn's work will be presented to the Board in time for the Annual Report, only a short statement is now given, indicating rather the

[1] Preliminary Report of the Investigation Committee of the Fishery Board for Scotland.

lines of further investigations than the results already obtained.

During our stay in the Moray Firth our attention was constantly directed to the change in the position of the spawning grounds. It was stated that, some fifteen years ago, immense shoals of herring visited the inshore ground, in order to deposit their spawn in comparatively shallow water, but that now they had deserted their former favourite haunts for banks from thirty to eighty miles at sea, lying at a depth of from thirty to fifty fathoms. This has caused great distress, as from the absence of suitable harbour accommodation, the large boats fish from distant stations, and the inshore "takes" of the smaller boats (all of which can be beached) is not now sufficient to give employment to the local population in curing. The Report of the Commissioners for British Fisheries for 1862 gives the total take at the ports especially devoted to the inshore fishing, viz. Lybster, Helmsdale, Cromarty, Findhorn, and Buckie, as 158,314 barrels, whereas in 1882 it was only 31,574. On the other hand, at Fraserburgh, a great centre for the deep-sea fishing, the take has increased from 77,124 in 1862 to 233,297 in 1882. Though these figures, and our experience during the autumn, show conclusively that herring are no longer so abundant on the inshore grounds, they do not prove that the shoals are every year spawning farther and farther from our shores, as is often alleged, or that, if we continue to disturb the offshore spawning grounds as we have the inshore, they will disappear from our waters altogether. Some who have had considerable experience believe that spawn deposited in forty fathoms water never develops, and that even if it did the herring fry would perish for want of the proper nourishment.

The disappearance of herring from inshore grounds is accounted for in many ways by the fishermen. Some believe that the offshore fishermen prevent the shoals from reaching the coast by the many miles of nets which they throw across their path; others that the inshore fishing has been destroyed by the winter sprat fishing, most of the so-called sprats being young herring. The former explanation seems to imply that the inshore and deep-sea herring are identical, whereas the latter seems to indicate that they are different. The Report of the German Commission bears that there is a difference between the autumn and spring herring of the Baltic; there may also be a difference between the deep-sea and inshore forms. When this problem is solved we may be able to account for the disappearance of the inshore herring. Should some herring have been so modified that they prefer to spawn on rocky ground in shallow brackish water rather than on deep gravel banks in the open sea, or if herring return to their birthplace to spawn, it will be possible by skilful management to restore the inshore fishing to its original productiveness.

Having examined the inshore spawning grounds, we next proceeded to investigate the banks where the deep-sea herring were believed to spawn. At the outset we felt there was no evidence that these banks had not always been used by herrings as spawning beds. We do know, however, that as the herring boats increased in size enterprising fishermen were enabled to proceed farther to sea, and as a reward they discovered great shoals of herring, the comparative density and condition of which form an interesting subject for immediate investigation. It may have been a mere coincidence that this took place about the same time as the inshore shoals began to diminish. We have no reason for supposing that what we now speak of as deep-sea herring have not been as abundant for centuries as they are at the present day. Man, it seems to your Committee, is not likely much to reduce the number of herring some fifty miles at sea, however much influence he may exert over those which frequent our territorial waters. The time at our disposal did not permit our making a thorough examination of the offshore grounds; in fact, we were only able to begin this part of the work. But there can be no doubt, from the observations already made, that spawn is deposited on these banks, and that the slight difference of the bottom temperature (some 3° C.) would only slightly retard development. Further, the fry once hatched would find an ample supply of food in the rich surface fauna.

The Committee feel that, in order to obtain satisfactory information as to the food of the herring, it will be necessary to make continuous observations for a year or more at all the principal fishing stations around our coast. This could easily be undertaken through the fishery officers.

As to the so-called migrations of the herring, the Committee has not had sufficient time to make a careful investigation, but from the observations made it seems evident that, as the spawning season approaches, the isolated herring and the small groups congregate together, and thus form dense shoals. The shoals once formed instinctively select banks free from mud and shifting sand, and provided with numerous rocks and stones, or with an abundant coating of seaweeds. Having found a convenient bank covered with water at a suitable temperature, and with the requisite specific gravity, they hover over it, if left undisturbed, apparently not paying much heed to the claims of hunger, but feeding on whatever crustacea, sand eels, or other small forms come in their way. The spawn once ripe, they congregate at the bottom, the females depositing the roe on the rocks and seaweeds, to which it at once firmly adheres, and the males fertilising it with their milt. How long a period is required for the whole of the roe to escape has yet to be ascertained. Soon after the "shotten" condition is reached, both males and females begin to leave the spawning ground,—hunger being probably the chief factor in the dispersal of the spent fish,—and this goes on until the whole shoal is dispersed, the hungry disbanded members, either singly or in small companies, hurrying hither and thither in anxious search of food. When they have partly recovered from their exhausted condition they may collect into larger groups; but their further movements are probably largely influenced by the shoals of crustacea on which they chiefly subsist. In all probability their principal feeding ground lies somewhere between the Shetland Islands and the Scandinavian coast. This region is probably the great reserve feeding ground for the fish of the North Sea, and it should at an early date be carefully explored.

The examination of the three firths—Dornoch, Cromarty, and Inverness—has shown that they are all extremely well adapted for producing mussels. Part of the Dornoch Firth already is a considerable source of wealth to the authorities of Tain, but even there the cultivation might be greatly extended. The demand for mussels is great, and the want of them, when herring are unattainable, is often a great hardship to the fishermen; with a little care, the three firths mentioned would supply bait for the whole east coast of Scotland.

The Committee recommend the Board to remit the consideration of the Scottish mussel and oyster banks to a special committee, with the view of taking steps to have their complete control transferred from the Board of Trade to the Scottish Fishery Board.

As the work of the Committee proceeded they have been impressed with the fact that almost everything has still to be learned regarding the habits and life-history of all our food fishes, and they concur in the truth of the following extract from a recent report of the International Fisheries Exhibition:—"It is a very striking fact that the one point on which all speakers at the conferences held during the past summer at the Exhibition were agreed was this—that our knowledge of the habits, time and place of spawning, food peculiarities of the young, migrations, &c., of the fish which form the basis of British fisheries is lamentably deficient, and that without further knowledge any legislation or attempts to improve our fisheries by better modes of fishing, or by protection or culture, must be dangerous, and, indeed, unreasonable."

Further, your Committee feel that in order to make any progress the work must be undertaken in a systematic manner; the investigations must not be carried on by fits and starts, but continuously from month to month and from year to year, until all the facts have been collected and all the experiments made that are likely to throw any light on the difficult problems.

It having been alleged that the food fishes were disappearing from the eastern coasts of the United States, the Central Government in 1871 appointed a commissioner of fish and fisheries to inquire into the matter. The commissioner, instead of contenting himself with collecting evidence from people who knew little or nothing about the subject, proceeded to make careful and elaborate investigations. As the result of these inquiries the United States fisheries have been greatly improved, to the benefit of both the general public and the fishermen, and our knowledge of fish has been materially increased.

In the same way, and about the same time, a German Commission set to work, and although their results are not so striking, they are extremely interesting, a fourth section of their report, only published the other day, containing a careful description, with an outline drawing, of all the fish found in the Baltic.

The example set by America, Germany, and other Continental States we must follow. We have as a nation at last made a liberal acknowledgment of our ignorance, and at the conferences of the International Fisheries Exhibition expressed regret.

It is satisfactory that, while we are taking steps to increase our knowledge, we shall at one and the same time be improving our inshore fisheries. The measures necessary, *e.g.* for enabling us to discover for the first time when herring fry become maties, and when maties reach the stage of full herrings, are exactly the measures required for the artificial cultivation of the herring. From experience gained during the autumn we are now able to hatch immense numbers of herring; each herring produces from 30,000 to 50,000 eggs, but so small are they that 20,000 one layer thick can be placed on a square foot of glass, and from 1000 herrings it would be possible to obtain about 30,000,000 fry, and this in from ten to fifteen days. It is well known that where there is an abundance of herring there is also an abundance of cod and other food fish, hence the annual introduction of some millions of young herring into our territorial waters might serve to attract numerous large food fishes to our shores. And what is true of the herring holds for many other useful fishes, and some of them, such as the sole and turbot, which are less migratory than the herring, might be manipulated in much the same way as trout and salmon, if we only knew more of their habits.

In order to be able to carry on the work of investigation, the importance of which is now universally recognised, the Committee recommend that an application be made for sufficient funds to enable the Board to establish a marine station, and further that a steam vessel take the place of the *Vigilant* at present at the service of the Board.

The *Vigilant* is in every respect inadequate for the ordinary work of the Board, and if there is added to that work the acquiring of new knowledge as to the habits of our food fishes, the nature of their food, their time and place of spawning, and the way in which these may be influenced by the various modes of fishing, a steam vessel will be absolutely necessary.

The Committee have much pleasure in stating that they are deeply indebted to Lieut. Prickett, in command of H.M.S. *Jackal*, for the ready assistance rendered by him and his officers, and for their unfailing courtesy and kindness during the expedition.

They have also to state that it was a source of great satisfaction to them to find that the commander of the *Vigilant* was not only greatly interested in the work of the Committee, but that, having a strong instinct for scientific work, he will be able to render much assistance in any further investigations that may be undertaken.

To Mr. Romanes, F.R.S., the Committee are greatly indebted for many valuable suggestions, and they are also indebted for the use of the Marine Laboratory instituted some years ago by Mr. Romanes and Prof. Ewart. Without this laboratory much of the work which will form the substance of the forthcoming Report could not have been undertaken.

J. COSSAR EWART, Convener
J. R. GIBSON-MAITLAND
A. FORBES IRVINE
J. MAXTONE GRAHAM

Edinburgh, November 5

THE ORIGIN OF CORAL-REEFS

SO much additional information has in recent years been obtained regarding the physical and biological conditions of the sea that such a problem as that presented by the coral-islands of mid-ocean may well be reconsidered. Several able naturalists have lately called attention to this problem, and have insisted that the generally received solution of it is not satisfactory. Among geologists there may not unreasonably be a good deal of unwillingness to admit that this contention can be well-founded. They have long been accustomed to regard Darwin's theory of coral-formation with justifiable pride as a masterpiece of exhaustive observation and brilliant generalisation. It has played an important part in their speculations regarding the larger movements of the earth's crust, and they have been so deeply impressed with its simplicity, and the grandeur of the conclusions to which it leads, that they will naturally and rightly refuse to surrender any portion of it save under the strongest compulsion of evidence. Some, indeed, may be inclined even to resent, almost with the warmth inspired by a personal injury, any attempt to show that it can no longer claim the general applicability which has been regarded as one of the strongest arguments in its favour. But the example of Darwin's own candour and overmastering love of truth remains to assure us that no one would have welcomed fresh discoveries more heartily than he, even should they lead to the setting aside of some of his own work. I propose to give here somewhat in detail the more important data accumulated in recent years on this subject, and to state the conclusions to which a careful consideration of the evidence seems to me inevitably to lead.

Before the memorable voyage of the *Beagle*, the generally received opinion regarding the origin of the circular coral-reefs or atolls of mid-ocean was that they had grown up on the rims of submerged volcanic craters. The enormous size of some of the atolls—thirty miles in diameter—might have been thought a sufficiently formidable objection to this explanation. But it did not appear insuperable even to so cautious a philosopher as Lyell, who only noticed it to refer his readers to the great dimensions reached by truncated volcanic cones, which he thought might retain their forms more easily under a deep sea than on land.[1]

An earlier and better theory, as Darwin admitted, had been started by Chamisso, who supposed that the circular form of an atoll was due to the fact that, as the more massive kinds of coral thrive most vigorously in the play of the surf, they naturally keep to the outside of the reef, and raise that portion to the surface

[1] "Principles of Geology," 4th edit. (1835), vol. iii. p. 310.

first. But when Darwin's own views were published, first in abstract before the Geological Society in 1837, and subsequently more fully in his separate volume on the Structure and Distribution of Coral-reefs in 1842, they were soon generally accepted, and were regarded not only as affording a satisfactory explanation of the whole phenomena, but as comprising one of the most impressive generalisations with which geology, fertile in such achievements, had yet astonished the world.

The theory proposed by Darwin, now so familiar, connected all the types of reef together as stages of one long process, every step in which could be illustrated by actual examples. At the one end stood the fringing-reefs, some of which might only lately have been started upon a recently upraised sea-bottom. Out of this stage, by continuous or intermittent subsidence, came barrier-reefs. Then as depression went on and the islands encircled by the barrier-reefs disappeared, their sites were taken by atolls. Lastly, where the rate of subsidence was too rapid for the upward growth of the corals, an atoll might become a submerged bank. Not only was this explanation self-consistent, but it harmonised well with the conclusion, derived from totally different evidence, that there may have been widespread and long-continued subsidence over the ocean basins. It was moreover supported by the independent testimony of competent observers, who, with at least equal opportunities of studying the subject, had espoused Darwin's views. Of these witnesses the most important was undoubtedly Prof. Dana, who accompanied the Wilkes Exploring Expedition of 1838-42.[1] Another powerful ally was found in Mr. Couthouy, who had studied coral-growth in the Pacific and in the West Indian seas.[2] But even without the concurrent testimony of eye-witnesses the theory proposed by Darwin fitted so admirably into the geological theory of the day that it came itself to be used as one of the most cogent proofs of vast oceanic depression. And such is still the position which it holds.

By a gradually widening circle of observation, however, a series of facts has been established, which were either not known or only partially known to Darwin. It should be borne in mind that, compared with more recent explorers, he did not enjoy a large opportunity of investigating coral-reefs. So far as can be judged from his published works, he appears to have examined only one atoll—the Keeling reef; and one barrier reef—that of

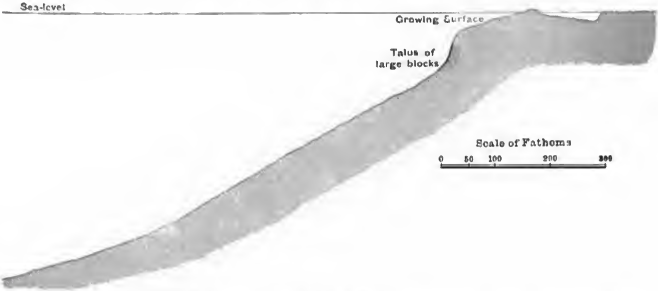


FIG. 1.—Section of the Barrier Reef, Tahiti, on a true scale, vertical and horizontal. By Mr. Murray and Lieut. Swire, R.N., of the *Challenger* Expedition.

Tahiti. The Admiralty charts, the work of previous voyagers, and unpublished information communicated to him, enabled him to extend his generalisation over the whole of the rest of the coral-regions which he had not personally explored. The deep-sea expeditions of recent years have now brought so much new light to bear on the whole question that we are in a much better position to discuss it than he was, nearly half a century ago. Of a few of the more important investigations a brief *résumé* may here be given, and their bearing upon Darwin's theory of coral-reefs will then be discussed.

As far back as the year 1851 the late L. Agassiz stated that, in his opinion, the theory of subsidence could not be applied in explanation of the Florida reefs; that on the contrary the southern end of Florida is built up on successive concentric barrier-reefs which have been gradually connected and cemented into continuous dry land by the accumulation of mud-flats between them, and that this process is still going on and must eventually convert the present keys and reefs from Cape Florida to the Tortugas into similar land.[1]

In 1863 Prof. Carl Semper published the results of his researches among the Pelew Islands. He found himself unable, by the theory of subsidence, to account for the phenomena there presented, and threw doubts on the general applicability of that theory. He pointed out that while the southern islands, probably once atolls, consist of coral-rock, upraised to from 400 to 500 feet above the sea, and are flanked by living coast-reefs, true living atolls exist at the northern end of the group. He contended that there is absolutely no evidence of subsidence, that the association of all the different kinds of reefs within so circumscribed an area seems entirely to disprove the notion of subsidence, and that, at least in this group of islands, Darwin's theory cannot be applied. In some suggestive observations on their probable origin, he remarks that the reefs depend mainly for their form upon the nature of the bottom on which they begin. Atolls are formed on submarine banks. A species of *Porites* takes root in little colonies varying from the size of the fist to masses six or eight feet in diameter. In time the central portions of these growing colonies die, while the outer

[1] *Bull. Mus. Comp. Zool.*, vol. i. See also J. Le Conte, *Silliman's Journal*, xxiii. (1857), p. 46, and E. B. Hunt, *op. cit.* xxxv. (1863), p. 388.

[1] The narrative containing Prof. Dana's observations on coral-reefs was published among the Reports of the Expedition. In 1872 he published a volume on "Coral and Coral-Reefs," where he again gave the weight of his authority to the theory of subsidence.

[2] *Boston Journ. Nat. Hist.*, iv. (1843-44), p. 137.

parts flourish and gradually build up a ring of coral. This ring, which may be circular or elongated in form, is sometimes continuous, but more commonly is traversed by one or more channels. The interior portions are scoured out and deepened by the tidal currents. Or if the form of the bottom and other conditions be suitable, a great many individual masses of coral gradually grow into a more or less continuous reef, through which the strong ebb and flow of the tides serve to keep open some channels. Thus fringing-reefs, through the scour of the sea, become barrier-reefs, which retreat from the adjacent coast in proportion to the gentleness of the slope on which they are built. On a steeply shelving sea-bottom the reefs must obviously remain fringing-reefs.

Dr. Semper admitted that possibly many atolls and barrier-reefs were formed during subsidence, and even that the downward movement may in many cases have furnished the conditions for starting them into existence. The solution of the problem ought in each case, he thought, to be determined by actual detailed observation. But that the alternate currents of the tides are the main agents in the building of coral-reefs could be proved, he maintained, by many cases which, on the theory of subsidence, must be regarded as exceptional of inexplicable, such as the occurrence of true atolls in the midst of areas of elevation.[1]

In the second edition of his "Coral Islands," published in 1874, Darwin briefly referred to these observations. He thought it not improbable that the Pelew Islands originally subsided, were afterwards upraised, and again subsided, but admitted that the proximity of fringing-reefs was opposed to his views. He suggested that if the submarine slope were steep reefs which began as fringing-reefs would continue to be of that form, even during subsidence. There is, however, no admission that any valid objection had been made to his theory, or that true atolls and barrier-reefs might be formed in many places without subsidence.

In 1868 Prof. Semper reiterated his dissent from the prevailing theory of coral-reefs.[2] Next year he reprinted his original paper (which seemed to him to have remained unknown to most naturalists) in a general account of the Philippine Islands, wherein he appended some additional notes.[3] In one of these he refers to the observations of Pourtales and others on a submarine calcareous deposit which in some regions is slowly being upraised to serve as a foundation for coral-reefs. To the objection that if atolls and barrier-reefs could be formed during a period of elevation, they ought to be found not merely at, or only slightly above sea-level, he replies that they are not in fact confined to that limited zone, but that even if they were, this would not invalidate his conclusion that the reefs are due to a complex cooperation of coral-growth with the waves and currents of the sea, and not to the one cause—the subsidence of entire regions—invoked by Darwin.

In the following year another contribution to the anti-subsidence literature was made by Dr. J. J. Rein, who, in an interesting memoir on the physical geography of Bermuda, offered some observations on the coral-reefs of those islands.[4] He suggested that the Bermuda group might originally have been a submarine mountain or bank on which colonies of deep-water corals took root, and where other organisms flourished in such abundance as gradually to raise the top of the submerged ground to the zone in which reef-building corals could flourish. He adduced no evidence in support of this suggestion further than that there is no proof in Bermuda of subsidence, which, however, as Darwin had so cogently shown, from the very fact of the movement being downward, is in most cases not to be looked for.

An important memoir, marking a totally new departure in coral-reef literature, appeared in 1880 containing an abstract of observations made by Mr. Murray during the great voyage of the *Challenger*.[1] The chief features of this contribution may be thus briefly summarised :—With hardly an exception the oceanic islands are of volcanic origin, and it is therefore to be presumed that the submarine ridges and peaks, which rise to within various distances from the surface, are likewise due to the protrusion of volcanic materials. There is thus no actual evidence of the still unsubmerged portions of any extensive continent or mass of land such as Darwin's theory requires. Whether built up above the sea-level into islands, or brought up to varying heights below that level, the volcanic eminences of the ocean may conceivably be brought into the condition of platforms for reef-builders by two causes. In the first place the erosive force of waves and tidal scour must tend to reduce all prominent oceanic summits to the lower limit of breaker-action, and thereby to produce truncated cones or flattened domes and ridges on which coral-reefs, if not already established, might spring up. In the second place, submarine eminences may have been brought up to within the zone of the reef-builders by the deposit of organic detritus upon them. One of the most remarkable results of recent deep-sea exploration has been the accumulated evidence of the extraordinary profusion of pelagic life in the tropical surface waters. From experiments made during the cruise of the *Challenger*, Mr. Murray estimated that, if the organisms are as numerous down to a depth of 100 fathoms as they were found to be in the track of the tow-net, there must be more than sixteen tons of carbonate of lime in the form of calcareous shells in the uppermost hundred fathoms of every square mile of ocean. The shells and skeletons of these organisms fall in a constant rain to the bottom, where they supply some of the food needed by the fauna which there subsists upon the mud. By the accumulation partly of these superficial exuviæ, partly of the remains of the creatures living at the bottom, an organic deposit is growing over the sea-floor in the tropical regions wherein coral-reefs flourish. Owing probably to the greater solvent action of the increased proportion of carbonic acid in sea-water at great depths, or to the greater mass of water through which they must sink, the shells of the upper waters seem never to reach the bottom or at least soon disappear from it, for they are seldom met with in deep dredgings. But in shallower portions of the ocean they abound. Consequently it may be legitimately inferred that the rate of growth of the calcareous organic deposit on the sea-bottom must be more rapid in the shallower waters. The tops of submarine peaks and banks, being constantly heightened from this cause, will in course of time be brought up to a depth at which sponges, hydroids, deep-sea corals, annelids, alcyonarians, mollusks, polyzoa, echinoderms, and other organisms can flourish abundantly. When this has taken place, the upward growth of the calcareous formation will be accelerated by the accumulation of the remains of this abundant fauna as it lives and dies on the bottom. At last the zone of reef-building corals will be reached, and thereafter a growth of coral-rock will bring the sea-floor up to the level of low water. That coral-reefs undistinguishable from barrier-reefs and even atolls might be formed upon banks of sediment in a deep sea was admitted by Darwin.[2] But the assumption of so many submerged banks as this explanation would require, seemed to him so improbable that he dismissed it from further consideration. He was not aware, however, of the enormous abundance of minute cal-

[1] *Zeitsch. Wissensch. Zoologie*, 1863, xiii. p. 558. Reprinted in 1869 in "Die Philippinen und ihre Bewohner," with additional notes.

[2] *Verhandl. Physik-med. Gesellsch. Wurzburg; Sitzungsber.*, February 1, 1868.

[3] "Die Philippinen und ihre Bewohner." Würzburg, 1869, pp. 100-109. A brief account of the coral-reefs of the Philippine Islands will be found at pp. 19-33.

[4] *Bericht. Senckenberg. Naturforsch Gesellsch.*, 1869-70, p. 157.

[1] *Proc. Roy. Soc. Edin.* (1879-80), x. p. 505.

[2] "Coral Islands," 2nd edit. p. 118.

careous organisms in the surface waters and of the comparative rapidity with which these remains might be accumulated on the sea-bottom.

Reef-builders starting on a submarine bank, whether prepared for them by erosion, by subsidence, or by the upward growth of organic deposits, would form reefs that must necessarily tend to assume the atoll form The central portions of the colony or clump of coral will gradually be placed at a disadvantage as compared with the peripheral parts of the mass in being further removed from the food-supply, and will consequently dwindle and die. In proportion as the reef approaches the sea-level these central parts are brought into increasingly uncongenial conditions, until at last an outer ring of vigorous, growing coral-reef encircles an inside lagoon overlying the central stunted and dead portions. The possibility of such a sequence of events was likewise recognised by Darwin. "If a bank, either of rock or of hardened sediment," he says, "lay a few fathoms submerged, the simple growth of the coral, without the aid of subsidence, would produce a structure scarcely to be distinguished from a true atoll." [1]

As the atoll increases in size the lagoon becomes proportionately larger, partly from its waters being less supplied with pelagic food and therefore less favourable to the growth of the more massive kinds of coral, partly from the injurious effects of calcareous sediment upon coral-growth there, and partly also from the solvent action of the carbonic acid of the sea-water upon the dead coral. The solution of dead calcareous organisms by sea-water is undoubtedly one of the most interesting facts brought to light by the naturalists of the *Challenger* Expedition.

Moreover, a connected chain of atolls might be formed on a long, submarine bank, and similar conditions of growth would then be displayed as in the case of a single atoll. The marginal atolls having a better supply of food would grow more vigorously than those towards the centre, and would tend to assume elongated forms, according to the shape of the bank beneath them. Many of them might coalesce, and might even ultimately give rise to one large atoll. Such a chain of atolls as that of the great Maldive group may be thus explained without the necessity for any disseverment by oceanic currents as Darwin supposed. On the other hand, the submerged coral-banks of the Lakadivh, Caroline, and Chagos archipelagos may be regarded as representing various stages in the growth of coral-reefs, some of them being still too deep for reef-builders, others with coral-reefs which have not yet quite grown up to the surface. But scattered among these banks are some of the most completely formed atolls. Mr. Murray contends that it is difficult to conceive how such banks can have been due to subsidence, when their situation with respect to each other and to the perfect atolls is considered. He reverses the order of growth as given by Darwin, who cited the great Chagos bank as probably an example of an atoll which had been carried down by a subsidence more rapid than the rate at which the corals could build upwards.

From a careful study of barrier-reefs Mr. Murray concludes that, in their case also, all the phenomena can be explained without having recourse to subsidence. He found from personal observation and a comparison of the Admiralty charts that most exaggerated notions prevail regarding the depth of water immediately outside the reef, which is usually supposed to be very great. After minutely exploring the barrier-reef of Tahiti, and sounding the water both inside and outside the reefs, he found that the slopes are just such as might be looked for on the supposition that the corals have grown up without any sinking of the bottom. The accompanying section (Fig. 1), drawn to a true scale will show that there is nothing abnormal in the declivities. Beginning near the shore or wherever the bottom whether of rock or sediment comes within the range of the reef-builders, a barrier-reef grows vigorously along its outer face, while its inner parts, as in the case of an atoll and for the same reason, are enfeebled and die. The force of the breakers tears off huge masses, sometimes 20 or 30 feet long, from the face of the reef, especially where from the borings of mollusks, sponges, &c., the coral-rock has been weakened. These blocks tumble down the seaward face of the reef, forming a remarkably steep talus. It is this precipitous part of the reef which has probably given rise to the notion that the water outside suddenly descends to a profound depth. The steep front of fallen blocks is succeeded by a declivity covered with coral sand, beyond which the bottom slopes away at an angle of no more than 6°, and is covered chiefly with volcanic detritus. Mr. Murray insists that any seaward extension of the reef must be on the summit of the talus of broken coral. The reef will gradually recede from the shore of the island or continent, and will leave behind here and there a remnant to form an island in the slowly broadening lagoon-channel.

[1] *Op. cit.* p. 134.

The very general occurrence of proofs of elevation among the regions of barrier-reefs and atolls is in harmony with the volcanic origin of the ground on which these coral-formations have grown, but is, as Mr. Murray contends, most difficult of explanation on the theory of widespread subsidence. He affirms that all the chief features of coral-reefs and islands not only do not necessarily demand the hypothesis of subsidence, but may be satisfactorily accounted for, even in areas where the movement is an upward one, by the vigorous outward growth of the corals on the external faces of the reef in presence of abundant food, by their death, disintegration, and removal by the mechanical and chemical action of the sea in the inner parts, and by the influence of subaërial agencies and breaker-action in lowering the level of the upraised areas of coral-rock.

ARCH. GEIKIE

(To be continued.)

NOTES

It will be seen from our Diary that the meeting of the Linnean Society on December 6 is to be exclusively devoted to the reading of a posthumous essay on Instinct by the late Mr. Darwin. We are informed that this essay is full of important and hitherto unpublished matter with regard to the facts of animal instinct considered in the light of the theory of natural selection; and as the existence of the essay has only now been divulged, we doubt not that the next meeting of the Linnean Society will be of an unusually interesting character.

The death is announced, at the age of seventy-six, of Mr. John Eliot Howard, F.R.S., well known as a chemist and quinologist. He was the son of Mr. Luke Howard, F.R.S., a well-known meteorologist in his day.

We announced some time ago that the Finnish Senate had voted a sum of 37,000 marks to Prof. Lemström for the continuation of his experiments with the aurora borealis at Sodankylä in the Finnish Lappmark during 1882-83, of which he gave an account in NATURE (vol. xxvii. p. 389). The plan to be followed during the present winter at this station is to make observations three times in every twenty-four hours, with the exception only of the first and fifteenth of every month, when they are made every five minutes throughout the twenty-four hours, and three days of the month when they will be effected every half minute during two hours. In order partly to obtain the necessary data for the control of the variation of the current from the atmosphere with the latitude, and partly to reduce the effect of probable influences, a branch station will be temporarily established during the months of November, December, January, February, and part of March at the buildings of the Kultala gold works, some distance from the principal station at Sodankylä. At Kultala exhaustive experiments will be made as to the effect which the increase of the area of the "utströmnings" apparatus, invented by Prof. Lemström for producing the aurora borealis, has on the intensity of the current. The observations will in other respects be the same at both stations. At Sodankylä they will be continued until September 1, 1884.

The Report by the Board of Trade on their Proceedings and Business under the Weights and Measures Act, 1878, for the past year has been issued. The following are some of the leading points in the Report: During the past year the Standards Department has had the opportunity of assisting the United States Government in a comparison of their standard of length (Yard No. 57), with the standards at this office. Prof. C. S. Peirce, of the United States Coast and Geodetic Survey, came to London for this purpose in June last, on behalf of Prof. J. E. Hilgard, who has charge of the Bureau of Weights and Measures at Washington. A large number of comparisons of these measures was made with all possible care, and it was found that at 62° F., Yard No. 57 was 0·000022 inch longer than the Yard No. 1 deposited at this office. The results of these comparisons, as calculated by Prof. Peirce, will be referred to in a printed memorandum which will be separately drawn up. It was found necessary to test the accuracy of the standard kilogram, and the only resource was to apply to the Comité International des Poids et Mesures for permission to compare the British standard kilogram with that deposited at their bureau near Paris. By the report of this comparison, it is seen that our standard kilogram is now 2·0178 milligrams too light. The Report rather naively points out that, but for the courtesy of the Comité, the Standards Department would have been unable to re-verify our unit of metric weight, as this country is not represented on the Comité, and consequently does not contribute towards its expenses. In a previous Report it is also pointed out that the Board of Trade had been then able to avail itself of the results of the scientific researches which had been carried out under the directions of the Bureau. A note on the instrumental equipment of the Bureau of the Comité International is attached to the Report; of the equipment of this Bureau we recently gave a detailed description. The tables of densities and expansions hitherto in use at the Standards Office not having been found entirely in accord with the most recent scientific research, new tables have been drawn up for future use in the accurate comparisons of standards of measure and weight, and these are given in the Appendix. At the last annual trial of the pyx, the Report states, the differences in weight and fineness of the new coins then submitted for testing were again found to be far within the legal amounts allowed, *particularly on those allowed in the fineness of the gold coin*. With reference to the Electric Lighting Act, the Report remarks that with the advance of science there arise from time to time measures and weights of new forms and denominations which, in their application to commercial purposes, subsequently receive the sanction and force of legislative enactment. Among the most important of such new measures are those for the measurement of mechanical and of electrical energy, as applied to the measurement of electricity under the Electric Lighting Act of last year. A present unit of measurement has been taken in Provisional Orders under this Act, which is equivalent to "the energy contained in a current of 1000 amperes flowing under an electromotive force of one volt during one hour." No practical meter of electricity capable of use in commerce and daily life has yet received official sanction. The Report and Appendices show that Mr. Chaney continues the work of his office as efficiently as his means will permit.

At the last sitting of the Academy of Sciences M. Pasteur read and commented on a posthumous paper by Dr. Thuilier his pupil, who died in Alexandria, where he was sent in August, in order to make observations on cholera. The late Dr. Thuilier takes an intermediate position between M. Pasteur and M. Bouchardat. M. Pasteur seems not to be quite opposed to the views of his pupil.

The German Cholera Commission are going, not, as they originally intended, to Bombay, but to Calcutta, as they consider the latter place more suitable for their investigations.

In an official pamphlet published at Washington there is an interesting sketch of the work and history of the United States Bureau of Education. Not only does the Bureau publish reports on education in the United States, but at frequent intervals issues "Circulars of Information" containing data of great value, and in many cases not otherwise accessible. Among other things these circulars contain information on the systems of education in nearly every civilised country, including China; the pamphlet referred to contains a useful list of all the circulars issued, with their contents.

In the report by Dr. Daniel Draper on the New York Meteorological Observatory for 1882, it is shown that the actual hours of sunshine at Greenwich Observatory were 1245 in 1878 and 977 in 1879, when the possible hours were 4447; whereas at New York in the former year the actual hours were 2936, and in the latter 3101, when the possible hours were 4449.

The "Howard" Medal of the Statistical Society for 1883, with a prize of 20*l.*, has been awarded to Dr. R. D. R. Sweeting, S.Sc. Cert. Camb., Medical Superintendent of the Western District Fever Hospital, Fulham, for the best essay on "The experiences and opinions of John Howard on the preservation and improvement of the health of the inmates of schools, prisons, workhouses, hospitals, and other public institutions, as far as health is affected by structural arrangements relating to supplies of air and water, drainage," &c.

The cultivation of Sorghum (*S. saccharatum*) and the manufacture of sugar from its stems has of late occupied a large share of attention by the Government in America, reports on which have been issued at different times. The most recent of these is an "Investigation of the Scientific and Economic Relations of the Sorghum Sugar Industry." This is in the form of a report drawn up by the committee of the National Academy of Sciences, in which the subject of the cultivation, production, and manufacture of the sugar is treated in considerable detail. The report is one of considerable value, especially to those interested in the progress of this industry.

From Dr. King's Annual Report of the Royal Botanic Garden, Calcutta, for the year 1882–83, and Mr. J. F. Duthie's Report of the Government Botanical Gardens at Saharunpur and Mussoorie for the year ending March 31, 1883, both of which have recently reached us, we learn something of the progress of botany at these botanical centres in India. It is satisfactory to note that at Calcutta considerable improvements have been effected during the year, not only in the general arrangements of the garden itself but also in the scientific department, for Dr. King informs us that "the bamboo and mat erections which used to do duty as conservatories have been replaced by three large, handsome, and efficient structures of iron, on which a thin thatch of grass is spread, and under shelter of which tropical plants thrive admirably." As usual at Calcutta considerable attention has been given to various economic plants, notably those which produce the valuable article indiarubber, and which have occupied so much attention of late. Dr. King says the cultivation of the soy bean of Japan (*Glycine soja*) has of late been pressed on the people of India, and "more in obedience to the loudness of this clamour than from a belief in its soundness" he has arranged for a supply of the beans from Japan, which he proposes to distribute extensively for trial. Much consideration has also been given to the utilisation of the various fibrous plants. In the Lloyd Botanic Garden, Darjeeling, much damage continued to be done by the cockchafer grubs until pretty nearly every plant in the garden was killed. "The whole of the grass in the garden and all herbaceous plants rapidly succumbed to its ravages, as did many of the flowering shrubs, only the deeper rooting shrubs and trees being spared. Even the plants in the conservatories did not altogether escape; eggs of the insect having got in considerable numbers into the soil of the pots." In response to vigorous efforts to exterminate this plague about six millions of the grubs were collected and destroyed by the garden labourers, so that at the time of writing the Report it was showing signs of disappearing. In Mr. Duthie's Report it is satisfactory to find that economic plants, as at Calcutta, are largely cared for, and that the cultivation of medicinal plants and the preparation of drugs from them is being proceeded with. Amongst these may be mentioned Alexandrian senna (*Cassia acutifolia*), henbane (*Hyoscyamus niger*), belladonna (*Atropa belladonna*), &c. Additions are also being constantly made to the museum.

PART VI. of the "Herefordshire Pomona" has been issued, and Part vii. and last will be published in the autumn of next year, after the Congress and Exhibition of the Pomological Society of France, to be held at Rouen in October.

IN the *Japan Mail* of August 23 and September 24, Mr. E. Knipping describes the course of two storms which occurred, one on August 17 to 20, and the other September 11 to 14. These descriptions show how very completely the Japan meteorological service is organised, and that good work is being done in the Far East in collecting data for scientific meteorology.

MESSRS. MACMILLAN AND CO. have published as one of their "NATURE Series" volumes, Drs. Gladstone and Tribe's "Chemistry of the Secondary Batteries of Planté and Faure." "About Photography and Photographers" is the title of an interesting gossipy little volume by Mr. H. Baden Pritchard, published by Messrs. Piper and Carter.

MISS J. M. HAYWARD wishes to state with reference to Mr. Denning's letter (p. 56) that she did give the hour (10.30) at which her letter was written, with the date, at the end. She adds that a clock struck ten shortly before she saw the meteor; but she thinks the clock was probably slow, as it generally is. She has no doubt it was the same meteor as that seen at Bath, Bristol, and Chelmsford about the same time.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*) from India, presented respectively by Mr. H. G. Rose and Miss Morant; a Common Fox (*Canis vulpes*), British, presented by Mr. H. Vaughan; two Bullfinches (*Pyrrhula europæa*), European, presented by Mr. Archibald Aitchison; four Moorish Toads (*Bufo mauritanicus*) from Tunis, presented by Mr. Frederick Bridges; twelve Ruffe, or Pope (*Acerina cernua*) from British waters, presented by Mr. T. E. Gunn; two Michie's Tufted Deer (*Elaphodus michianus* ♂ ♀), a Chinese Water Deer (*Hydropotes inermis*), two Elliot's Pheasants (*Phasianus ellioti*) from China, deposited; six Coal Titmice (*Parus ater*), British, purchased; a Spotted Ichneumon (*Herpestes nepalensis*) from Nepal, five Blue-crowned Hanging Parrakeets (*Loriculus galgulus*) from Malacca, received in exchange.

OUR ASTRONOMICAL COLUMN

PONS' COMET.—Mr. S. C. Chandler has communicated to the *Astronomische Nachrichten* his own experiences at the Observatory of Harvard College with reference to the remarkable increase in the brightness of this comet on September 22, which has been already mentioned in NATURE (vol. xxviii. p. 624). He observed with an aperture of 6¼ inches. On September 21, between 8h. 55m. and 11h. M.T. he found the comet very faint and diffuse; the central condensation or nucleus about equal to a star of 11 m. On September 22, about 7h. M.T. he was astonished to find exactly in its place a bright, clearly-defined 8 or 8½ mag. star without sensible trace of nebulosity, except with a power of only 50, giving a field of 1¼ degrees, and even with that not noticeable except with attention. It was so distinctly stellar an object that an experienced observer might have failed to distinguish it from stars of similar brightness in the neighbourhood. On September 23, at 7h. 30m., he found the physical appearance again greatly changed. The nucleus seemed spread out into a confused bright disk about a half minute (arc) in diameter, outside of which was a nebulous envelope much brighter than on the preceding night, and about one minute and a half in diameter. The comet was judged to be a half magnitude brighter than on September 22. On September 25 it appeared spread out into a confused disk two minutes in diameter, a faint nucleus or concentration of light not brighter than 11 m. So rapid an increase and diminution of light is a very unusual phenomenon; Mr. Chandler thinks that phases of this kind may be characteristic of the comet's mode of light development, as the same variation was repeated on a smaller scale on October 15, when a nucleus of about 9·3 m. appeared, which gradually dissipated on the following evenings, through expansion into the general nebulosity. The comet's distance from the sun when Mr. Chandler remarked the great increase of brightness was 2·18, the earth's mean distance being taken as unity, not the least surprising condition in the case.

In the same number of the *Astronomische Nachrichten* Prof. Schiaparelli gives some account of his observations on the physical appearance of the comet at Milan, which are of much interest in connection with those of Mr. Chandler. On September 22 he found the comet about 3′ in diameter, faint and diffuse, the nucleus about 13m., but the sky was not perfectly clear; the observations for position were made at 8h. 30m. M.T. On September 23, about 8h. 13m., the comet had increased in brightness since the previous evening in an extraordinary manner; it now appeared as a star of 8 m., with a very faint surrounding nebulosity of from 1′ to 1½′ diameter. The central part was not exactly a luminous point, but had a sensible diameter and indistinct outline. On the 25th it was still bright, but the nucleus of the 23rd had spread out so as to form a circular nebulosity 3′ in diameter, without notable central condensation.

Comparing the Milan and Harvard observations, it would appear that the rapid increase in the light of the comet took place between September 22, at 7h. 45m. and 11h. 45m. Greenwich mean time; it remains to be seen how observations elsewhere will accord with this inference. Mr. Chandler suspected, from a comparison of his own notes with those made by the observers at Kiel and Vienna, that the increase would be found to have taken place between the European and American observations on September 22.

M. Bigourdan, of Paris, says on November 19, "The comet is a nebulosity of from sixth to seventh magnitude, with nucleus: the brightest part of the coma, that which borders on the nucleus, is not symmetrical about it; it is less extended in the angle 110°—140°, and is brightest in the angle 280°—290°." Taking the comet's theoretical intensity of light on November 19 as unity, the intensity on December 31 will be 9·5, and on January 14 (when it is at its maximum), 13·0. In the absence of moonlight the comet must be, for some time, a naked eye object.

THE GENERAL THEORY OF THERMO-DYNAMICS

THE first of the six lectures on "Heat in its Mechanical Applications" at the Institution of Civil Engineers was delivered on November 15 by Prof. Osborne Reynolds, M.A., F.R.S., the subject being as given in the title. The following is an abstract of the lecture:—

Thermodynamics, Prof. Reynolds said, was a very difficult subject. The reasoning involved was such as could only be expressed in mathematical language; but this alone would not prevent the leading facts and features of the subject being expressed in popular language. The physical theories of astronomy, light, and sound involved even more mathematical complexities than thermodynamics, but these subjects had been rendered popular, and this to the great improvement of the theories.

What rendered the subject of thermodynamics so obscure was that it dealt with a thing or entity (heat) which, although its effects could be recognised and measured, was yet of such a nature that its mode of operation could not be perceived by any of our senses. Had clocks been a work of nature, and had the mechanism been so small that it was absolutely imperceptible, Galileo, instead of having to invent a machine to perform a definite function, would have had, from the observed motion of the hands, to discover the mechanical principles and actions involved. Such an effort would have been strictly parallel to that required for the discovery of the mechanical principles of which the phenomena of heat were the result.

In the imagined case of the clock, the discovery might have been made in two ways. By the scientific method: from the observed motion of the hands the fact that the clock depended on a uniform intermittent motion would have led to the discovery of the principle of the uniformity of the period of vibrating bodies; and on this principle the whole theory of dynamics might have been founded. Such a theory of mechanics would have been as obscure but not more obscure than the theory of thermodynamics based on its two laws. But there was another method; and it was by this that the theory of dynamics was brought to light—to invent an artificial clock, the action of which could be seen. It was from the actual pendulum that the principles of the constancy of the periods of oscillating and revolving bodies were discovered, whence followed the dynamical theories of astronomy, of light, and of sound.

As regarded the action of heat, no visible mechanical contrivance was discovered which would afford an example of the mechanical principles and motions involved, so that the only apparent method was to discover by experiment the laws of the action of heat, and to accept these as axiomatic laws without forming any mental image of their dynamical origin. This was what the present theory of thermodynamics purported to be.

In this form the theory was purely mathematical and not fit for the subject of a lecture. But as no one who had studied the subject doubted for one moment the mechanical origin of these laws, Prof. Reynolds would be following the spirit if not the letter of his subject, if he introduced a conception of the mechanical actions from which these laws sprang. This he should do, although he doubted if he should have so ventured, had it not been that while considering this lecture he hit upon certain mechanical contrivances, which he would call kinetic engines, which afforded visible examples of the mechanical action of heat, in the same sense as the pendulum was a visible example of the same principles as those involved in the phenomena of light and sound. Such machines, thanks to the ready help of Mr. Foster his assistant in constructing the apparatus, he should show, and he could not but hope that these kinetic engines might remove the source of the obscurity of thermodynamics on which he had dwelt.

The general action of heat to cause matter to expand was sufficiently obvious and popularly known; also that the expanding matter could do work was sufficiently obvious. But the part which the heat played in doing this work was very obscure.

It was known that heat played two, or it might be said three, distinct mechanical parts in doing this work.

These parts were:—

1. To supply the energy necessary to the performance of work.

2. To give to the matter the elasticity which enabled it to expand—to convert the inert matter into an acting machine.

3. To convey itself, *i.e.* heat, in and out of the matter.

This third function was generally taken for granted in the theory of thermodynamics, although it had an important place in all applications of this theory.

The idea of making a kinetic engine which should be an example of action such as heat, had no sooner occurred to him than various very simple means presented themselves. Heat was transformed by the expansion of the matter caused by heat.

At first he tried to invent some mechanical arrangement which would expand when promiscuous agitation was imparted to its parts, but contraction seemed easier—this was as good. All that was wanted was a mechanism which would change its shape, doing work when its parts were thrown into a state of agitation.

In order to raise a bucket from a well either the rope was pulled or the windlass wound—such a machine did not act by promiscuous agitation; but if the rope was a heavy one (a chain was better) and it was made fast at the top of the well so that it just suspended the bucket, then if it was shaken from the top waves or wriggles would run down the rope until the whole chain had assumed a continually changing sinuous form. And since the rope could not stretch, it could not reach so far down the well with its sinuosities as when straight, so that the bucket would be somewhat raised and work done by promiscuous agitation. The chain would have changed its mechanical character, and from being a rigid tie in a vertical direction would possess kinetic elasticity, *i.e.* elasticity in virtue of the motion of its parts, causing it to contract its vertical length against the weight of the bucket. Now it was easy to see in this case that to perform this operation the work spent in shaking the rope performed the two parts of imparting energy of motion to the chain and raising the bucket. A certain amount of energy of agitation in the chain would be necessary to cause it to raise a bucket of a certain weight through a certain distance, and the relation which the energy of agitation bore to the work done in raising the bucket followed a law which if expressed would coincide exactly with the second law of thermodynamics. The energy of agitation imparted to the chain was virtually as much spent as the actual work in raising the bucket, that was to say, neither of these energies could be used over again. If it was wanted to do further work the raised bucket was taken off, and then to get the chain down again it must be allowed to cool, *i.e.* the agitation must be allowed to die out; then attaching another bucket, it would be necessary to supply the same energy over again.

He had other methods besides the simple chain which served better to illustrate the lecture, but the principle was the same.

In one there was a complete engine with a working pump. By mere agitation the bucket of the pump rose, lifting 5 lbs. of water one foot high; before it would make another stroke the agitated medium must be cooled, *i.e.* the energy which caused the elasticity must be taken out, then the bucket descended, and, being agitated again, made another stroke.

He felt that there was a childish simplicity about these kinetic engines, which might at first raise the feeling of "Abana and Pharpar" in the minds of some of his hearers. But this would be only till they realised that it was not now attempted to make the best machine to raise the bucket, but a machine that would raise the bucket by shaking. These kinetic engines were no mere illustrations or analogy of the action of heat, but were instances of the action of the same principles. The sensible energy in the shaking rope only differed in scale from the energy of heat in a metal bar. The temperature of the bar, ascertained from absolute zero, measured the mean square of the velocity of its parts multiplied by some constant depending on the mass of these parts. So the mean square of the velocity of the links of the chain multiplied by the weight per foot of the chain really represented the energy of visible agitation in the chain.

The waves of the sea constituted a source of energy in the form of sensible agitation; but this energy could not be used to work continuously one of these kinetic machines, for exactly the same reason as the heat in the bodies at the mean temperature of the earth's surface could not be used to work heat-engines.

A chain attached to a ship's mast in a rough sea would become elastic with agitation, but this elasticity could not be used to raise cargo out of the hold, because it would be a constant quantity as long as the roughness of the sea lasted.

Besides the waves of the sea there was no other source of sensible agitation, so there had been no demand for kinetic engines. Had it been otherwise, they would not have been left for him to discover—or, had they been, he might have been tempted to patent the inventions. But there had been a demand for what might be called sensible kinetic elasticity to perform for sensible motion the part which heat-elasticity performed in the thermometer.

And it had not been left for him to invent kinetic mechanism for this purpose, although it might be that its semblance to the thermometer had not been recognised. The principle was long ago applied by Watt. The common form of governors of a steam-engine acted by kinetic elasticity, which elasticity, depending on the speed at which the governors were driven, caused them to contract as the speed increased. The governor measured by contraction the velocity of the engine, while the thermometer measured by expansion the velocity in the particles of matter which surrounded it; so that it could now be seen that having to perform two operation, the one on a visible scale, the other on a molecular scale, the same class of mechanism had been unconsciously adopted in performing both operations.

The purpose for which these kinetic engines was put forward was not that they might be expected to simplify the theory of thermodynamics, but that they might show what was being done. The theory of thermodynamics could be deduced by the laws of motion from any one of these kinetic engines, just as Rankine deduced it from the hypotheses of molecular vortices.

Nothing had yet been said of the third part which heat played in performing work, namely, conveying heat in and out of matter. It was an innovation to introduce such considerations into the subject of thermodynamics, but it properly had a place in the theory of heat-engines. It was on this part that the speed at which an engine would perform work depended.

The kinetic machines showed this. If one end of a chain was shaken, the wriggle ran along with a definite speed, so that a definite interval must elapse before sufficient agitation was established to raise the bucket; further, an interval must elapse before the agitation could be withdrawn, so that the bucket might be lowered for another stroke. The kinetic machine, with the pump, could only work at a given rate. He could increase this rate by shaking harder, but then he expended more energy in proportion to the work done. This exactly corresponded with what went on in the steam-engine, only owing to the use of separate vessels, the boiler, cylinder, and condensers, the connection was much confused. But it was clear that for every h.p. (2,000,000 ft.-lbs. per hour) 15,000,000 ft. lbs. had to be passed from the furnace into the boiler, as out of the 15,000,000 no more than 2,000,000 could be used for work; the remaining 13,000,000 were available for forcing the heat into the boiler and out of the steam in the condenser, and they were usefully employed for this purpose.

The boilers were made as small as sufficed to produce steam, and this size was determined by the difference of the internal temperatures of the gases in the furnaces, and the water in the boiler; and whatever diminished this difference would necessarily increase the size of the heating surface required, *i.e.* the weight of the engine. The power which this difference of temperature represented could not be used in the steam-engine, so it was usefully employed in diminishing the size of the engine.

Most of this power, which in the steam-engine was at least eight times the power used, was spent in getting the heat from the gases into the metal plates, for gas acted the part of conveyance far less readily than boiling water or condensing steam. If air had to be heated inside the boiler and cooled in the condenser with the same difference of temperature, there would be required thirty or forty times the heating surface—a conclusion which sufficiently explained why attempts to substitute hot air for steam had failed. In one respect the hot-air engines had an advantage over the steam-engine. During the operation in the cylinder the heat was wanted to be kept in the acting substance; this was easy with air, for it was such a bad conductor of heat, that unless it was in a violent state of internal agitation it would lose heat but slowly, although at a temperature of 1000 degrees and the cylinder cold.

Steam, on the other hand, condensed so readily that the temperature of the cylinder must be kept above that of the steam. It was this fact which limited the temperature at which steam could be used. Thus, while hot air failed on account of time economy, the practical limit of the economy of steam was fixed by the temperature which a cylinder would bear. These facts were mentioned because at the present time there appeared to be the dawn of substituting combustion-engines in place of steam engines.

Combustion-engines, in the shape of guns, were the oldest form of steam-engine. In these, the time required for heating the expansive agent was zero, while they had the advantage of incondensible gas in the cylinder, so that if the cylinder was kept cool it cooled the gas but slightly, although this was some 3000 degrees in temperature.

The disadvantage of these engines was that the hot gas was not sufficiently cooled by expansion, but a considerable amount of the heat carried away might be used again could it be extracted and put into the fresh charge; to do this, however, would introduce the difficulty of heating-surface in an aggravated form. However, supposing the cannon to have been tamed and coal and oxygen from the air to be used instead of gunpowder. Thermodynamics showed that such engines should still have a wide margin of economy over steam-engines, besides the advantage of working with a cold cylinder and at an unlimited speed. The present achievement of the gas-engine, stated to be some 2,000,000 ft.-lbs. per lb. of coke, looked very promising, and it was thus not unimportant to notice that whatever the art difficulties might be, thermodynamics showed no barrier to further economy in this direction, such as that which appeared not far ahead of what was already accomplished with steam-engines.

But however this might be, he protested against the view which seemed somewhat largely held that the steam-engine was only a semi-barbarous machine, which wasted ten times as much heat as is used—very well for those who knew no science, but only waiting until those better educated had time to turn their attention to practical matters, and then to give place to something better. Thermodynamics showed the perfections not the faults of the steam-engine, in which all the heat was used, and could only enhance the admiration in which the work of those must be held who gave, not only the steam-engine, but the embodiment of the science of heat.

PROFESSOR AUGUST WEISMANN ON THE SEXUAL CELLS OF THE HYDROMEDUSÆ[1]

PROF. WEISMANN of Freiburg is most highly skilled and most indefatigable in research, and all the memoirs which he publishes are of extreme scientific importance, and abound in original views and suggestions which render them of peculiar and widely spread interest. His "Studien zur Descendenz Théorie," his researches on the Daphnoids and on the fauna of Lake Constance, which are known to all naturalists, may be mentioned as examples of his work. Since the spring of 1878 till the present year he has been engaged in investigating the mode of origin of the gonad elements of the Hydromedusæ, and the results are embodied in the present splendid work, which consists of a volume of text of about 300 pages quarto and twenty-four most beautifully executed coloured plates, the whole representing a vast amount of laborious research. Some portions of the results have already appeared in short preliminary papers, but they form a very small instalment of what is here put forth. In the course of the investigation, which has extended to thirty-eight species of Hydromedusæ, important new observations on the habits and composition of Hydroid colonies generally and on their histology were made, and the results of these are fully described here, since most of them have a direct bearing on the elucidation of the main subject of the monograph. The work thus forms secondarily, as stated in the title-page, "a contribution to the knowledge of the structure and vital phenomena of the Hydromedusæ generally."

The principal value of the work, however, lies in the importance of the bearings of the results of the investigations detailed in it upon the general question of the origin of gonad cells. The Hydromedusæ were selected as the subject of research because they appeared to be of all groups of the animal kingdom best adapted for the purpose both because of the transparent nature of their tissues and because they present in closely allied forms so many remarkable differences in the development of the gonad elements.

The work commences with an historical introduction, which can be but briefly referred to here. The question of the origin of the sexual elements in the Hydroida has undergone several important transformations. Prof. Huxley, when he first defined the body of the Medusa as consisting of two layers of tissue—ectoderm and endoderm, raised the question in which of the two layers do the gonad elements originate, and at first concluded that they were formed between the two, and subsequently in 1859, from physiological considerations mainly, that they must originate in the ectoderm. As soon as the advance of histological method permitted accurate direct observation to be made on the matter, Keferstein and Ehlers showed that in the Siphonophora with well developed medusoid sexual individuals, the Calycophoridæ and male Physophoridæ, the germinal cells are developed in what is now recognised as the ectoderm of the manubrium;

[1] "Die Entstehung der Sexualzellen bei den Hydromedusen." Zugleich ein Beitrag zur Kenntniss des Baues und der Lebenserscheinungen dieser Gruppe, von Dr. August Weismann, Professor in Freiburg-i Br. (Jena: G. Fischer, 1883.)

whilst in the female Physophoridæ the origin of the single ovum is different (in the endocodon). As soon as the homogeny of the two layers of the Cœlenterata with the two primitive layers of the higher Metazoa became evident, the question arose whether the germinal cells of the Metazoa generally were of ectodermal or endodermal origin, and a large number of observers attempted to settle the question offhand by investigating the process of development of the germinal cells in some one Cœlenterate. Each assumed that his particular results must hold good for the entire group, and as the results were conflicting—the place of first appearance of the germinal cells lying as is well known in some Cœlenterates in the ectoderm and in others in the endoderm—much confusion arose. At this period, E. van Beneden's memoir appeared which, on the strength of the conditions occurring in a Hydractinia, a Campanularia, and a Clava, started the theory that the germ layers were themselves sexually differentiated, the female elements arising from the endoderm and the male from the ectoderm, and that in the union of a derivative of each layer lay the essence of impregnation, the necessary precursor of reproduction. This brilliant conception was soon shown by further observation to be erroneous, and as Prof. Weismann points out it was from the first not in accordance with the phenomena of parthenogenesis. As the next important phase in the question came the attempt of the brothers Hertwig to prove that the Cœlenterata belong to two distinct stocks, the one consisting of the Anthozoa and Scyphomedusæ, in which the germinal cells are derived from the endoderm (Endocarpæ), and the other of the Hydromedusæ and Ctenophora, in which they originate from the ectoderm (Ectocarpæ). If this position be correct, and, as will be seen in the sequel, one of the most startling of the conclusions arrived at in the present work is that, notwithstanding all the apparent evidence to the contrary, it probably is so in reality, then the important principle of inheritance and continuity in development in the germ layers receives a strong support, of which with regard to the gonad elements it seemed in great need. Prof. Weismann was led to undertake the present prolonged researches by his observing that in certain of the Hydromedusæ the germinal cells originate, not in the sexual individuals themselves nor even in the blastostyles that support them, but in the cœnosarc of the colony, in the common parenchym of the stem and its branches, and that this occurs not only in the case of the female but also in some instances in that of the male germinal cells. The existence of ovicells of cœnosarcal origin had been previously observed by Quatrefages, F. E. Schultze, Fraipont, and others, but these elements had not been recognised as the sole source of supply of the female gonophores with ova. E. van Beneden further had observed the origin of the egg-cells in Hydractinia, in that part of the blastostyle which subsequently becomes evaginated to form the gonophore. Kleinenberg published his account of his discovery of the migration of the egg-cells of Eudendrium from the ectoderm into the endoderm and in the opposite direction just before Weismann had arrived at a similar conclusion and had found in his preparations egg-cells in the act of boring through the basement membrane with one half lying in the ectoderm and the other in the endoderm. The establishment of the fact that migration of the sexual cells of a most remarkable character in the many forms in which he has proved it to occur is a constant phenomenon, the history of its details, and the discussion of the phylogenetic origin and general biological bearings of the curious phenomena presented by it, form the most important features of the present work.

The author as more convenient adopts—instead of Allman's terms, phanerocodonic gonophore and adelocodonic gonophore—"medusa" and "medusoid gonophore" respectively. He applies the latter term to all gonophores, not becoming free medusæ, in the walls of which any traces, however rudimentary, can be detected of the three layers, viz. the inner and outer ectoderm layers and the intervening endoderm lamella—of which the wall of the bell of the medusa is composed. He uses the term sporophore for those gonophore sacs in which no indication of anything beyond a single layer of ectoderm and endoderm can be discovered.

A structure which assumes great importance in the history of the wanderings of the ovicells is the duplicature of ectoderm, which grows inwards at the summit of the simple sac-like bud out of which a medusa is formed, depressing the endoderm lamella and forming the hollow of the bell. It is necessary that this embryonic organ or mass of cells, observed by so many investigators, should receive a special name, and it is termed "endocodon."

It is pointed out that each hydranth of a colony does not consist alone of that part containing the stomach and bearing the tentacles and hypostome, but also of a stem-shaped portion, which is developed at the same time with it out of the same bud. This region is termed the "hydrocope," and is included in the hydranth, the remaining region of which is the "hydro-

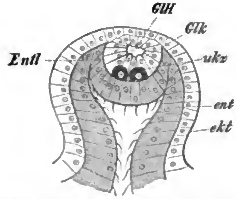


FIG. 1.—Diagram of a bud of a medusa or medusoid gonophore—*Glk*, endocodon; *GlH*, sub-umbrella space; *Entl*, primitive endoderm lamella; *ukz*, primitive germ cells; *ent*, endoderm; *ekt*, ectoderm.

cephalis." The hydrocope corresponds to the region in Tubularia which Allman terms hydrocaulus, but not to the whole system of stems and branches in an arborescent colony. In such colonies the production of buds is entirely confined to the hydrocope and its counterpart in the blastostyle, the "gonocope."

In the Tubularinæ it is necessary to distinguish amongst the

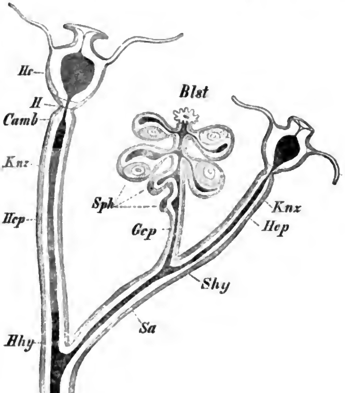


FIG. 2.—Diagram of a primary, *Hhy*, and lateral, *Shy*, hydranth of Eudendrium; *Hc*, hydrocephalis; *H*, neck; *Camb*, cambium zone; *Knz*, zone of gemmation; *Hcp*, hydrocope; *Sa*, lateral branch; *Blst*, blastostyle; *Gcp*, gonocope; *Sph*, sporophore.

hydranths of a stock the "principal" from the "lateral" hydranths. The principal hydranths are those which remain permanently at the extremities of the stems or branches throughout the growth of the stock by lateral budding. In the arborescent stocks of the Tubularidæ the first hydranth sprung from the egg remains permanently at the extremity of the principal stem, the lateral buds of which never surpass it in growth. In the same way the first formed hydranth of each lateral branch retains its position at the tip of that branch, and must be distinguished as a principal hydranth of secondary order, becoming such so soon as it produces a hydranth bud above its distal gonophore. This distinction is necessary not only because the primary and lateral hydranths often differ in size, but mainly from the most important fact that the principal hydranths are sexually sterile; only the lateral hydranths produce gonophores. No such distinction of principal hydranths occurs amongst the Campanularidæ and the Sertularidæ.

The above brief historical sketch and preliminary explanation is extracted from the introductory part of the work. The special part, which forms by far the greater portion of the whole, treats separately of the details of the series of species investigated.

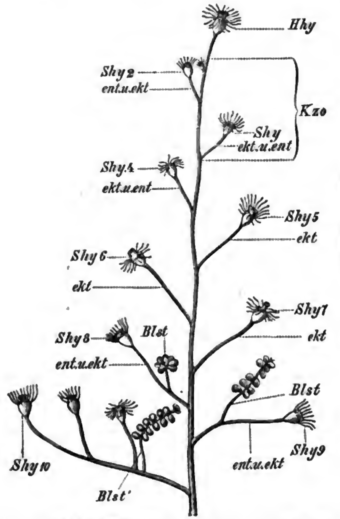


FIG 3.—Tip of a stem of *Eudendrium racemosum* (actual, not diagrammatic), with the principal hydranths, *Hhy*, and ten lateral hydranths, *Shy* 1-10; *Blst*, blastostyle, with female gonophores or ova; *Kzo*, germinal zone in wider sense, *i.e.* extent of the main stem and hydrocope containing egg-cells. The letters *ent* and *ect* indicate whether in the lateral hydrocopes of the specimen ovicells were present in the ectoderm or endoderm, or in both.

The results with regard to two of these forms, *Cordylophora lacustris* and *Eudendrium*, will be followed here, the former being chosen mainly because the account of it is illustrated by a woodcut, which it is advantageous to reproduce. The structure of *Cordylophora lacustris* is well known from F. E. Schulze's most excellent most excellent monograph. Weismann finds that the regular branching of the stock in this species depends on its following the law that "a principal or terminal hydranth of a principal stem or lateral branch produces no buds but those of hydranths, never those of gonophores, and that only the hydranths, and not the gonophores, can produce buds." The zone of gemmation of the hydranths lies in the hydrocope, just below the neck. In the female stocks the germinal cells do not take their origin in the gonophores, but arise in the cœnosarc in the ectoderm of the zone of gemmation of a principal hydranth and in this well defined and restricted region only.

The ovicells are certainly not preformed in the embryo or larva, but are formed in the zone before the lateral hydranth bud begins to appear out of ectoderm cells which differ in no respect from other young ectoderm cells. The ovicells migrate in the ectoderm from their place of origin to that where the bud of the lateral hydranth has begun to form, and, passing into the lateral hydrocope as it grows out, enter the gonophore as soon as it is developed, their entire course of travel lying in the ectoderm. Every ovicell becomes an ovum, and enough ovicells migrate in a group into the lateral hydranth to fill several gonophores; those not destined for the first formed gonophore move onwards past it, and a part of them pass later into the second gonophore when this becomes formed between the first and the neck of the lateral hydranth. This change of position of the ovicells must be partly due to active movement, since the simple shifting due to growth could not push the cells past the first gonophore, and long before the first gonophore is ripe these cells are found lying beyond it, whereas beforehand they lay below it (see Fig. 4, *wz*).

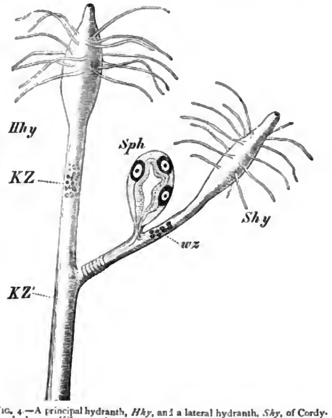


FIG. 4.—A principal hydranth, *Hhy*, and a lateral hydranth, *Shy*, of Cordylophora: *KZ*, actual germinal zone, also zone of gemmation; *KZ'*, former position of the germinal zone, *Sph*, female sporophore; *wz*, migrating ovicells.

The migration must take place very slowly and in a particular direction, for the cells are never found scattered irregularly along the whole stem, but always together in a small troop, and they never make their way by accident into a hydrocephalis. The same process is repeated in the formation of the second, and, if ovicells enough be present, of the third gonophore. A fresh swarm of ovicells is never introduced from the main stem into a lateral branch, and no new ovicells are developed in any lateral hydranth until it ceases to become such by developing a hydranth bud above its distal gonophore. It then becomes a principal hydranth of secondary order, and acquires at once a germinal zone beneath its neck, which supplies the gonophores developed on its lateral hydranth buds with ova by migration, just as in the case of the primary principal hydranth. It produces no further gonophores itself, and differs in no respect from the primary principal hydranth excepting in that it was once a lateral hydranth, and produced a set of gonophores, whilst the primary principal hydranth never was lateral and never produced gonophores. The ova ripen in the ectoderm of the sporophores.

The primitive male germinal cells in Cordylophora are formed like the female from young ectoderm cells, but their place of origin lies in the zone of gemmation of the lateral hydranth at the spot where the gonophore bud is formed.

In the genus Eudendrium most remarkably there is a difference in the formation of the gonad elements in the case of different species. In *Eudendrium racemosum* the gonophores are not borne by the hydranths but on blastostyles, which bud out only from the lateral hydranths. Both male and female germinal cells have their place of origin not in the gonophores or blastostyles, but in the cœnosarc; the gonophores are only the ripening places of the cells. The blastostyles are not regarded by the author as hydranths which in an ontogenetical sense become atrophied in the history of each colony, in consequence of the exhaustive effect of the development of gonophores on them, but as special structures probably derived originally from hydranths, but which have undergone a permanent phylogenetic modification (at all events in *E. racemosum* and *E. capillare*) to adapt them for their peculiar function. The developing buds from which blastostyles are formed are very early to be distinguished from those forming hydranths, and do not vary in colonies of the same sex, though they show a constant difference in form in the two sexes. The male blastostyles have no hypostome, mouth, or trace of tentacles. The female have also no hypostome but have a double crown of tentacles, and appear at the time when the gonophores are ripe to have a small temporary mouth, which it is suggested may possibly swallow the spermatozoa to effect fertilisation.

In the female stocks of *Eudendrium racemosum* when in full sexual maturity the cœnosarcal tubes at all the free ends of the branches contain large quantities of ovicells. The fine twigs are often full of hundreds of them. They occur in both ectoderm and endoderm, but far more abundantly in the former, where they are found in all stages of development, whereas in the endoderm scarcely any but large egg-cells are found. The primitive germinal cells are derived from ordinary young ectoderm cells, with which in rapid process of multiplication the whole germinal zone is filled. This zone lies only in the principal hydranths, commencing a little below their necks and extending a shorter or further distance down the stem, but as a rule not further than the second lateral hydranth (*Kzo*, Fig. 3). Within this zone the production of new ovicells is almost entirely restricted to its uppermost region. As the principal hydranth grows, the germinal zone, which maintains a constant length, rises with it, and as soon as it rises above the point of junction of any lateral hydranth, this hydranth is cut off from any further supply of ovicells. The ovicells never occur in the endoderm within the germinal zone, but are only found in that layer within the hydranth and gonocope. This is because of the remarkable migrations which the cells perform, which take place in perfectly definite directions at definite times. The cells remain in their place of origin, the ectoderm of the germinal zone, until a new lateral hydranth bud begins to be formed, and into this they migrate through the ectoderm, not at once, but as soon as the hydranth has attained a well defined stem. They wait here in the ectoderm, growing considerably, until they have attained a certain size, and then bore their way into the endoderm, nearly all the cells in each lateral hydrocope effecting the penetration of the basement membrane simultaneously, just at the time when a blastostyle bud commences to form. The cells hold on to the basement membrane on its inner face by one end, and stretch forwards the other in the direction of the position of the future blastostyle, and become remarkably elongate, their free ends being drawn out into long slender filaments amongst the endoderm cells. As soon as a hollow is formed in the blastostyle bud they creep in, still clinging to the basement membrane and always to its endodermal face. As the hollow enlarges, more and more creep in, and the bud takes on a pear shape. As the gonophores are budded out from the blastostyle the cells pass into the endoderm of these, then almost simultaneously bore through the basement membrane again, and reach the ectoderm layer of the sporophores, their final ripening place. The ovicells never reach maturity on the hydranths in which they originate, but always in the blastostyle of a lateral hydranth.

In the male stocks of *Eudendrium racemosum* the place of origin of the germinal cells is the ectoderm of the region of gemmation of the lateral hydranths. Thence they migrate by the endoderm into the sporophores, and then like the ovicells bore their way out into their ripening place, the ectoderm of the sporophores.

In the other species of Eudendrium examined, *E. capillare*, the place of first appearance of both male and female germinal cells is in the endoderm.

The results obtained as to the history of the generative elements in the various species examined are given in a concise tabular form under a series of headings, the importance and distinctness of which will now be recognised. The case of Podocoryne is taken as an example. The German terms are not easy to find English equivalents for.

Podocoryne carnea

Keimstätte. Germinal place. (Layer in which the earliest appearance of the germinal cells can be detected.)	Male germinal cells: the ectoderm. Female germinal cells: the endoderm.
Keimzone Germinal zone. (Region of the colony where these cells are earliest detected.)	In male stocks: the manubrium of the Medusa buds. In female stocks: the endoderm sac of the gonophore bud.
Abkunft. Actual origin of the most primitive germinal cells, (in very many cases a matter of inference only).	Male germinal cells: young ectoderm cells. Female germinal cells: probably ectoderm cells which have migrated into the endoderm.
Ripening place.	The ectoderm of the manubrium of free-swimming Medusæ.
Migrations.	The male cells none. The female cells out of the primary endoderm sac of the gonophore bud into the spadix and thence into the ectoderm of the manubrium.

The facts with regard to all the investigated species, when thus placed in a tabular form, appear at first sight so varied and complicated as to defy all reduction to uniform law. The germinal cells appear to be developed sometimes here, sometimes there, without rule of any kind and without definite relation to the germ layers. A most remarkable fact lies in the circumstance that the greatest differences in these matters occur in closely allied genera and even species. But, since this can occur without affecting the general evidences of these relationships, "the variations must depend on such differences as can occur amongst nearly related forms." And in this circumstance really lies in Prof. Weismann's opinion the key to the whole matter. By careful use of the comparative method, he has arrived at the conclusion that the differences in the position of the place of first appearance of the germs depend on a "phylogenetic shifting" of this position, and have ensued *pari passu* with the degeneration of the primitive free medusæ unto sessile brood sacs. The advantage gained by the animal in the shifting which has brought this about, has lain in the earlier ripening of the gonad elements.

In accordance with a widely accepted view, the sessile gonophores of all the attached hydromedusæ except hydra, are probably to be regarded as degenerated medusæ. In the ancestral medusæ the gonad elements of both kinds originated in the ectoderm of the manubrium, and ripened there as they do now in six out of seven Tubularine genera bearing medusæ examined by the author, viz. Dendroclava, Bougainvillia, Perigonimus, Cladonema, Corymorpha, Syncoryne. Both the origination and ripening of the germinal cells occurred during the free life of the medusæ. Certain causes rendered the free medusa stage disadvantageous, and in many instances the gonophores in consequence became sessile, whilst the sexual elements originated and ripened in them at an earlier stage. At first the elements retained the same place of origin as in the free medusæ, a condition which survives in the medusoid gonophores of the existing Cladocoryne. But it became advantageous that the elements should not wait for their formation by cell division and for their gradual maturation until the process of construction of the gonophores by budding had been completed, and thus the formation of the ovicells became shifted, and appeared in an earlier stage. What may be regarded as a first stage in this process is represented in Pennaria and Tubularia, in which the germinal cells of both sexes first appear in the endocodon (see Fig. 1) of the gonophore bud, being carried afterwards, as development proceeds, to the original ripening place, the manubrium. As a further stage in the process, the primitively ectodermal germinal cells migrated into the endoderm, and here we find them making their first appearance in all the Tubularinæ bearing medusæ or medusoid gonophores, in which they do not originate in the ectoderm of the manubrium or in the endocodon. Most important is the fact that in Podocoryne and Clava, and other forms, the male elements have a different place of first appearance from the female. In Podocoryne the male germinal cells arise in the ancestral place, the ectoderm of the manubrium; the female, however, first appear in the endoderm of the medusa bud. In Clava the male elements originate in the endocodon; in the female they are first detected in the endoderm of the gonophore stem.

Here the phylogenetic shifting of the place of first differentiation of the germinal cells has operated only in one sex or in one more than the other. In all such cases it is the place of first differentiation of the female elements which has undergone further shifting than that of the male, apparently because, under similar circumstances, owing to their more minute subdivision, spermaries become more easily and rapidly ripened than ovaries. In the case of *Eudendrium racemosum*, already described, three further stages of the shifting back of the place of origin of the germinal cells appear to have been undergone by the female stocks beyond those evidenced in Podocoryne.

In some forms, as in Cordylophora already described, the entire long migration takes place entirely in the ectoderm, and it is plain that the shifting of the place of origin of the germinal cells backwards from the gonophores has taken in different forms two different lines of progress, one into the endoderm, the other through the ectoderm only. It is a remarkable fact that in no real medusa is the place of first appearance of the germinal cells shifted further back than at most to the endoderm of the gonophore. The difference of position of the generative elements in the medusæ of the Campanularinæ is regarded by the author as secondary, derived from a primitive disposition, as in the Anthomedusæ, by phyletic shifting from the manubrium to the radial canals, evidence in proof of which is adduced.

A most intensely interesting section is that devoted to the subject of the migration of the germinal cells. These cells seem to be guided in their movements by an extraordinary instinct. Every ovicell on setting out for its travels appears to have before it a definite route to a particular gonophore, and to follow it with certainty; and, further, to be able to distinguish a young hydranth bud from a young blastostyle bud, never entering the one in error for the other. The migrations may be compared to those of certain birds the young of which are believed by some ornithologists to find their way to their distant home without the aid of any old birds who have already made the journey to guide them. The author suggests that it must be the outcome of an excessively fine sense of minute differences of pressure which enables the ovicells of Podocoryne, after they have bored their way into the ectoderm, to arrange themselves in four longitudinal rows in the interradii of the manubrium, instead of forming an even zone round it. No doubt, as he points out, the same laws are at work here which determine the size, shape, number, and sequence of the cells in every organism; but this free mobility of these germinal cells in the Hydroida, with their definite line of march and goal, is a new factor, to which there seems to be no parallel known in other groups, although migrating cells pursuing comparatively indefinite courses are known in most Metazoa. As having a nearer resemblance to these movements are cited those of the mesoblast cells which are set free from the blastophore of the gastrula larva of Echinoderms, and which arrange themselves in regular order on the inner surfaces of its cavity. That there is no absolute difference between these curious tissue-building migrations and ordinary growth follows from the evident fact that they have arisen phylogenetically out of the formation of organs by ordinary process of growth.

The question of the immediate origin of the primitive germinal cells of the Hydroids is discussed in a most able summary chapter of the utmost interest, but which it is impossible to do justice to here. With regard to the relations of the elements to the two layers, the conclusion is that in all the Hydromedusæ, including the Siphonophora, the actual origin of the primitive germinal cells is from ectoderm cells. In all cases in which the first traces of the germinal cells can only be detected in the endoderm, the parent primitive germinal cells have migrated out of the ectoderm. This position is supported by two lines of argument, the one drawn from the comparison of the various stages in the shifting of the place of origin of the germinal cells exhibited in the various species of Hydromedusæ, and especially in the two sexes of the same species, which points clearly to the original and essential source of both sexual elements having lain in the ectoderm, as is still the case in the primitive, hermaphrodite, freshwater Hydra; whilst the other dwells on the circumstance that in all Hydroids in which the first appearance of the germinal cells takes place in the endoderm, a satisfactory proof of the endodermal origin of these cannot be brought forward. Where they originate in the ectoderm their identity with young ectoderm cells is obvious. When found in the endoderm, at the bases of the peculiar flagellate cells composing this layer, they have a similar appearance to the primitive germinal cells found in the ectoderm, but no connection of gradation between them and the endoderm cells can be detected, nor any subdivision of the endoderm cells tending to their production.

Having arrived at the above conclusion, the author is led to believe, as already mentioned, that the division of the Cœlenterata into Endocarpæ and Ectocarpæ introduced by the brothers Hertwig may very probably still hold good, the Hydromedusæ, with the Siphonophora and Ctenophora, being sprung from a separate phylum of the primitive Cœlenterates from that comprising the Anthozoa and Scyphomedusæ.

The work closes with a reference to the question of the alternation of generations in the Hydromedusæ. Now that the cœnosarcal origin of the germinal cells is proved in so many instances, can the gonophores or medusæ, the sexual cells of which are formed in the cœnosarc of the hydranth or stem before they themselves are begun to be developed, be regarded as sexual individuals? It is obvious that it would lead only to confusion if the old way of regarding the matter was upset. The past history of the gonophores must be taken into account, and the fact that the sexual elements, though now developed at a greater or less distance in many species, formerly undoubtedly originated within the gonophores. If an opposite view were adopted, the absurd difficulty would arise that the male gonophores in some species would have to be taken as sexual individuals and the females in the same species as not.

The author's discovery of the gradual phylogenitic shifting of the place of origin of the sexual elements in Hydromedusæ seems, as he points out, to throw most happy light on the vexed controversy between Brooks and Salensky as to the alternation of generations in the Salpæ. The ovarium in the stolon of the solitary Salpa discovered by Brooks doubtless belonged originally to the sexual chain Salpæ and has become shifted in order to hasten its maturation into the stolon of the nurse, which is no more to be regarded as sexual because of its preparing an ovary for the buds than are the principal hydranths of *Eudendrium racemosum* to be regarded as such because they supply the ovicells to the gonophores borne by the blastostyles. As in so many of the Hydromedusæ, the male elements of the sexual individuals have undergone no corresponding shifting. The discrepancies between the results of the two observers probably depend on the circumstance that the process of phylogenetic shifting has attained, as in Hydromedusæ, different stages of development in the various species. The mode of reproduction of the Salpæ is still to be regarded as a case of alternation of generation, even should Salensky's well founded suspicion that the chain Salpæ are themselves able to produce a second ovary after the first has been used up prove invalid.

The remarkable differences in the development of the germinal cells in nearly allied Hydromedusæ seem to be paralleled to some extent by the extraordinary condition in the early embryology of the Salpæ discovered by Salensky,[1] where the differences occurring in the different species are so great and important that, as he writes, "they hardly bear comparison with one another." In all Salpæ the early segmentation of the ovum takes place as usual, but then "gonoblasts," cells derived from the epithelium of the egg-follicle, not sexually fertilised elements, suppress the blastomeres, which atrophy whilst the entire embryo is formed from the gonoblasts with or without other unfertilised matter. Salensky calls this extraordinary process, which is without parallel in the rest of the animal kingdom, "follicular budding."

Possibly some of the curious differences as to the extent to which the gonoblasts and parts of the ovary and oviduct enter into the formation of the embryo in Salpæ (Gymnogonæ and Thecogonæ) may be hereafter explained on some such principle as that of Prof. Weismann of "phylogenetic shifting."

H. N. MOSELEY

[1] Prof. W. Salensky, "Neue Untersuchungen über die embryonale Entwicklung der Salpen." II. Th. Schluss, "Mittheilungen aus der Zool. Station zu Neapl.," Bd. iv. Heft 3.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Public Orator (Mr. J. E. Sandys) made the following address to the Senate in presenting Mr. Andrew Graham, First Assistant to Prof. Adams at the Observatory, for the complete degree of M.A. *honoris causâ*. Mr. Graham discovered the ninth minor planet *Metis*, a fact cleverly turned to account by the Orator:—

"Dignissime domine, Domine Procancellarie et tota Academia:

"Quam invidenda nobis illorum vita est, qui a rerum terrestrium strepitu remoti, templum quoddam observando cælo dedicatum incoluut, ubi noctibus serenis tot lucidorum orbium ortus obitusque contemplantur, tot stellarum immotarum stationes perpetuas accuratissime definiunt, tot siderum errantium cursus prius ignotos admirabili quadam divinatione augurantur. Consentaneum nimirum est eum, cui primo quondam Oceani filia, Metis, inter sidera affulserat, tot annos in rure illo suburbano cum Neptuni inventore nostro celeberrimo feliciter esse consociatum. Iuvat certe tanti viri adiutorem fidelissimum hodie civitate nostra donare, virum et linguarum recentiorum et studiorum mathematicorum perquam peritum, neque in numeris tantum computandis sollertissimum, sed in sideribus quoque observandis perspicacissimum. Ipse rerum omnium Fabricator, cetera quidem animalia terram prona spectare passus,

'os homini sublime dedit cælumque tueri,
iussit et erectos ad sidera tollere vultus;'

quanto igitur honore illi digni sunt qui, qua in re ceteris animantibus homines præstant, in ea hominibus ipsis tam præclare antecellunt.

"Vobis præsento virum et de scientia astronomica et de Academia nostra optime meritum, Andream Graham."

SOCIETIES AND ACADEMIES

LONDON

Geological Society, November 7.—J. W. Hulke, F.R.S., president, in the chair.—James Diggle, Charles Anderson Ferrier, and Prof. W. Stephens were elected Fellows of the Society.—The following communications were read:—On the geology of the South Devon coast from Tor Cross to Hope Cove, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author, after a brief reference to the literature of the subject, stated that the chief petrographical problem presented by this district was whether it afforded an example of a gradual transition from slaty to foliated rocks, or whether the two groups were perfectly distinct. He described the coast from Tor Cross round by the Start Point to Prawle Point, and thence for some distance up the estuary leading to Kingsbridge. Commencing again to the north of Salcombe, on the other shore of this inlet, he described the coast round by the Bolt Head and Bolt Tail to Hope Cove. These rocks, admittedly metamorphic, consist of a rather thick mass of a dark mica-schist and of a somewhat variable chloritic schist, which also contains a good deal of epidote. In the lower part of this are some bands of a mica-schist not materially different from the upper mass. It is possible that there are two thick masses of mica-schist, one above and one below the chloritic schist; but, for reasons given, he inclined to the view that there was only one important mass, repeated by very sharp foldings. The junction between the admittedly metamorphic group and the slaty series at Hope Cove, as well as that north of Salcombe, is clearly a fault, and the rocks on either side of it differ materially. Between the Start and Tor Cross the author believes there is also a fault, running down a valley, and so concealed. On the north side of this the rocks, though greatly contorted and exhibiting such alterations as are usual in greatly compressed rocks, cannot properly be called foliated, while on the south side all are foliated. This division he places near Hallsands, about half a mile to the south of where it is laid down on the geological map. As a further proof of the distinctness of the two series, the author pointed out that there were clear indications that the foliated series had undergone great crumpling and folding after the process of foliation had been completed. Hence that it was long anterior to the great earth-movements which had affected the Palæozoic rocks of South Devon. He stated that the nature of these disturbances suggested that this district of South Devon had formed the flank of a mountain-range of some elevation, which had lain to the south. Of the foundations of this we may see traces in the crystalline gneisses of the Eddystone and of the Channel Islands, besides possibly the older rocks of South Cornwall and of Brittany. He also called attention to some very remarkable structures in the slaty series near Tor Cross, which appeared to him to throw light upon some of the structures observed at times in gneisses and other foliated rocks.—Notes on Brocchi's collection of Subapennine shells, by J. Gwyn Jeffreys, F.R.S. In this paper the author gave the results of an examination of the collection of fossil shells from the Subapennine Pliocene described by Brocchi in his "Conchiologia fossile Subapennina," and now preserved in the Museo Civico at Milan. The author cited fifty-five of Brocchi's species, upon most of which the collection furnished more or less interesting information. In conclusion he remarked upon the importance of identifying Brocchi's species with forms still living in the neighbouring seas, and also upon the difficulty of distinguishing between the Upper, Middle, and Lower Pliocene in Italy. From his examination of Italian Pliocene shells he concluded that the deposits containing them were for the most part formed in comparatively shallow water, probably not more than fifty fathoms in depth, a remark which also applies to the Italian Miocene; and that in the case of species still existing no difference can be recognised between Pliocene and recent specimens.—British Cretaceous Nuculidæ, by John Starkie Gardner, F.G.S. The author commenced by discussing the question whether the Nuculidæ should be separated as a family from the Arcidæ, and stated that species of *Leda* and *Nucula* exist and sometimes abound in the marine Cretaceous deposits, with the exception of the White and the Red Chalk, from which, however, he thought that the shells may have been dissolved out. He also referred to the probable derivation of the species from preexisting forms, and discussed the question of how far the relationships thus established could be expressed in the nomenclature of the species, his researches upon the Nuculidæ leading him in some cases to suggest a trinomial nomenclature. The probable lines of descent of the shells described in the present paper were also discussed at some length.

Anthropological Institute, November 13.—Prof. Flower, F.R.S., president, in the chair.—The election of the following new members was announced:—Dr. G. B. Barron, Prof. D. J. Cunningham, H. O. Forbes, J. S. Hunt, Capt. E. C. Johnson, R. Morton Middleton, jun., Capt. C. A. Moloney, S. B. J. Skertchley Joseph Smith, jun., and Dr. Johnson Symington.—Mr. J. E. Price exhibited a selection of objects from ancient grave mounds in Peru.—Dr. Garson exhibited two iron lamps that he had procured from the Orkney Islands for the Oxford University Museum. They were very similar to the lamps of the Esquimaux described by Dr. E. B. Tylor in his paper read before the Institute at the end of last session, and each consists of two flat receptacles prolonged into a spout-like depression on the anterior portion.—Prof. Flower exhibited the skull of a young chimpanzee (*Troglodytes niger*) which had been sent to him from Lado in the Soudan, by Dr. Emin Bey. It was the subject of acrocephalic deformity, associated with complete synostosis of the coronal suture, and partial obliteration of the sagittal suture, both of which are normally open long after the age to which this individual had attained.—The Director read a paper by Mr. Edward Palmer on some Australian tribes.

Zoological Society, November 20.—Prof. W. H. Flower, F.R.S., president, in the chair.—A letter was read from Mr. G. B. Sowerby, jun., in which he proposed to change the name of *Thracia jacksonensis*, given in his paper "On New Shells," read in January, 1883, to *Thracia brazieri*.—A letter was read from Mr. W. H. Ravenscroft, of Colombo, Ceylon, describing the effectual mode in which a female Axis Deer in confinement concealed its young one from observation.—The Secretary exhibited, on the part of Major C. H. T. Marshall, F.Z.S., a specimen of a new Impeyan Pheasant from Chumba, N.W. India, which Major Marshall proposed to name *Lophophorus chumbanus*, and some other birds from the same district.—Mr. H. Seebohm, F.Z.S., exhibited and made remarks on a new Owl from Japan, which he proposed to call *Bubo blakistoni*, after Capt. Blakiston, its discoverer.—Mr. H. E. Dresser, F.Z.S., exhibited and made remarks on some Ringed Pheasants from Corea.—Prof. Bell, F.Z.S., exhibited and made remarks upon some Australian Crinoids infested by a large number of Myzostomata.—Prof. Flower read a paper on the characters and divisions of the family Delphinidæ, in which the following generic divisions were admitted and defined:—*Monodon*, *Delphinapterus*, *Phocæna*, *Neomeris*, *Cephalorhynchus*, *Orca*, *Or-*

cella, *Pseudorca*, *Globicephalus*, *Grampus*, *Feresia*, *Lagenorhynchus*, *Delphinus*, *Tursiops*, *Clymenia*, *Steno*, and *Sotalia*. Critical remarks were added upon the characters and synonymy of the best-known species of each.—Prof. Flower also gave an account of a specimen of Rudolphi's Rorqual, *Balænoptera borealis*, Lesson (= *Sibbaldius laticeps*, Gray), lately captured in the River Crouch, Essex, being the first well-authenticated example of this species met with in British waters.—A communication was read from Dr. M. Watson, F.Z.S., containing additional observations on the structure of the female organs of the Indian Elephant (*Elephas indicus*).—A communication was read from Mr. F. Moore, F.Z.S., containing the descriptions of some new Asiatic Diurnal Lepidoptera.—A communication was read from Mr. R. Trimen, F.R.S., in which he gave a description of a remarkable semi-melanoid variety of the Leopard (*Felis pardus*) in the Albany Museum, Grahamstown, which had been obtained in the east of the Cape Colony.—A communication was read from the Count H. von Berlepsch and Mr. L. Taczanowski, in which an account was given of an extensive collection of birds made by MM. Stolzmann and Siemiradzki in Western Ecuador.

Edinburgh

Royal Physical Society, November 21.—The first meeting of the 113th session was held in the Institution Rooms, St. Andrew Square, Dr. Ramsay H. Traquair, F.R.SS. London and Edinburgh, president, in the chair.—A nest of the reed-warbler, found near Combe Abbey, Warwickshire, was exhibited to the Society by Dr. Herbert.—The opening address of the session was then delivered by Dr. Archibald Geikie, F.R.SS. London and Edinburgh, Director-General of the Geological Survey of Great Britain and Ireland on "The Relation between Geology and Palæontology."

Sydney

Linnean Society of New South Wales, September 26.—Dr. James C. Cox, F.L.S., in the chair.—The following papers were read:—On a very dolichocephalic skull of an Australian aboriginal, by Baron N. de Miklouho Maclay. The cephalic index of this skull, which was found in the interior of Queensland, was only 58·9, calculated on the ophrio-occipital length, and 58·3, calculated by the glabello-occipital length, an index lower probably than that of any skull hitherto described. The skull was not a deformed one in the ordinary sense, but was a fair example of the so-called roof-shaped type of cranium.—On a fossil humerus, by Mr. C. W. De Vis.—Notices of some undescribed species of Coleoptera from the Brisbane Museum, by William Macleay, F.L.S. The species described are a few unnamed Coleoptera occurring in a large collection sent by Mr. De Vis to the author for identification. Their names are:—*Pamborus viridiaureus*, *Catascopus laticollis*, *Eutoma ponctipenne*, *Carenum terræ-reginæ*, *C. ianthinum*, *C. De Visii*, *C. pusillum*, *Tibarisus robustus*, *Pœcilus lævis*, *Diphucephala hirtipennis*, *D. cærulea*, *D. latipennis*, and *Liparetrus convexiusculus*.

Paris

Academy of Sciences, November 19.—M. Blanchard, president, in the chair.—Remarks on the recent volcanic disturbances in Sunda Strait; mineralogical analysis of the ashes collected, by M. Daubrée. From the examination of these ashes, which fell at Batavia on August 27, the author considers it highly probable that the surface waters penetrating deeply into the underground cavities, and there becoming superheated, form the chief agency in such volcanic eruptions as those of Krakatoa and Ischia.—On the velocities acquired in the interior of a vessel by the various elements of a fluid during its discharge through a lower orifice (continued), by MM. de Saint-Venant and Flamant.—On the process of purple dyeing amongst the ancients according to a fragment attributed to Democritus of Abdera, by M. Berthelot.—On the production of extremely low temperatures by means of continuous apparatus, by M. Cailletet.—Report on the French expedition to Cape Horn, by M. Martial. The expedition, undertaken mainly to observe the transit of Venus, embarked on board *La Romanche* at Cherbourg on July 17, and reached its destination on September 6. Three contacts were observed under favourable conditions by M. Courcelle-Seneuil. A great part of Tierra del Fuego was visited, numerous dredgings were made at various points, and rich collections, especially botanical and ethnological, were brought back These included living specimens of most of the Fuegian flora, two native canoes with their full equipment, a complete hut with all the utensils, arms, and other objects in use amongst the aborigines. A cairn twenty feet high was erected in Orange Bay to commemorate the French expedition to Cape Horn.—On the transformations of which certain equations of the second order are susceptible, by M. R. Liouville.—On the electrochemical energy of light, by M. F. Griveaux.—Observations of the Pons-Brooks comet made at the Paris Observatory (equatorial of the west tower), by M. G. Bigourdan.—Observations of the same comet and of the planet 234 made at the Marseilles Observatory, by M. Coggia. — Photometric observation of an eclipse of the first satellite of Jupiter, by M. A. Obrecht. — Remarks on a formula of Tisserand connected with celestial mechanics, by M. R. Radau. — On the resisting power of a ring, by M. J. Boussinesq.—On the curve-lines of wave surfaces, by M. G. Darboux.—Application of a proposition in mechanics to a problem connected with the figure of the earth, by M. E. Brassinne.—Note on the action of carbonic acid on saccharine dissolutions more or less charged with lime, by M. D. Loiseau.—On a new kind of ureometer (one illustration), by M. W. H. Greene.—Experiments on the passage of charbon bacteridæ into the milk of animals affected by charbon, by MM. J. Chambrelent and A. Moussous.—On the embryogeny of *Sacculina carcini*, an endoparasitic crustacean of the order of Kentrogonides, third note, by M. Yves Delage. In this highly important contribution to the study of parasitic entomology the author proposes to constitute a new order of Kentrogonides, distinct from, but allied to, that of the Cirrhipedes.—Development of the Stylorhynchus, by M. A. Schneider.—On the genus Ptychogaster, Pomel, a fossil Chelonian found associated with the remains of crocodiles in the Saint-Gérand-le-Puy formations, by M. L. Vaillant.—On "vaugnerite," a phosphatiferous rock occurring in the Irigny district on the banks of the Rhone, by M. F. Gonnard.—Note on a prehistoric flint mine worked during the Stone age at Mur-de-Barrez, Aveyron, by M. E. Cartailhac.—Concluding remarks on the waterspouts observed at Villefranche-sur-Mer, Maritime Alps, during the month of October, 1883, by M. J. Jeanuel.—Note on the effects produced by lightning during a thunderstorm at Rambouillet on November 10, by M. A. Laugier.

CONTENTS

THURSDAY, DECEMBER 6, 1883

THE GEOLOGY OF THE LIBYAN DESERT

Beiträge zur Geologie und Palæontologie der Libyschen Wüste und der angrenzenden Gebiete von Ægypten, unter Mitwirking mehrerer Fachgenossen, herausgegeben von Karl A. Zittel I Theil und II Abtheilung, 1 Heft. (Contributions to the Geology and Palæontology of the Libyan Desert and of the Neighbouring Districts of Egypt. By Karl A. Zittel, with the assistance of several scientific men. Part I. and Part II., Section 1.) (Cassel: Fischer, 1883.)

IN NATURE, vol. xxii. p. 587, there appeared a notice of the anniversary address for that year to the Academy of Natural Sciences in Munich delivered by Prof. Karl A. Zittel, the well-known Professor of Geology and Palæontology at the Munich University. The address contained a preliminary sketch of the work, the complete account of which occupies the quarto volume and portion of a second volume now before us.

In the winter of 1873-74 a scientific expedition under the leadership of Gerhard Rohlfs was despatched with aid from the late Khedive of Egypt, Ismail Pacha, to explore the Libyan desert or north-eastern portion of the Sahara. The scientific results of this expedition are now being published in a series of separate volumes, of which the Geology and Palæontology will form two. The first of these lies before us, the second is as yet incomplete, and only one section containing a description of the Eocene Echinoidea, by P. de Loriol, has hitherto appeared. The first volume comprises the geological description of the country by Prof. Zittel himself, an account of the fossil wood from the Nubian sandstone and from the well-known "fossil forest" near Cairo (Cretaceous), by Dr. A. Schenk; of the Miocene fauna of Egypt and the Libyan desert, by Dr. Th. Fuchs; of the Tertiary (Upper Eocene or Oligocene) fossils from the western island in the lake of Birket-el-Qurûn (about fifty miles south-west of Cairo), by Prof. Karl Meyer-Eymar; of the Foraminifera (the Nummulites excluded) from the Eocene beds of the Libyan desert and Egypt, by Conrad Schwager; a monograph of the Nummulites from the same areas, by the late Dr. Phil. de la Harpe; and a description of the Eocene corals, by Magister E. Pratz. These palæozoic descriptions are illustrated by thirty-six plates.

The remaining portions of the second volume will include an account of the Eocene Mollusca, by Prof. Meyer-Eymar; of the Cretaceous fauna, chiefly by Prof. Zittel himself; and of a few other subjects. Amongst the contributors, besides those already enumerated, the names of Prof. Beyrich, the Marquis de Saporta, Prof. Haushofer, and Prof. Zirkel are mentioned in the preface to the first volume.

An array of scientific names like the above, chosen from amongst the most eminent specialists of Germany, Switzerland, and France, proves that this is a work of more than ordinary geological importance. The principal author and editor, Prof. Zittel, is both a good geologist and a good palæontologist, a much rarer combination than is usually supposed.

On the geological map in the first volume an area occupying rather more than 5° of latitude (25° to 30° N.) and above 8° of longitude (about 25° 30′ to 33° 40′ E.) is coloured. This country includes the Nile valley from Cairo to Edfu (the geology of the valley itself is shown as far south as Assuan), and extends eastwards to the shores of the Red Sea, and westward far into the great desert tract of Northern Africa. The whole area coloured geologically may be roughly estimated at between 150,000 and 160,000 English square miles.

It will easily be understood that the mapping is of a very rough description, a geological sketch in fact, but in desert countries, owing to the want of vegetation to conceal the rocks, and to the clearness of the atmosphere, it is remarkable with what accuracy geological formations can be traced by the eye to great distances. A considerable proportion of the area is coloured from the observations of other travellers, and especially of Schweinfurth. The routes of the expedition under Rohlfs and of other travellers are marked on the map, and show how much of the area has actually been examined.

Among the numerous points of interest presented by the volume it is difficult to select any one as superior to the others. In the former notice in NATURE the general characters of the geological systems observed (Cretaceous, Eocene, Miocene, and the so-called Quaternary and recent) were briefly described. To enter at any length into a notice of the palæontology would take too long. At the present time when the writings of F. von Richthofen and others have called especial attention to the subaërial or Eolian formations of the latest geological times and the present day, the description of the surface phenomena presented by the desert tracts of the Sahara, coming from so keen an observer as Prof. Zittel, are well worthy of attention, and a few remarks upon them may prove interesting.

The geological portion of the work is divided into two chapters: the first, containing forty-two pages, being devoted to the Sahara as a whole; the second to the geology of the Libyan desert and Egypt. In both of these chapters considerable space is devoted to the superficial characters of the desert. The surface of the Sahara is divided by Prof. Zittel, according to its characters, into four kinds:—(1) Plateau-desert or Hammâda, occupying the largest portion of the area, a level, hard, stony surface in general, without noteworthy elevations or depressions, but passing locally into (2) mountainous desert. The so-called (3) erosion-desert consists of depressions more or less occupied by salt-marsh. The last form of surface, the most remarkable and interesting of all, is the (4) sandy desert or Areg, composed of drift sand forming hills or downs (dunes).

Prof. Zittel shows, on what appears to be an overwhelming amount of evidence, that the popular idea of the Sahara having been the basin of a sea in Pleistocene times is without foundation. The greater part of the area has apparently been above water ever since the Cretaceous epoch; a comparatively small tract in the north-eastern portion was submerged beneath a Tertiary sea, whilst the only part that can have been under water in post-Tertiary times consists of a tract extending from the Nile delta to the oasis of Ammon, and to the so-called "Chotts" of Tunis, and even in this tract marine conditions in late geological times are doubtful. But Prof. Zittel considers that the climate must have been damper, the rainfall heavier, and freshwater denudation more active in Pleistocene days than now, to account for the erosion that has taken place, the abundance of fulgurites, and the present distribution of the fauna and flora, especially in such cases as the occurrence of Central African crocodiles in the marshes and streams of the completely isolated Ahaggar Mountains. Reasons are also given for believing that the Nile was formerly a larger river than it now is. It is probable that Prof. Zittel's views on some of these points will be contested, but it is impossible to deny that his arguments are admirably expressed and clearly reasoned out.

Some very interesting details are given about the desert sand, and a careful description of its arrangement in the form of sandhills. The sand of the Sahara is considered to have been largely derived from the decomposition of the so-called Nubian sandstone, the original matrix of the well-known silicified wood. In the Libyan desert there are some remarkable anomalies in the arrangement of the sandhills, and it is clear that they cannot have been entirely formed by accumulation through the agency of the prevailing wind as it exists at the present day. It may here be remarked that very similar observations were made, a few years since, upon the sand ridges of the Indian desert east of the Indus. Some of the sand ridges, both in Africa and India, attain an elevation of about 500 feet, and in both areas the largest appear to have undergone no change within the memory of man, although in places, in both continents, moving tracts of sand occasionally overwhelm cultivated land and buildings.

One mistake in the book deserves notice. In the comparative table of Upper Cretaceous and Eocene beds in Europe, Asia, North Africa, and North America the position assigned to some of the Tertiary stages of the Indian rocks requires correction. The lower Nari beds in especial were never supposed to be so old as Middle Eocene (Parisian), and they are now known to be in all probability true Oligocene. But trifling mistakes of this kind are to be expected: it is surprising that more should not have been observed.

W. T. B.

APPLIED MECHANICS

Applied Mechanics. By H. T. Bovey, M.A., Professor of Civil Engineering and Applied Mechanics, McGill University, Montreal, Fellow of Queen's College, Cambridge. Part I., pp. 190. Part II, pp. 150. (Montreal: J. Lovell and Son, 1883.)

THIS work appears to be designed as a college text-book for somewhat advanced students, who have already received good training in mathematics (as far as the elementary parts of the integral calculus) and theoretical mechanics.

Part I. treats of the strength of materials, dealing with longitudinal stress, the strength of beams and pillars, torsion, and the strength of hollow cylinders and spheres.

In Part II. we have chapters on frames, roofs, bridge-trusses, suspension bridges, arched ribs, and in conclusion one on "details of construction," which includes a discussion of the strength of rivets and other fastenings.

In his exposition of these subjects the author manifests a power of clear and precise statement; and the treatment of the more difficult problems of the first part is perhaps as profound as could be attained without a knowledge of the general theory of elasticity. The numerous illustrations serve sufficiently well in Part I., where they consist chiefly of diagrams; but in Part II. they are on too small a scale for the complicated structures illustrated: and in clearness of detail are far below the standard reached in recent English books on the same subjects. Analytical methods are preferred throughout; and generally speaking geometry is used merely to illustrate results previously obtained in a symbolical form. Thus graphical statics is quite subordinate in Part II.; stress diagrams are introduced, but there are not sufficient instructions in the text to enable a student, who has not studied the subject independently, to construct them for himself.

In the extended treatment of a parabolic rib of uniform stiffness (pp. 101-120) the author follows very closely the lines in Rankine's "Civil Engineering," with some further consideration of the additional terms depending on change of temperature.

There is no acknowledgment in regard to this and other parts of the work where Rankine's influence is clearly apparent. But as no preface is given to the present volume, perhaps other portions of the great subject of applied mechanics are in course of preparation by our author; and till the completion of his work he is postponing the statement of his obligations to those who have gone over the ground before.

We have referred to the apparent excess of symbolical reasoning: but none of this is due to the introduction of investigations better left to treatises on pure mathematics and theoretical mechanics.

Difficulties special to the subject of the work, such as the equations of the "neutral axis" (so-called) for all the different modes of loading and supporting a beam, the theorem of three moments, the moments of inertia of complicated forms of section, the deflection of struts, are however treated with the fullness of detail required by ordinary students.

Such investigations constitute the best feature of the book. The detailed application to problems such as occur in actual practice is but slightly touched on; perhaps for this we are to look to the "Examples," of which some few are worked out in the text; appended to the several chapters, moreover, are close upon 400 proposed for the exercise of the student.

These form a very important collection. A great number involve numerical results, and unfortunately the answers are not given; this greatly lessens their value for private students at any rate. Several examples are taken from existing structures, and are liberally furnished with diagrams in illustration of the data.

Many are new to text-books, and the author has evidently taken great pains in collecting and arranging them.

A. R. WILLIS

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Meteors

HERE, November has generally been unpropitious for astronomical observations. However, during favourable intervals I have seen many brilliant meteors; from twenty to thirty on an average every night. They were principally seen with the face to the north, and glancing from shoulder to shoulder; but not a single Andromede did I see. I had the pleasure of seeing altogether about a score of Leonids before the 12th and after the 19th November. Leo Minorids and Arietids were plentiful, and a goodly number of Geminids were seen; but the richest field for meteors during the month was in the neighbourhood of the Plough. November 6, at 4.30 a.m., a large meteor passed from γ Ursæ Majoris right down to the horizon. From 4.35 to 5.15 three veritable Leonids proceeded from the Sickle; one dashed down to the right-hand, and another from the top of the Sickle to the left over the Lion's back. They were very large. November 10, at 8 p.m., a brilliant meteor started from a point nearly half way between Aldebaran and Saturn, and disappeared at a point down more than half way to the horizon. At 9.30 a very bright one appeared at a point about 1° above Castor and above Jupiter to the north. At 11.25 an exceedingly large and brilliant meteor burst out from ½° below Menkar (in the Whale), and went down at right angles to the very horizon, leaving a long, bright streak behind. November 11, a large one, at 0.15 a.m., dropped down to the horizon from θ Ursæ Majoris. At 0.55 a.m. a very large one proceeded from ½° to the right of α Lacertæ and disappeared at γ Cygni. November 18, at 1.40 a.m., a very large reddish meteor burst out from the top of Ursa Major's head, and passed right above Vega, and disappeared about 4° beyond it in a strange sparkling explosion. At 1.55 a.m. a very brilliant meteor dashed out about 2° above α Arietis, went through the Square of Pegasus, leaving a beautiful stream of blue fire behind, and lasting a few seconds. About 5.30 another large blue meteor passed from the centre of Leo's back through a point 4° above Denebola, and ended in a beautiful explosion 15° beyond. On the night of November 22 there was a fine display of (generally) large meteors from Taurus to Ursa Major; many of them proceeded from the Lion's Head. During the month a great number of meteors passed from some point in Scorpio, under Jupiter and Mars, right into the Lion's Head. They were all large and bright. During the last half of the month some fine displays of morning meteors were seen. At 4 a.m., November 29, I observed a very large and swift meteor. It blazed out from a point about 8° above Denebola, and dashed with great velocity up the heavens, passing 4° above δ Leonis and over the Lion's Head, and exploded about 5° beyond, leaving a stream of the most beautiful blue light in its wake that I ever witnessed. DONALD CAMERON

Mossvale, Paisley, December 3

As your columns frequently contain notices of meteors, I may mention that I observed one of unusual brilliancy last night (November 28) at 10.50. It appeared in the constellation Taurus, and, following the line of the ecliptic, disappeared about five to ten degrees above the eastern horizon. The meteor was visible for not less than fifteen seconds, had a brilliant train or cone of light of from two to three degrees in length, and outshone Jupiter, near which it passed. From the slow, angular movement of the meteor I feel certain that the train was not an optical impression, but a real luminous object. F.R.S.E.

Edinburgh, November 29

A FINE meteor was observed here by me at 10h. 38m. last night, Wednesday, November 28. Bursting into sight near *h* Ursæ Majoris, it passed in a course almost parallel to, but about 2° north of, a line joining α, δ, ε, ζ, and η Ursæ Maj., its light expiring near λ Boötis. Length of path = 40°. No train was observed; the only variation of uniformity of light being at about half way of its passage, where it slightly paled for an instant and then as quickly recovered. Duration about four seconds. Brilliancy three or four times Venus at its brightest. Colour resembled that of magnesium light. W. WICKHAM

Radcliffe Observatory, Oxford, November 29

LAST night, about 10.30, I saw a magnificent bolide shoot across the sky in a northerly direction. It came from the middle star in Orion's belt, and disappeared at a point almost in a line with "the Pointers" in the Great Bear, and at a distance below the lower of the two stars almost equal to the distance between them. Its path was perceptibly arched, but not to any great extent, and, as far as I could judge, it was not parabolic. When the bolide first appeared, it seemed a mere luminous point moving with great rapidity, and without a tail. But about half way it suddenly grew large and brilliant, a tail shot out, and the path behind it remained luminous and distinct. I could compare the bolide at this point to nothing so much as to a red-hot cannon ball emitting sparks of fire. It was accompanied by no sound, and was gone in half a dozen seconds. During its passage the streets seemed to be lit up with the electric light. It was apparently so close that I should think a few miles would have made a very sensible difference in its apparent position in the heavens. J. B. OLDHAM

Stockport, November 29

LAST night at 11h 2m. I saw in the north-west, near the horizon, one of those slow-moving balls of fire, not so bright as an ordinary meteor, and leaving no train. This seemed the size of a cricket ball; but I have seen one the size of a cheese-plate. A few flashes of lightning occurred soon after. From the slowness of the motion the phenomenon seemed to be wholly atmospheric. It was in sight for about three or four seconds. It instantly suggested an incandescent vortex whorl; but I cannot say whether the appearance confirmed the idea or not, for I do not know how such a meteor would look. Its red light might be due to its proximity to the horizon, perhaps 8°. Hence there is no dependence to be placed upon my impression that the light was the result of friction rather than of electricity. I have seen probably a dozen in the course of my life, always in the west or north-west, and always about the same height from the horizon, but never annular. HENRY H. HIGGINS

Rainhill, December 4

"Anatomy for Artists"

MAY I add a few more words on the subject of Mr. Marshall's book, and in answer to his letter in NATURE? Mr. Marshall says the reasons that led him to adopt the plan of omitting reference letters to his illustrations of the bones "still remain sound." Turning to p. 30 of the book to learn those reasons, I find he says that "The numerous minute points which demand the attention of the anatomist and the surgeon necessitate such aids; but the art-student's mind should be left unincumbered by such unnecessary details."

I cannot see that this is a reason; I wanted references to what is described in the text—to the necessary, not the unnecessary details.

Secondly, Mr. Marshall says, "The pure form of the bones, represented on so small a scale, in black and white, would have been seriously marred by such references." If this be "sound," may there not be more and equally sound reasons for opposing it? I think there are; and if Mr. Marshall will turn to p. 136 of the book, I will try to show him how his plan works. The student reads there that "All the bones of the hand are visible in the skeleton, on its palmar aspect (Fig. 58), carpal, metacarpal, and phalangeal;" he turns to Fig. 58, but where is it? It is mentioned in a list of figures under *three* illustrations. He has to make up his mind which of the three is 58, recalls that it is the palmar aspect, and goes on. He has no clue, let Mr. Marshall observe, by which to know which are the carpal, metacarpal, and phalangeal portions of the hand for which he originally looked at the palmar aspect of it. He hopes he may come to that; and, reading on, finds that the eight carpal bones are "in the carpus;" but then, which *is* the carpus? He does not know, and is not told. Never mind, he thinks, he will find that out by the description of the single bones, and, beginning with the first mentioned, he reads that the semi-lunar bone ". . . . occupies the centre of the first row, and is crescentic in shape." Looking again at the illustration, for "rows" he finds that the bones which seem to be arranged in rows are those which he may afterwards learn to be the metacarpals and phalanges. Supposing, however, that he guesses the carpus rightly, which of its bones is semi-lunar or crescentic in shape? I think if the picture were put before *any* ordinary observer, told to point out a crescentic bone, he would select the scaphoid. There is, thinks the student, still a clue left, for the semi-lunar "occupies the centre of the first row." But the first row contains *four* bones; at least he has read that "the eight bones are clustered together so as to form two groups," and he is not told that these groups are not the "rows" afterwards mentioned. He gives it up, and reads the other bones to learn them and find the semi-lunar by the exhaustive process. The guide he finds to the cuneiform bone is that it is "on the ulnar side of the semi-lunar," which he has perhaps failed to guess rightly, and articulates with certain other bones, which are to be afterwards described, and are unknown to him; and so on.

The mode of progression is like that I made once in Ireland, when on asking a peasant my way I was told to take the last turning before coming to the next milestone. There were a good many steps to retrace after finding the next milestone.

I have no doubt at all of the moral influence of Mr. Marshall's plan *if the student perseveres in using his book;* he will have exercised patience, attention, command of temper, and careful criticism of words, but I do not think his anatomical will equal his moral gain.

The process described above simply distracts the student's attention from the form of what he is studying. Would Mr. Marshall wish the Map of England taught in the same manner—no names or references given to the counties, and Hampshire to be recognised because it is in the last row and adjoins certain other counties, which in their turn adjoin it?

ART STUDENT

Barytes from Chirbury

I HAVE to thank Mr. Woodward for pointing out that the plane (412) has been established for barytes. It was first given by Helmhacker (*Denksch. der K. Akad. der Wiss. Wien*, vol. xxxii. 1872) as occurring on crystals from Svárov and Krušná hora in Bohemia, but is rejected by Schrauf as insufficiently determined. The distinguishing peculiarities of the Chirbury crystals are (1) the predominance of the plane E which does not truncate an edge as is the case in Carl Urba's crystals; (2) the frequent occurrence of ω and ξ; (3) the tendency of the face o to develop small faces on its edges which are inclined to o at angles near 3°. Such faces are Q and Y, and I have since determined a face Λ on the edge $o\mu$ with indices near (25.1.27).

British Museum, November 26 H. A. MIERS

THE ORIGIN OF CORAL REEFS[1]

II.

THE most detailed investigation of coral-reefs which has yet appeared has just been published by Prof. A. Agassiz.[2] This able naturalist is engaged in prosecuting a series of researches into the biological phenomena of the seas on the eastern side of the United States, under the auspices of the United States Coast Survey, and in the course of these explorations he has had occasion to devote himself to the detailed study of the coral-reefs of the Florida seas. For purposes of comparison he has likewise visited the reefs among the West Indian Islands, as well as those on the coast of Central America. His observations are thus the most exhaustive and methodical which have yet been published, and the deliberate conclusions to which he has come deserve the most attentive consideration. He traces the history of a coral-reef from its latest stages as dry land to its earliest beginnings, and even beyond these to the gradual evolution of the conditions requisite for the first starting of the reef. His familiarity with the nature of the bottom all over the area in question, and with the life so abundant in the tropical waters, gives him a peculiar advantage in this inquiry. The upheaval of recent coral-formations to considerable heights above the sea in various parts of the region enabled him to examine the inner structure and foundations of the reefs, and to obtain therefrom altogether new data for the solution of the problem. Following him in his induction we are led back to a comparatively recent geological period, when the site of the peninsula of Florida was gradually upraised into a long swell or ridge, having its axis in a general north and south direction, sinking gently towards the south, but prolonged under the sea as a submarine ridge. The date of this elevation is approximately fixed by the fact that the Vicksburg limestone was upraised by it, and this limestone is assigned to the Upper Eocene series. As a consequence of the elevation, a portion of the sea-bottom was brought well up into the waters of the Gulf Stream, which were probably shifted a little eastward.

No marine fauna yet explored equals in variety of forms or number of individuals that which peoples the waters of the Caribbean Sea and the Gulf of Mexico from the depth of 250 to about 1000 fathoms. This prolific life is traced by Prof. Agassiz to the copious food-supply carried by the warm tropical currents, combined with the food borne outwards from the sea-board of the continent. The corresponding abundant fauna found by the *Challenger* in the Japanese current may be regarded as its counterpart in the Pacific Ocean. Prof. Agassiz points also to the diminished richness of the fauna on the western side of the continents as being probably connected with the absence of those warm equatorial currents which bring such an abundant supply of food to the eastern shores. "No one," he remarks, "who has not dredged near the hundred-fathom line on the west coast of the great Florida Plateau can form any idea of the amount of animal life which can be sustained upon a small area, under suitable conditions of existence. It was no uncommon thing for us to bring up in the trawl or dredge large fragments of the modern limestone, now in process of formation, consisting of the dead carcasses of the very species now living on the top of this recent limestone." Mollusks, echinoderms, corals, alcyonids, annelids, crustacea, and the like, flourish in incredible abundance on the great submarine banks and plateaux, and cover them with a growing sheet of limestone, which spreads over many thousands of square miles and may be hundreds of feet in thickness. In these comparatively shallow waters, and with such a prodigiously prolific fauna which supplies constant additions to the calcareous deposit, the solvent action of the carbonic acid upon the dead calcareous organisms is no doubt reduced to a minimum, so that the growth of the limestone is probably more rapid than on almost any other portion of the sea-bottom.

From the charts we learn how extensively submarine banks are developed in the West Indian region in the track of the warm currents. East of the Mosquito Coast, in Central America, one of these banks may be said to stretch completely across to Jamaica. Similar banks rise off the Yucatan coast; likewise on the windward side of the islands, where the ocean currents first reach them.

That these banks lie upon volcanic ridges and peaks can hardly be doubted, though we have no means of telling what depth of recent limestone may have accumulated upon them. Among the islands, recent volcanic masses rise high above sea-level, in Martinique reaching a height of more than 4000 feet. And as usual in volcanic regions there are numerous proofs of recent upheaval, such as the Basse Terre of Guadaloupe, the successive terraces of recent limestone in Barbadoes, and the upraised coral-reefs of Cuba, which lie at a height of 1100 feet above sea-level.

The West Indian seas have long been famous for their coral-reefs. Prof. Agassiz insists that the distribution of these reefs is determined by the direction of the food-

[1] Continued from p. 110.
[2] "On the Tortugas and Florida Reefs." *Trans. Amer. Acad.* xi. (1883).

bearing ocean currents. They flourish on the windward side of the islands and along the whole eastern coast of Honduras, Venezuela, and Yucatan. But on the leeward shores they do not exist at all. Cuba is fringed both on the north and south side with reefs, but the southern reefs, directly bathed by the Gulf Stream and exposed to the prevailing winds, are more flourishing than the northern reefs, which are to some extent cut off from the equatorial current by banks and islands.

The depth at which corals will flourish in these seas has been found to be rather less than that which has been ascertained to be in general their downward limit elsewhere. Prof. Agassiz concludes that they do not thrive below a depth of six or seven fathoms in the Florida seas, though on the outer reef, directly exposed to the open currents and prevalent winds, they descend in scattered heads to about ten fathoms.

Each successive stage in the growth of an atoll seems to be laid open for study in the prolongation of the Florida reefs. The map of that region (Fig. 2) shows a remarkable broken line of islets and strips of land running parallel with the coast, first in a southerly direction, but gradually curving round until it takes a due westerly trend. This westward curve is attributed mainly to the influence of the strong counter-current which, with a width of ten to twenty miles, sweeps westward into the Gulf of Mexico along the left side of the Gulf Stream, and heaps up organic debris in its track. Florida is growing westward in the line of this current. Reef after reef is added to the land at the east end, while towards the west, new reefs successively begin on the bank, as its surface is gradually built up by the accumulation of organic debris.

The last and youngest of the reefs marked on the maps and charts is the group known as the Tortugas. But immediately to the west of this group Prof. Agassiz has found a prominence on the submarine bank, on which corals have begun to grow. Large heads of Astræans and Madrepores have fixed themselves at a depth of from six to seven fathoms, and Gorgoniæ are found a little lower. This is the beginning of an atoll. The Tortugas, which present a further stage of development, consist of an elliptical, atoll-shaped reef, in three chief parts, whereof the largest forms a crescent, fronting to the east

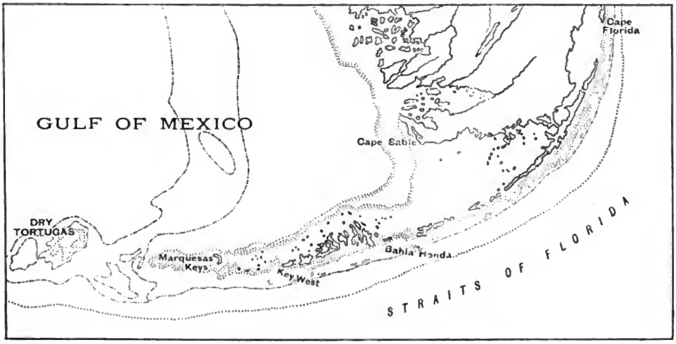


Fig. 2.—Map of the Florida Reef and Keys.

round the edge of the submarine bank, while the two other portions have grown south-westwards along the bank. Three channels between these portions allow powerful tidal currents to rush across the central chiefly submerged parts of the atoll. Seven islands have been formed at the higher parts of the reef by the accumulation and induration of calcareous debris tossed up on the reef by the waves. To the breakers and currents combined with the distribution and habits of growth of the reef-builders Prof. Agassiz entirely attributes the form and growth of the reef. The most important corals are the Madrepores, which flourish in extensive patches, two common species of *Porites* occurring in clusters over the shallow tracts of coarse sand, and *Mæandrina areolata*, growing between the marine lawns of *Thalassia*, with occasional patches of *Anadyomene*. Immense masses of nullipores and corallines grow on the tops of the dead branches of Madrepores which have been killed by exposure to the air during extreme low tides or when strong winds have blown the water off the flats. Large heads of Astræans and *Mæandrina* occur here and there towards the edge of the reef, which is occupied mainly by clusters of *Gorgoniæ*. The destruction of the reefs by the waves is very great, the sea being occasionally discoloured with the chalky sediment to a distance of from six to ten miles after a storm. Broken coral-heads, and branches, dead corallines, shells of mollusks, old serpulæ tubes, stalks of *Gorgoniæ*, and other organisms are thrown up in lines that consolidate into a low dyke, which in turn is pounded up and removed by the breakers. A prodigious quantity of calcareous sediment is thus produced, much of which is swept into the interior of the reefs, where it accumulates in flats of sand and silt. It is only on the outer edges of the reef, where the scour of the sea is greatest, that the corals can flourish; elsewhere they are choked and buried under the deposit of calcareous sediment. Some of this sediment accumulates in steep submarine banks, like sand-dunes, which shift to and fro as winds and currents vary; though by the action of the carbonic acid of the sea-water they are apt to be cemented into solid slopes, some of which have an angle of as much as 33°. So great is the destructive and transporting influence of the sea under the combined or antagonistic working of tides, currents, and wind-waves, that the whole mass of the reef as well as the flats and shoals inside may be said to be in more or less active movement. Hence none of the landmarks furnished by the islands can be relied upon for the location of buoys.

A still more perfect example of an atoll formed under similar conditions is that of Alacran on the opposite coast of Yucatan. Its eastern face is a great arc of about 20 miles, where, exposed to the open sea and easterly winds, the corals flourish vigorously. On the eastern or interior face of the western chord of the reef, however, the silt derived from the pounding of the breakers to the eastward has already killed the corals. The lagoon is occupied by detached coral-heads with lanes of deep water between them [1]

To the east of the Tortugas, nearer the mainland of Florida, older stages of development among coral-reefs may be traced. By the westward drift of the calcareous sand and silt the lagoons have been converted into flats, and these in succession have been turned into more or less continuous dry land. There is no evidence of subsidence. The area seems to have remained stationary for a long period, or if there has been movement at all, it has been in an upward direction. Should the present condition of things be prolonged, there will be a further extension of the Florida coast-line. By the heaping up of the shells of dead organisms in the track of the counter current, the submarine bank will continue to be brought up within the depth at which reef-building corals can flourish. Successive clumps of reef-builders, springing up and growing outward, will build up atoll-shaped reefs. The abrading action of the waves upon these reefs will furnish detritus to be drifted into the lagoons and channels, which will eventually be silted up into dry land.

An interesting indication of the progress of these changes is furnished by the terrestrial flora and fauna of the reefs. The plants of the mainland are found likewise on the reefs, but become fewer in number as they are followed southward, until on the Tortugas,—the last addition to the dry land,—the flora consists of a few Bay-cedars, a hop-vine with a thick white flower, Bermuda grass, and a solitary mangrove tree. One of the species of land-shells common at Key West has found its way to the Tortugas. No terrestrial reptiles have yet reached that furthest atoll, though at Key West, less than 100 statute miles to the east, many of the frogs, toads, lizards, and snakes common to the southern mainland have already established themselves.

It will be observed that the conclusions arrived at by Prof. Agassiz from his own independent researches entirely confirm those previously announced by Mr. Murray. That two observers, who have enjoyed exceptional advantages in the investigation of this subject, should come to practical agreement must be admitted to be a strong argument in favour of the views which they have adopted.

Putting together all the data which have here been summarised, I think we are driven to admit that barrier reefs and atolls may be formed without subsidence of the sea-floor. Whether this has been the usual or only an exceptional manner of their origin is a question that will depend for its solution upon whether or not it can be shown that there are general phenomena which can only be explained by subsidence. Three such phenomena may be adduced: I am not aware of any others that deserve serious consideration.

1. One of the early difficulties which Darwin's explanation satisfactorily solved was the necessity for the existence of so many peaks, coming up from the depths of ocean just to the zone in which reef-building corals live. No cause was conceivable which should have so generally arrested the upward growth or upheaval of these submarine heights at the limit where coral-reefs might begin. And this difficulty has always been looked upon as furnishing one of the strongest arguments in favour of the theory of subsidence, for that theory completely removes it, by showing how, in a general submergence, peak after peak would sink, and come within the sphere of the operations of the reef-builders.

The difficulty is met in a totally different way by those who believe it to be more formidable in appearance than in reality. They contend that, while it must not be forgotten that many peaks do rise above the sea-level, and many submarine banks still fall far short of the coral-zone, two powerful causes conspire to bring submarine banks to a common uniformity of level at a short distance below the surface of the ocean. On the one hand, those portions of volcanic mountains that rise above the sea-level are worn down by the atmosphere and the waves, and unless otherwise preserved, must inevitably be reduced to the lower limit of wave-action, which is probably nearly coincident with the lower limit of reef-builders. On the other hand, submarine banks in tropical seas are built up towards the surface by the accumulation of the aggregated remains of plants and animals which live on the bottom or fall down to it from upper waters, and the magnitude of this upward growth is hardly yet adequately realised.

In balancing these opposite views, we must, I think, admit that subsidence is adequate to provide platforms for coral-reefs, but that these platforms could likewise be furnished by the two other processes just referred to. Subsidence has been invoked because no other solution of the problem seemed admissible. But as another solution has been found the argument in favour of subsidence has no longer the same force. The new solution, being based upon facts which are everywhere observable in the coral regions, appears to me to be more probable than the older one, which is only an inference resting on no positive proofs.

2. The precipitous descent of the outer face of the reefs to depths far below those at which corals can live is another difficulty which finds a ready explanation on the theory of subsidence. If it were true, as is popularly assumed, that a coral reef presents towards the ocean a vast perpendicular wall of limestone, entirely composed of solid coral, there could be no escape from the conclusion that subsidence must have occurred, to permit of such an aggregation of coral-rock. We learn, however, that much misconception exists on this subject. Some of the earlier accounts of coral-islands speak of "unfathomable" depths at a short distance seawards from the reefs; but more recent soundings afford no confirmation of these statements. Instead of being the summits of vast submarine pillars of limestone, atolls, as well as barrier-reefs, appear to be really planted on the tops of submarine peaks and ridges. The outer face of the reef is undoubtedly steep, in some places vertical. At Tahiti, for example, as shown in Fig. 2, the living face of coral may extend to a depth of 30 to 35 fathoms, beneath which huge detached blocks of coral are piled up and cemented together, forming a steep face, which descends to about 150 fathoms at a distance of 180 fathoms from the upper edge of the reef. The sea-bottom beyond that point is covered with coral sand and slopes at 25° to 30°, after which the angle lessens to 6°. By the abrading action of the breakers in tearing off blocks of coral, and strewing them down in steep talus-slopes, a platform is prepared on which the actually growing part of the reef can build outwards.

In Darwin's section of the Gambier Islands the thickness of the encircling reef is made to be about 2000 feet.[1] Prof. Dana by one estimate puts it at 1150, and by another at 1750 feet. He assumes that in general the thickness of solid coral must be considerable, though he admits that calculations based on the seaward continuation of the slope of the land are liable to error from many causes.[2] Even if we admit (what cannot be proved) that the calcareous mass of any coral-reef does attain a thickness of many hundred feet, it would not necessarily con-

[1] *Bulletin Mus. Comp. Zool.*, v. No. 1.

[1] "Coral Reefs," 2nd edit. p. 65.
[2] "Corals and Coral Islands," 2nd English edit. (1875), p. 126.

sist wholly of solid coral.[1] Prof. Agassiz has followed the growth of a reef upon a platform of calcareous organic debris, and he has found elevated coral-reefs which rest on such a platform. Mr. Murray's observations explain how a reef may grow outward on a talus of its own debris. There appears to be no reason, indeed, why a calcareous mass of almost indefinite thickness might not be formed without the aid of subsidence. Its upper zone might be directly due to coral growth, while the larger part of the mass might be composed of an aggregate of coral debris mixed with the remains of mollusks, echinoderms, and other calcareous organisms. So rapid is the destruction of organic structure through the solution and redeposit of carbonate of lime by infiltrating water, that a special and careful search might be required to determine the actual limits of the true reef and of its calcareous platform, and even such a search might not be successful.

After a full consideration of this second difficulty I feel compelled to admit that no valid argument in favour of subsidence can be based on the steepness of the seaward face of a reef and the thickness of the calcareous mass of the reef itself.

3. The depth of some lagoons and lagoon-channels furnishes probably the strongest argument in favour of Darwin's views. Occasionally a depth of forty fathoms is reached, and as this is beyond the depth at which reef-builders ordinarily live, it has been regarded as a proof that subsidence has taken place.

This third difficulty is thus met by the opponents of subsidence. We must remember, they say, that from the very conditions of their growth, patches of coral tend to assume an annular or atoll-like form, because the outer parts grow vigorously, while the central portions eventually die. Where the coral-patches coalesce and extend along a bank or shore, it is their outer or seaward faces that flourish. The inner parts, as they are more and more cut off from the food-supply, gradually die. While the outer face of the reef grows seaward, the inner margin is attacked partly by the solvent action of the carbonic acid of sea-water, partly by wind-waves, and the tidal scour sweeps away much fine detritus through gaps in this reef. In this way the lagoon-channel is widened and deepened. In a perfect atoll, that is, an unbroken annular reef of coral, the lagoon could not be deepened by any mere abrasion of the dead coral and removal of the detritus in suspension, but solution by carbonic acid would still come into play. It is further to be borne in mind that small lagoons are shallow and are being filled up, and that it is only the large ones, encircled by nearly continuous reefs, where the corals in the lagoon and along the margin are dead, and where the effects of solution may be conceived to have been longest in operation, that the depth of the lagoon descends below the limits at which reef-builders live.

I do not regard this solution of the difficulty as wholly satisfactory. Of the fact that dead calcareous organisms are attacked and carried away in solution by the carbonic acid of sea-water there cannot be any question, and this process must be of great geological importance. Whether the solvent action is sufficient to account for the exceptional depth of some lagoons, is still, I think, open to inquiry. It seems to me not improbable that these comparatively few deep lagoons may owe their depth partly to subsidence. But if this be the case it would lend, I am afraid, but slender support to a theory of wide oceanic depression. That there must be some areas of subsidence over the coral regions is almost certain, and the few scattered deep lagoons may possibly indicate some of these areas.

Having thus fully examined the arguments on both sides of this interesting and important question, I feel myself reluctantly compelled to admit that Darwin's theory can no longer be accepted as a complete solution of the problem of coral-reefs. No one could be more impressed than myself with the simplicity of this theory, the brilliancy of its generalisation, its remarkable fitness in geological theory, and the grandeur of the conceptions of geographical revolution to which it leads. I am fully alive to the serious changes which its abandonment will make in some departments of geological speculation. But in the face of the evidence which has now been accumulated, I can no longer regard the accepted theory as generally applicable. That it may possibly be true in some instances may be readily granted. There may be areas of subsidence, as there certainly are areas of elevation, over the vast regions where coral-reefs occur. It may be conceded that subsidence may sometimes have provided the platform whereon coral-reefs have sprung up, and may have contributed to heighten some reefs and to deepen some lagoons and lagoon-channels. But I do not believe that we are now justified in assuming subsidence to have taken place, from the mere existence of atolls and barrier-reefs. Its occurrence at any locality must be proved by evidence of special local movement. It may have gone on at many localities where atolls and barrier-reefs are found, but the existence of such reefs is no more necessarily dependent upon subsidence than upon elevation. These subterranean movements must be looked upon as mere accidents in a general process of coral-growth which is wholly independent of them.

I may in conclusion refer to one or two difficulties which have long been felt to be serious drawbacks to the theory of subsidence, but which disappear when the newer views of the origin of coral-reefs are accepted. If, as Darwin supposed, the coral-islands of the Pacific and Indian Oceans represent the last peaks of submerged continents, it is incredible that continental rocks should not be found among them. The oceanic islands (except of course those composed of coral-rock) are of volcanic origin and show none of the granites, schists, and other rocks which might have been looked for on such elevated summits. They have been piled up by the accumulation of lavas and tuffs discharged from the earth's interior, and, where they occur, point to upheaval rather than subsidence. Again, as Mr. Murray has shown, the inorganic deposits of the ocean-floor are composed of volcanic debris with a singular absence of the minerals that constitute the usual crystalline rocks of our continents.

No satisfactory proofs of a general subsidence have been obtained from the region of coral-reefs, except from the structure of the reefs themselves, and this is an inference only, which is now disputed. From the nature of the case, indeed, traces of subsidence can hardly be expected. A few examples have been cited, such as the occurrence of trunks of cedar-trees in a layer of red soil at Bermuda, lying between the calcareous deposits and at a depth of 42 feet below low-water mark. This indicates a recent subsidence of that tract; but it may be merely local, and may be due to the sinking down of the roof of one of the caverns into which the limestone is so abundantly honeycombed. Occasionally along the margins of lagoons trees are found at the water edge, in a position suggestive of subsidence. But the removal of the calcareous rock by solution or wave-action might equally account for their condition.

Of elevation in the region of atolls and barrier-reefs, there is almost everywhere more or less distinct evidence. Prof. Dana has collected the facts which prove that recent elevatory movements of unequal and local extent have occurred in all parts of the ocean.[1] Upheaval has taken place even in areas where barrier-reefs and atolls are in vigorous growth. Such an association of upheaval with an assumed general subsidence requires, on the subsidence theory, a cumbrous and

[1] Prof. Dana (*op. cit.*) cites examples of raised coral-reefs 250 to 300 feet above sea-level; but we do not yet know how much of the rock is solid coral and how much may be formed of aggregated organic debris.

[1] Corals and Coral Islands," 2nd edit. p. 284.

entirely hypothetical series of upward and downward movements. These are unnecessary if we can be convinced that coral-reefs grow up independent of terrestrial movements, which may in one area be in an upward, in another in a downward direction. From this point of view the reefs stand up as the result of a complex series of agencies, among which the more important are on the one hand, the temperature, solvent power, currents, tides, and waves of the sea, and on the other hand, the amount and direction of the supply of pelagic food, the upbuilding of calcareous deposits to the zone of reef-builders, the outward vigorous growth of the coral-masses and their decay and death, and the solution of their skeletons in the inner parts of the reefs. All these causes are known and visibly active. Without the cooperation of any other supposed or latent force they appear to be entirely adequate to the task of building up the present coral-reefs of the oceans. ARCH. GEIKIE

DR. JOHN LAWRENCE LECONTE

INFORMATION has just been received in this country announcing the death of Dr. LeConte. He was born in New York on May 13, 1825, and was the son of a distinguished officer in the United States army, himself an entomologist. He adopted the medical profession, and during the secessionist war he entered as medical officer of volunteers. The foregoing necessarily brief, specially biographic account is chiefly derived from information furnished in Dimmock's "Special Bibliography of American Entomologists, No. 1."

LeConte could have been only nineteen years old when he published his first entomological paper on certain new species of North American *Coleoptera* (*Proceedings of the Academy of Natural Sciences of Philadelphia*, vol. ii.). From that time forward a continuous series of works and papers on North American *Coleoptera* was produced by him until his death. He made a speciality of *Coleoptera*, and, with few exceptions, all his writings were devoted to that order of insects, and through his exertions the beetles of the United States are now almost as well known as are those of Europe. At the time of his death his published papers must have been nearly 200. Moreover he was the acknowledged authority in the United States on all matters coleopterological, a position which must naturally have caused him vast trouble and correspondence, sometimes with inadequate results. Latterly he worked greatly in company with Dr. G. H. Horn, of Philadelphia, a worthy follower of his tutor and a worthy successor. Their joint labours culminated *this year*, when was published ("Smithsonian Miscellaneous Collections," No. 507) a "Classification of the *Coleoptera* of North America," a volume extending to nearly 600 pages. It is needless here to refer to the revolution this work and other memoirs (chiefly by Dr. Horn) created in the minds of coleopterists as to the sequence of main divisions, &c. All working entomologists are sufficiently alive to the importance of the new ideas put forth. In fact this volume might have been considered a model of a special monograph were it not for a somewhat crude "Introduction" on insects in general that precedes the systematic portion.

In the present condition of entomological science in the United States the loss of Dr. LeConte seems almost irreparable. He and his coadjutor, Dr. Horn, and one or two others, stood almost alone amongst the prominent American entomologists in holding no special official position in connection with their subject.

LeConte once made a lengthy stay in Europe, and was well known personally in this country to all the prominent Coleopterists. Moreover he was honorary member of several of the European entomological societies, including the Entomological Society of London; his personal friends in this country were numerous. Since the death of Say (whose scattered works were carefully collated and re-edited by the subject of this notice) entomological science in America has not had to deplore so severe a loss, and Say's death was not fraught with the same significance.

R. MCLACHLAN

THE LATE MR. DARWIN ON INSTINCT

AT the meeting of the Linnean Society this evening (December 6) a highly interesting posthumous paper on Instinct, by Charles Darwin, will be read and discussed. We have been favoured with an early abstract of the same, which we here present to our readers.

After detailing sundry facts with reference to the migratory instincts of different animals, Mr. Darwin proceeds to suggest a theory to account for them. This theory is precisely the same as that which was subsequently and independently enunciated by Mr. Wallace in NATURE, vol. x. p. 459. Thus, to quote from the essay: "During the long course of ages, let valleys become converted into estuaries, and then into wider and wider arms of the sea; and still I can well believe that the impulse [originally due to seeking food] which leads the pinioned goose to scramble northward, would lead our bird over the trackless waters; and that, by the aid of the unknown power by which many animals (and savage men) can retain a true course, it would safely cross the sea now covering the submerged path of its ancient journey."

The next topic considered is that of instinctive fear. Many facts are given, showing the gradual acquisition of such instinctive fear, or hereditary dread, of man, during the period of human observation. These facts led Mr. Darwin to consider the instinct of feigning death as shown by sundry species of animals when in the presence of danger. Seeing that "death is an unknown state to each living creature," this seemed to him "a remarkable instinct," and accordingly he tried a number of experiments upon the subject with insects, which proved that in no one case did the attitude in which the animal "feigned death" resemble that in which the animal really died; so that the instinct really amounts to nothing else, in the case of insects at all events, than an instinct to remain motionless, and therefore inconspicuous, in the presence of danger. From the facts given with regard to certain vertebrated animals, however, it is doubtful how far this explanation can be applied to them.

A large part of the essay is devoted to "Nidification and Habitation," with the object of showing, by an accumulation of facts, that the complex instincts of nest-building in birds and of constructing various kinds of habitations by mammals, all probably arose by gradual stages under the directing influence of natural selection.

The essay concludes with a number of "miscellaneous remarks" on instincts in general. First the variability of instinct is proved by sundry examples; next the fact of double instincts occurring in the same species; after which, "as there is often much difficulty in imagining how an instinct could first have arisen," it is thought "worth while to give a few, out of many cases, of occasional and curious habits, which cannot be considered as regular instincts, but which might, according to our views, give rise to such." Finally, cases of special difficulty are dealt with; these may be classified under the following heads:—(1) Similar instincts in unallied animals; (2) dissimilar instincts in allied animals; (3) instincts apparently detrimental to the species which exhibit them; (4) instincts performed only once during the lifetime of an animal; (5) instincts of a trifling or useless character; (6) special difficulties connected with the instinct of migration; (7) sundry other instincts presenting more or less difficulty to the theory of natural selection.

The "Conclusion" gives a summary of the general principles which have been set forth by the whole essay. This, therefore, we shall quote *in extenso*:—

"We have in this chapter chiefly considered the instincts of animals under the point of view whether it is possible that they could have been acquired through the means indicated on our theory, or whether, even if the simpler ones could have been thus acquired, others are so complex and wonderful that they must have been specially endowed, and thus overthrow the theory. Bearing in mind the facts given on the acquirement, through the selection of self-originating tricks or modification of instinct, or through training and habit, aided in some slight degree by imitation, of hereditary actions and dispositions in our domesticated animals; and their parallelism (subject to having less time) to the instincts of animals in a state of nature: bearing in mind that in a state of nature instincts do certainly vary in some slight degree: bearing in mind how very generally we find in allied but distinct animals a gradation in the more complex instincts, which shows that it is at least possible that a complex instinct might have been acquired by successive steps; and which moreover generally indicate, according to our theory, the actual steps by which the instinct has been acquired, in as much as we suppose allied instincts to have branched off at different stages of descent from a common ancestor, and therefore to have retained, more or less unaltered, the instincts of the several lineal ancestral forms of any one species: bearing all this in mind, together with the certainty that instincts are as important to an animal as their generally correlated structures, and that in the struggle for life under changing conditions, slight modifications of instinct could hardly fail occasionally to be profitable to individuals, I can see no overwhelming difficulty on our theory. Even in the most marvellous instinct known, that of the cells of the hive-bee, we have seen how a simple instinctive action may lead to results which fill the mind with astonishment.

"Moreover, it seems to me that the very general fact of the gradation of complexity of instincts within the limits of the same group of animals; and likewise the fact of two allied species, placed in two distant parts of the world and surrounded by wholly different conditions of life, still having very much in common in their instincts, supports our theory of descent; for they are explained by it: whereas if we look at each instinct as specially endowed, we can only say that it is so. The imperfections and mistakes of instinct on our theory cease to be surprising: indeed it would be wonderful that far more numerous and flagrant cases could not be detected, if it were not that a species which has failed to become modified and so far perfected in its instincts that it could continue struggling with the co-inhabitants of the same region, would simply add one more to the myriads which have become extinct.

"It may not be logical, but to my imagination it is far more satisfactory, to look at the young cuckoo ejecting its foster-brothers, ants making slaves, the larvæ of the Ichneumonidæ feeding within the live bodies of their prey, cats playing with mice, otters and cormorants with living fish, not as instincts specially given by the Creator, but as very small parts of one general law leading to the advancement of all organic bodies—Multiply, Vary, let the strongest Live and the weakest Die."

PORTO RICO

THROUGH the courtesy of Sir Joseph Hooker, we are able to publish the following interesting communication from Baron Eggers on the island of Porto Rico:—

St. Thomas, October 22, 1883

DEAR SIR JOSEPH HOOKER,—It is a long time since I wrote you last. I have meanwhile at last accomplished my long-cherished design, partly at least, of exploring the Luguillo Mountains in Porto Rico, which island I visited during April and May this year.

I spent about five weeks there, living for some time in the hut of a "fibaro" or native labourer on the Sierra, at an altitude of about 2200′, on the edge of the primeval forests that still cover all the higher part of the mountain range.

Since my return I have been busy arranging my collections, the greater part of which appears in the ninth and tenth century of my "Flora Indiæ Occidentalis Exsiccata."

As for the general character of the Sierra forests, they of course resemble in their main outlines those of the other West India Islands. There is, however, especially one feature that strikes me as being peculiar to this mountain ridge compared with the woods of other islands, for example, of Dominica. Whilst the climate is just as moist in the Sierra of Porto Rico as in that of Dominica, the forests of Porto Rico seem nearly entirely *destitute of epiphytes* with the exception of some few Bromeliads and a very rarely occurring stray orchid. But orchids in general and epiphytical ferns, such as *Trichomanes* and *Hymenophyllum*, &c., are conspicuous by their absence. Of palms I found but one species, which I have distributed in my "Flora," I believe it is a *Euterpe*, grows gregariously at an altitude from 1500′ to 3000′. No Cycads were seen at all.

On the other hand, I found several interesting trees, especially a beautiful *Talauma*, with immense, white, odorous flowers and silvery leaves, which would be very ornamental. The wood is used for timber, and called Sabino. A *Hirtella* with crimson flowers I also found rather common; it is not described in any of Grisebach's publications. An unknown tree with beautiful, orange-like foliage, and large, purple flowers very similar in shape to those of *Scævola Plumieri*, split along one side, a tall *Lobeliacea*, a large *Heliconia*, nearly allied, it seems, to *H. caribbæa*, Lam., and several other as yet undetermined trees and shrubs, are among the most remarkable things found.

On the whole I was somewhat disappointed with regard to the result of the voyage, as I had expected a greater number of novelties, as well as a richer vegetation in general, at least something like the Caribbean Islands. But these partly negative results may no doubt be of some value also in forming an idea of the West Indian flora in general. Of tree-ferns, *Cyathea Serra* and an *Alsophila* were not uncommon.

One of the most conspicuous trees in some parts is the *Coccoloba macrophylla*, which I found on my first visit to Porto Rico. This tree is found up to an altitude of 2000′, but chiefly near the coast, where it forms extensive woods in some places, which at the time of flowering, with immense, purple spikes more than a yard long, are very striking. The tree is named Ortegón by the inhabitants; it does not seem to occur on any of the British islands, but to be confined to Porto Rico and Hayti; at least I do not see it mentioned in Grisebach's "Cat. Plant. cubensium."

The people cultivate sugarcane in the plains, which are very fertile, yielding three hogsheads on an average per acre without any kind of manure. Besides this staple produce, a very good coffee is produced; it does not appear that any blight has as yet perceptibly affected the shrubs here. Rice is very commonly cultivated on the hills in the Sierra. I suppose it must be a kind of mountain variety, as no inundation or other kind of watering is used. Rice is in fact the staple food of the labourers, together with plantain and yaüdia, *i.e. Caladium esculentum*. Immense pastures of *Hymenachne striatum* (Malahojilla) occupy a part of the lowland, and feed large herds of cattle of an excellent quality. St. Thomas and the French islands all obtain their butcher's meat from

Porto Rico; I believe even Barbados comes to Porto Rico for cattle.

The island is very richly endowed by nature, but miserably governed, and the people themselves not worth a much better government, being given to gambling in the extreme throughout, thus squandering away every dollar, from the rich planter and priest down to the lowest labourer and beggar. Yet they are hospitable and very polite to strangers, with that remarkable, unchanging, inbred Spanish politeness.

It may finally interest you to hear, from the fact that you take a prominent part in the advancement of the material progress of the English West India Islands, how we are working in that respect here in St. Thomas.

I have on my estate now about 4000 Divi-Divi trees growing and doing well, except for the deer, which do much damage. On the coasts I have over 2000 cocoanut trees planted; cultivation of the *Sanseviera guineensis* is going on for making fibres; a large tract of land stocked with *Hæmatoxylon* I have now preserved, and try to make it a regular forest, to be cut down gradually.

In company with an engineer here I have now ordered a machine from England, Smith's fibre machine, which is being used in the Mauritius, in order to work up our immense quantity of *Agave* and *Fourcroya*, the raw material being close at hand in unlimited quantity near the sea.

I have published a couple of articles on the material resources of these islands in one of the largest Danish newspapers, of which I beg to send you a copy, in order to make private persons and Government move. Among the former a good many have started on, but, as you may perhaps have heard, governments are sometimes slow in moving, representing, as they do eminently, that great law of nature, *vis inertiæ*.

However, so far, and considering the short space of time, I am very well satisfied. I think there is a fair chance now of the West Indies in general entering upon a new prosperous career.

I am also going to try experiments with the manufacture of tannin extracts from bark of *Coccoloba*, *Rhizophora*, and the pods of the various Acacias, which are a great nuisance here on account of their rapid growth.

The *Aloe sempervirens* will also be made useful in a similar manner as in Barbados and Curaçoa, it growing here spontaneously on barren rocks. H. EGGERS

THE REMARKABLE SUNSETS

UNDER the headings of "Cloud-Glow" and "Optical Phenomena" we have published several letters already on the recent remarkable sunsets; we have received many others, the most important of which we bring together here:—

PERHAPS it will interest you and your readers to hear that the phenomenon called "cloud-glow" in your last numbers, was seen also at Berlin on the three evenings of November 28, 29, and 30. As far as I could overlook the sky, the details were almost the same as your correspondents describe them: A greenish sunset at 3.50, an unusually bright red sky with flashes of light starting from south-west. An interesting physiological phenomenon which we call "Contrast-Farben," was there beautifully illustrated by some clouds, no longer reached by direct sunlight; they looked intensely green on the red sky. At 4.30 the streets were lighted by a peculiarly pale glare, as if seen through a yellow glass. Then darkness followed, and the stars became visible. But half an hour afterwards, at 5 o'clock, the western sky was again coloured by a pink or crimson glow. Persons who were not quite sure about its direction mistook it for a Polar aurora; others spoke of a great fire in the neighbourhood. f atmospheric refraction could be neglected, the matter (whatever it may be) thus illuminated by the sun one hour after sunset and 45° above the horizon, would be found to be at a height of about forty miles! At 6 o'clock all was over. The first day (November 28) this glow was still stranger, because the lower western sky was covered by a large, dark cumulus-cloud; but besides this the three remarkable evening skies were quite like each other. ROBERT VON HELMHOLTZ

N.W. Berlin, Neue Wilhelmstrasse 16, December 1

P.S.—To-day it rains; nevertheless an unusual brightness was to be seen in the west till 7 o'clock, which perhaps may be attributed to the same "glow."—R. v. H.

THE red glow described by your correspondents continued to be visible here every evening until yesterday (2nd inst.), and there was another fine display of *rayons du crépuscule*. Is not "cloud-glow" a misnomer as applied to what is seen in perfection only when there are no clouds, and is invisible when the clouds are thick? "After-glow" is too comprehensive an expression, as it embraces the usual effects of a brilliant sunset, and too limited, as it could not be applied to the phenomenon as recently seen before sunrise. In the absence of a scientific title for something which has been but little investigated, might not the name "upper-glow" be adopted, in contrast to the under-glow which is the predominant feature of ordinary effective sunsets. The red colour of the reflected light is in both cases I suppose equally due to diffraction, particles suspended in the air obstructing the rays of least wave-length. But in the "upper-glow" the reflecting matter is at a great height above the cloud-level, in the "under-glow" it consists of the lower surface of the clouds themselves. ANNIE LEY

December 3

Erratum.—In the first paragraph of my letter of the 27th ult. (p. 103) 2600 should be 26,000.

THE following extracts from my observations at York may assist in determining the cause of the extraordinary series of sunrise and sunset effects during the past month:—November 24: Unusual cloud tinge in morning. November 25: Similar effect in morning. From 2.45 to 3 p.m., blue sky from 10° to 25° or 30° from the sun, of a delicate rose pink. This noticed by several, when asked to say if they saw anything peculiar. It gave a greenish-gray cast to cirro-cumuli through which it was seen. Round the sun the sky looked yellowish. 5.30 p.m., "the west ruddy as from glare of fire;" not entirely gone till 6. Time of local sunset 3.38, calculated from almanac and observed sunrise on 28th.

A letter from my father, Street, Somerset, 26th, evening, speaks of "a wide arc above the sunset lit up with the most glorious pink shade. The clouds low in the horizon a stone-gray; but the most remarkable of all was a longish cloud to the north of sunset and above and beyond the circle of pink; that was a bright sage green. I never before saw such a colour in any cloud. . . . Later, rays shot up from the sun like the rays of aurora."

28th: Same pink halo at noon. Cloud-glare on morning of 26th and 27th; to-day, about 6 a.m. (sun rose at York 8.0, set 3.35). Sunset most striking; pink above, orange lower at 4.20; grass appeared of brownish sage green. At 5 p.m. lit up all over like red aurora. 29th: Same red glare, like that of a fire, at 6.20 a.m. Glare gone by 6.35; cirri in east-south-east lit up by 6.45. True sunrise glow 7.10; orange at base turned to yellow-green at 7.25, and cirri again black; relit at 7.35, with rosy tinge. Sun seen to rise clear of horizon at 8.2; Jupiter visible among faint haze until 8.13. 9.45 a.m., rosy glow round sun; 4.30 p.m., a fading ordinary sunset; 4.45, glare reappearing; 5 p.m., "finer than ever," as observed by Mrs. Clark. December 3: Remarkable lurid effects, 4.30 to 5.0 p.m. Letters from Street and Birmingham mention similar effects on the 28th and 29th. A paragraph in the *Daily News* reports them from Bideford, Devon, on Monday, 26th, soon after 5 p.m.; 27th, a.m.; and from 9.45, a "dusky orange and rosy band round the sun," till hidden by clouds at noon; 28th, p.m., 29th, a.m., and coloured "bands" again round the sun at 11 a.m. To me the glare never seemed as if reflected from cirrus clouds; it was much more like that from the smoke-originated clouds of manufacturing districts. The day effect was evidently from the same cause as the after-glow. May it not help us to connect it with the "green sun" phenomenon of India? In that case the possible connection of the latter with the volcanic eruptions of Java assumes special interest, and may give us a new insight into the upper currents of wind. We have already heard how ashes fell at great distances to windward, reckoning by the surface currents. The same upper winds, in the time that elapsed, seem to have carried lighter ashes, projected still higher, over India. May not the lightest and highest-projected, almost impalpable dust have been spread over the greater part of our hemisphere, or at any rate as far as England, whose distance from Calcutta is not double the distance from Calcutta to Java? The recent Greenland expedition has enforced the lesson of ocean soundings on the wide prevalence of such material. If this suggestion has any foundation, then the comparison to the lurid glare over cities may be a true analogy. Just as frozen fog particles form around solid nuclei of smoke, so the impalpable dust may have formed centres for cloud-formation in air strata above the normal range of clouds.

York, December 3 J. EDMUND CLARK

P.S.—December 4: My observations on last night's sunset were from hurried glances indoors. I find from Mrs. Clark that the appearances differed from the general character, being like those of Sunday evening, the 25th. She noticed, as did also another lady, the curious *green* colour of the moon. This fact was recalled to my mind to-night, when yesterday's sunset effects were repeated, the moon, to my surprise, having a most striking green tint. This was about 4.25, and it was still noticeable at 4.45.—J. E. C.

THIS singular atmospheric aspect prevails here daily at sunrise and sunset, though there seem to be indications that its splendour is on the wane. It has been visible for nearly a month, prolonging daylight upwards of an hour. At sunrise, on the 28th, the rich colours of the phenomenon again suffused the sky, and at sunset and for upwards of an hour afterwards the sky was effulgent with all the prismatic colours. The sunrise of the 29th surpassed all previous ones in magnificence, spread, and duration of colour. The day being favourable for observation, it was possible to detect a mass of attenuated, white, nebulous vapour surrounding the sun for a distance of some 30° or 40°. The sunset was less remarkable for tone and brilliancy of colour. Pearly-whites and steel-grays mostly prevailing at 4.15 p.m., a faint rosy colour suffused the whole sky. At 4.30 p.m. a band of glowing orange-coloured light, about 23° in altitude, stretched from north-west to a point near the south, and at 5.15 p.m. a remarkable body of rosy light formed in the west above the orange-coloured mass, and separated from it by a dark slate-coloured space, about 2° wide, small and pillar-shaped at first, with the apex pointing north, but soon spreading north and south. This nebulous body deepened in colour as it grew in mass till it became a remarkable volume of vivid crimson light some 5° or 6° in height, and 25° or 30° in length. At 6 p.m. the colour of the western sky had changed to orange; afterwards the colour slowly died out, and night prevailed. On the morning of the 30th ult. the glow was indistinctly apparent. In the afternoon there was a dense cloud canopy and considerable rainfall, but an orange coloured glare at sunset was discernible through the clouds. On the 1st inst. the radiance of the glow was conspicuous, and the sky richly coloured just before sunrise. At 4 p.m. the glare in the west was brilliant, with golden carmine and green colours. At 4.15 the carmine colour disappeared, the greater part of the sky became of a delicate blue, and long streaks of cirri of changeful colour lay across the sky. After many changes of tints and the appearance of the usual glow like that of a second daylight, at 5.15 p.m. the usual fiery glow rose in the west to an altitude of 25°, and continued till 6 p.m. On the 2nd, the sky was cloudy before sunrise, but the radiance was visible all the same, showing carmine and golden hues. On that morning a pale yellow coloured the sky till 11 a.m. At sunset the iridescent display was less brilliant than usual, and commenced later. But there were fiery reds, glowing yellows, and olive-greens in a sky with a detached cloud canopy. The usual fiery glow appeared at about 5.50 and prevailed till 6 p.m. On the morning of the 3rd, before sunrise, the coloured radiance reappeared in great beauty, and a yellow tint pervaded the sky throughout the day. The wind on this day was rough from the north-west. The thermometer at midday was 51°. At sunset the glow was less splendid than heretofore, and the fiery reds were dilute and diffuse. The sky was cloudy. The glow lighted up the heavens till 6 p.m. as usual. This morning (4th) the sky before sunset was resplendent with rich masses of prismatic colour. Suddenly, at 8.30 a.m., when the brilliant colours had vanished, a halo of iridescent colours encircled the sun for a short time, as though a body of vapour was swiftly traversing the sky. In a moment afterwards the colour of the sun changed to an exquisite emerald hue, staining the landscape and investing houses, buildings, glazed windows, and greenhouses with a remarkably weird aspect. Before there was well time to notice how things appeared in a bright green light, the rays of the sun changed to a deep yellow, and in a moment afterwards, as though some obscuring medium had been withdrawn, the ordinary daylight reappeared. At sunset to-day the display was magnificent in variety and tint of colour. At 4.15 the usual orange-colour bank of glowing, luminous vapour appeared in the west, extending to north-west and south-west, having above it a system of rays of a dull, fiery red. The sky was clear, flecked here and there with cirro-cumulus. At 4.45 the crescent of the moon, being just above the fringe of red light, assumed a lively green hue, and continued to exhibit the novelty of an emerald crescent till 5 p.m., when, the colour passing away, the satellite resumed its silvery hue and shone in the blue sky, while the fiery glow still lighted up the west and north-west. It seemed to me that the moon's rays neutralised in the neighbourhood the fiery tints which characterise this peculiar glow, as in the vicinity of the crescent blue sky prevailed. It may be mentioned that foreign particles are traversing the atmosphere. On July 14 black rain fell at places round this city, and some was collected at Crowle. A good observer, Mr. J. S. Haywood, the hon. secretary of the Naturalist Field Club, noticed the black sediment which the rain had deposited on the leaves of the plants and shrubs in his nursery. At the time I drew attention to the rainfall, and ventured to ascribe the discoloration to the presence of volcanic dust. It has since transpired that Krakatoa was in violent eruption from May 20 down to the fatal 26th of August, throwing up vast masses of dust. Discoloured rain again fell in the vicinity of this city on the 17th ult. J. LL. BOZWARD

Worcester, December 4

THE ruddy glow near the sun, so well described by J. Ll. Bozward in your last number (p. 102), was most conspicuous here on the 30th ult. both at sunrise and sunset. It should be examined with a spectroscope. Here there were neither clouds nor cirri visible. Yesterday it rained the whole day; towards evening the sky became clear near the zenith, heavy clouds clustering all round the horizon; above them the unexplained glow was very remarkable at sunset. If it has been observed in England on the same days, at a distance of 10° in latitude, its cause must be high in the atmosphere. Would it not be interesting to ascertain how far it has been seen, at least throughout Europe?

ANTOINE D'ABBADIE

Abbadia, near Hendaye, December 2

DURING the latter half of November we have had here also a constant succession of remarkable sunsets, and at least one sunrise of the same character. But here the effects have been accurately described by the expression "cloud-glow." Masses and streamers of cirro-cumulus vapour have hurried up from the west, evening after evening, as sunset approached, at a rate greatly in excess of the wind below, and then as the sun sank the whole sky has shone with a lurid coppery light which I have only very occasionally and partially seen before. Even when the dusk was early and thick, the same lurid glare has shone as it were behind the clouds.

HENRY CECIL

Bregner, Bournemouth, December 1

I SHOULD not have troubled you with a letter respecting the wonderful after-glows which have presented such magnificent displays during all the past week, especially on the 26th, and which have attracted such universal attention, had I not observed that no one has alluded to their appearance in the spectroscope. I made some observations on the 26th and 27th about 4.30 p.m., when the colour was at its greatest brilliancy, and was struck with the following particulars:—(1) The ordinary delicate tints of the spectrum were merged into two, a deep red and a peculiar blue-green; (2) in the middle of the red was a strong dark band; (3) on the green side of the D line, and separated from it by the light band so often conspicuous, was another band of deep citrine. The only *line* clearly distinguishable was one at the extreme end of the red.

E. BROWN

Further Barton, Cirencester, November 30

THE following note of observations of the western sky made with a pocket spectroscope on the evenings of Wednesday, November 28, and of the 4th and 5th inst., may be of interest. At about 4 o'clock—just after sunset—the band which Mr. Piazzi Smyth has termed the "low sun band," was abnormally strong, so was the line he calls a. The lines constantly seen in the "rain band" were not visible, and C_1 was very slight. In place of the ordinary "rain band"—a band of absorption shading off from D towards the less refrangible end of the spectrum—there was a broad band of absorption which extended nearly three-fourths of the way from D towards a, or nearly half way to C, its darkest part being at rather less than one-third of its width from D. From this darkest part it shaded off in both directions. In a short time this band gradually nearly disappeared, the low sun band also diminishing in intensity, while a became extraordinarily prominent—very dense in the middle, and slightly shaded off at both edges. At this time the yellow and orange of the spectrum seemed nearly to have disappeared, the green apparently extending to a considerable distance on the less refrangible side of D. This evening (the 5th), as Mr. Lockyer pointed out, there was also a strong band of absorption between b and F. I had not remarked this on the 28th or the 4th, and believe it is unusual or unusually strong.

December 5 J. F. D. DONNELLY

AN optical phenomenon has appeared at Hunstanton each afternoon commencing Sunday, the 25th ult., at about 4.30 p.m., up to and including to-day. The first appearance was a brilliant yellow light in the west, which, after a few minutes lit up the whole western horizon, the upper sky being a beautiful azure blue, showing up in contrast a few fleecy dark stratus clouds; after a few minutes the yellow light gradually turned to pink, and the horizon all round was tinged with this colour, eventually a crimson arch formed in the west, and gradually the whole thing disappeared. From the position of Hunstanton, facing west and north, remarkable and beautiful sunsets are of frequent occurrence. This morning as the sun was rising a thin layer of clouds pervaded the whole of the heavens, which were tinged with pink in every direction.

CHARLES W. HARDING

The Chase, King's Lynn, December 1

There has been much correspondence in the daily papers on the subject, and it may be useful to give here the leading points in these communications.

The phenomenon has not been confined to this country. The *Times* Rome correspondent telegraphs under date November 30:—"Yesterday evening the population of Rome was struck with admiration, mingled with awe, at the sight of a splendid phenomenon. From fifteen minutes after sunset until more than an hour later the north-western hemisphere was tinged with crimson, gradually increasing in intensity until it had the appearance of the reflection of an extensive conflagration, in front of which the tower of the Castle of Saint Angelo, the cupola of St. Peter's, and the outline of Monte Mario, as seen from the Pincio, stood out in prominent relief. Immediately above the horizon there was a broad belt of orange red, and above that another of green, surmounted by the crimson glare of the aurora. The sky of the eastern hemisphere presented a uniform sea-green tint. The phenomenon was repeated again this morning, and again this evening. A strong north wind blew all day yesterday; the sky was exceptionally clear, and the temperature was gratefully warm and balmy."

Again, an observer at Viareggio, Italy, near the Carrara Mountains, writes:—"At sunset the whole horizon, from Corsica to the Bay of Spezia, is literally bathed in a flood of red light, which, during the last few evenings, has been intensified in a remarkable degree, and prolonged till about 6 p.m., when the glow spread over the whole cloudless firmament, and was reflected on the Carrara Mountains—a truly glorious phenomenon, produced by the more than usually rarefied condition of the atmosphere under the influence of the low temperature which has prevailed for some days, the wind being north-north-west."

At the Cape also they have attracted attention. "A. D. S.," writing to the *Times* of December 4, says:—"The phenomenon in question seems to have been first noticed in this country on the evening of the 9th ult., and it recurred on several evenings during last week. A lady, who has lately been an early riser, informs me that the sky has had the same unusual light at sunrise. We have just received a letter from the Cape of Good Hope, dated November 2, in which the following passage occurs:—'We have had such extraordinary lights nearly every evening for the last five weeks. Shortly after sunset a red or yellow glow appears in the west, and it gets quite light again, and remains so for some time, and then it dies away. During the time it lasts all the flowers seem of such very brilliant colours, the pink roses especially. They look as bright as they are painted on Christmas cards, and the green of the oak trees is something wonderful. The lights appear sometimes in the morning also, an hour before sunrise, when it is generally pitch dark here.'"

So Mr. C. J. Thornton writes to the *Standard*, under date November 28, as follows:—"This afternoon I received a letter from Monghyr, Bengal, dated November 5, in which was the following passage: 'Have you seen any unusual appearances in the sky lately? For some time past in this country an extraordinary red glow has been seen in the sky just before sunrise and just after sunset. It seems to have been noticed all over India and in Egypt also, but I do not know if it has been seen in Europe. The natives are full of superstitious fears on account of it. No one, so far as I know, has been able to account for it, but several theories, more or less absurd, have been started, one trying to connect it with the eruption in Java, another with the spots on the sun, and so on. I do not know what it can be, but it is certainly very remarkable, and I never saw anything like it before.'"

A correspondent of the *Times* sends the following extract from the *Gold Coast Times* of September 14. The phenomena alluded to were seen at Cape Coast Castle:—"On the 1st or 2nd of this month the sun was described as being blue in the morning. It seems it rose as usual, and that the clouds which passed over it, from their greater rarity or density, gave it different apparent shades of rose colour, pink, and so on. After the passage of the clouds its appearance through the haze was white like the moon. In fact, an Englishman is said to have taken it for the moon."

In Paris also, and elsewhere in France, the phenomenon has been very striking.

A correspondent writing from Croydon to the *Standard*, under date November 26, says:—"At half-past three this afternoon the sky in the west quickly assumed a deep red colour, which, after some minutes, spread over the sky to a considerable distance, tinging it with a pale pink colour. This, again, in a few minutes, disappeared, and the sky assumed its normal condition."

Another correspondent on the same date, from Derby, states:—"This evening we have witnessed a most remarkable sunset, the sky being lit up with a pale bluish-yellow light, changing to orange and red."

Again, a correspondent to the same paper writing on November 28 from Skegness, Lincolnshire, says:—"Here, in the fens of Lincolnshire, where gorgeous sunsets are the rule, the phenomenon has been most remarkable, and each evening since Sunday last the heavens have presented an appearance both interesting and awe inspiring. On Monday evening last, when the sun set at 3.57, the western heavens were all aglow until 6.30, and the rich, lurid glare of the 'after-glow' had all the appearance of an immense illumination, the rays of which, starting from the direction of the setting sun as a centre, extended well towards the zenith. The most remarkable thing was the fact that whilst the western sky was thus all aglow the stars in the northern heavens were shining as brilliantly as at midnight. The 'blood-red' appearance has been repeated during the rest of this week. The effect was altogether different from the 'Aurora Borealis,' there being an utter absence of the peculiar scintillation common to that phenomenon."

From Eastbourne, according to a correspondent there, "a considerable space above the hills where the sun had disappeared was a clear sky with no tinge of red in it, but a pale greenish-blue transparency, to describe which I can find no precise words. Across this there floated three or four opaline cloudlets, while a great mass of violet-coloured vapour lay piled up in the south-west. Above the pale and clear transparency was a broad zone of rose-colour, which seemed denser here and there, and also appeared to shoot upwards in tongue-shaped undulations. As the evening advanced, and the true sunset, at 3 57, took place, the clear sky disappeared, as if drawn down behind the hills, which the rosy zone now touched, and was gradually drawn down in its turn, but remained unfaded to the last."

Mr. Sydney Hooper, writing to the *Standard* from Ealing, says:—"In none of the correspondence on the subject of the remarkable sunsets we have had lately have I seen any reference to what strikes me as the most curious fact in connection with them, and which in my experience is quite unique. I have observed sunsets carefully for the last thirty years, and I have invariably found that the crimson glow is the last; coming usually a considerable time after the yellow glow has faded. The crimson light is always followed by the cold gray which precedes the night, as many must have observed when the rosy light dies out from an Alpine peak. For the last few evenings, however, notably on Wednesday night, there has been a reversal of this rule. A yellow glow has first overspread the sky, extending almost to the zenith. This has gradually deepened to orange, then to crimson. The crimson has then gathered in intensity towards the horizon until it has become a deep, rich, horizontal bar, lingering long after sunset. Then came the effect which I refer to as unique. After the crimson had died away, the west was again lit up by a deep orange glow extending over half the sky, so intense in colour that the lamps showed as white light against it. This second glow is to me unaccountable, and indicates a very peculiar condition of the atmosphere. Another fact, equally remarkable, was that the whole effect was reproduced the following (Thursday) morning, but the order of the tints was, of course, reversed. At a quarter to six an exact reproduction of the orange tint of the previous evening was seen in the south-eastern sky. This was followed by the deep crimson bar low down in the horizon. Then the crimson gradually passed upwards, giving place finally to the greenish yellow with which the phenomena commenced in the evening."

NOTES

It is proposed to hold, during the year 1884, an International Exhibition, which shall also illustrate certain branches of health and education, and which will occupy the buildings at South Kensington erected for the International Fisheries Exhibition. The object of the Exhibition will be to illustrate, as vividly and in as practical a manner as possible, food, dress, the dwelling, the school, and the workshop, as affecting the conditions of healthful life, and also to bring into public notice the most recent appliances for elementary school teaching and instruction in applied science, art, and handicrafts. The influence of modern sanitary knowledge and intellectual progress upon the welfare of the people of all classes and all nations will thus be practically demonstrated, and an attempt will be made to display the most valuable and recent advances which have been attained in these important subjects. The Exhibition will be divided into two main sections, Division I. Health, Division II. Education, and will be further subdivided into six principal groups. In the first group it is intended specially to illustrate the food resources of the world, and the best and most economical methods of utilising them. For the sake of comparison, not only will specimens of food from all countries be exhibited, but the various methods of preparing, cooking, and serving food will be practically shown. The numerous processes of manufacture connected with the preparation of articles of food and drink will thus be exemplified; and, so far as the perishable nature of the articles will admit, full illustrations will be given of the various descriptions of foods themselves. In the second group, dress, chiefly in its relation to health, will be displayed. Illustrations of the clothing of the principal peoples of the world may be expected; and a part of this Exhibition, which, it is anticipated, will be held in the galleries of the Royal Albert Hall, will be devoted to the history of costume. In the third, fourth, and fifth groups will be comprised all that pertains to the healthful construction and fitting of the dwelling, the school, and the workshop; not only as respects the needful arrangements for sanitation, but also the fittings and furniture generally in their effect on the health of the inmates. The most improved methods of school construction will be shown, and the modes of combating and preventing the evils of unhealthy trades, occupations, and processes of manufacture will form portions of the Exhibition. The sixth group will comprise all that relates to primary, technical, and art education, and will include designs and models for school buildings; apparatus and appliances for teaching; diagrams, text-books, &c. Special attention will be directed to technical and art education, to the results of industrial teaching, and to the introduction of manual and handicraft work into schools.

ON the 22nd ult. the remainder of the furniture and stores for Ben Nevis Observatory were carried to the top under great difficulties. The party had intended to make the ascent at the beginning of the week, but, owing to the state of the weather, they could not think of it. On Thursday morning, however, although the weather was not very favourable, it was decided to make the ascent, and at 9 a.m. Mr. James M'Lean, contractor, and Alex. Turban, who is in charge of the stores, along with two assistants, started with some chairs and other stores. The first part of the journey was easily accomplished. The snow lay pretty heavy down to within a mile of Achintee farmhouse, and several deep wreaths were encountered before reaching the lake. On reaching the Red Burn they came upon a long wreath of about fourteen feet deep. The snow being somewhat soft, the party had to cut a passage through, which was a rather difficult task. Determined if possible to reach the top, they proceeded slowly, and, as they ascended, the snow was found to be deeper, in which they sometimes sank to their shoulders. Parts where the wind had driven off the snow were covered with ice, rendering the path difficult and dangerous. Their efforts were, however, ultimately crowned with success, for at 2.30 p.m., five and a half hours after starting, the party reached the Observatory. The average depth of snow on the level parts on the summit was about six feet, and round about the Observatory it was eight feet. Mr. Omond and his assistants were in excellent spirits, are very comfortable, and now feel quite at home. The party started on the return journey at 3.30, and Fort William was reached at 6.30 p.m., the whole journey, including a stay of an hour at the Observatory, occupying nine hours.

WE regret to learn of the death, on the 30th ult., of the celebrated Swedish zoologist, Prof. Sven Nilsson, of the Lund University, at the age of ninety-seven.

M. RENARD has communicated recently (November 3) to the Royal Academy of Brussels the results of a chemical and microscopic examination of the ashes from the great eruption of Krakatoa, which fell at Batavia on August 27 last. He finds that the volcanic dust consists mainly of glassy particles, among which may be distinguished crystals of plagioclase, often in rhomboidal lamellæ, augite, rhombic pyroxene, and magnetite. The rock which has been blown into this finely divided state presents the general mineralogical composition of the augite-andesites, but with a rather higher proportion of silica, which, on analysis, was found to amount to 65 per cent. of the whole.

A MEETING will be held on Friday at the rooms of the Royal Society, Burlington House, Piccadilly, when it will be proposed to appoint a Committee, and to make such other arrangements as may be considered necessary for the successful promotion of the William Spottiswoode Memorial Fund. The chair will be taken by Prof. Huxley, President of the Royal Society, at four o'clock precisely.

THE members of the Polar meteorological station which Denmark maintained at Godthaab in Greenland under the international scheme, have just returned to Copenhagen. The chief of the expedition, Lieut. A. Paulsen, reports that, having left Copenhagen on May 18, 1882, in the sailing ship *Ceres*, they arrived at Godthaab on June 14. On the voyage out observations of the temperature of the sea and air were made every hour. On the arrival out the expedition had to select the most suitable spot for the erection of the four wooden buildings brought with them, in which the magnetic and astronomical observations were to be made. A small mountain ridge near the church in the colony was chosen for this, as the preliminary researches in its neighbourhood showed that the influence of iron strata on the magnetic current was here very small. The buildings were then erected and the pillars raised on which the transit instrument, the great astronomical clock, and the eight different magnetical instruments were mounted, and simultaneously the instruments for the meteorological observations were also placed so that the weathercock and the anemometers, as well as the thermometer hut, were situated as free as possible. On August 1 the meteorological observations could be commenced, but the magnetic ones were through an accident delayed until the 7th. From that date complete observations were made in exact accordance with the international programme without interruption every hour until August 31 this year, and the expedition has thereby fully accomplished its object, viz. of obtaining a full year's magnetical and meteorological observations in this locality. A number of other scientific researches have also been pursued, of which those on the aurora borealis should particularly be mentioned. This phenomenon was frequently observed and studied during the winter, while some exceedingly valuable statistics were obtained as to the altitude of the aurora borealis above the earth's surface by measurements effected simultaneously in various places by light signals. The measurements of atmospheric electricity have also led to valuable results. It is stated to have been the best equipped Polar expedition ever despatched from Denmark. We hope soon to give further details.

THE following communication from Mr. Charles Ford, of the Botanic Garden, Hong Kong, dated October 3, 1883, has been forwarded to us from Kew for publication:—"By the s.s. *Laertes* which left this place for London last week I have sent two Wardian cases of live plants, one case of living orchids, and a case of herbarium specimens, which I brought back from the Lo-Fau Mountains up the East River, and distant about sixty miles from Canton, where I spent about three weeks in August. On this excursion I travelled over about eighty miles of country after leaving the river, and consequently had a considerable amount of trouble when the natives knew I had no boat to fall back upon, and was therefore very much in their hands. I intended to make another trip up the North River during this month, but that is now impossible, as Dr. Hance, who is Acting Consul at Canton, will not apply to the Viceroy for passports for any one, and he says he is afraid it will be a long time before he will feel at liberty to do so. You have no doubt heard of the very serious trouble at Canton, in which a riot occurred and nearly twenty European residences were attacked and burnt down by the Chinese and the valuable contents of the houses carried off by the mob. There is a very hostile feeling to foreigners prevailing now amongst the Chinese, and it is considered quite unsafe to travel in the country. I was in the Lo-Fau Mountains when the trouble at Canton commenced, but no one attempted to molest me, and I returned to Canton in a passage junk with 150 Chinese on board, and no foreigner besides myself; since then, however, matters have become much worse. Mr. Sampson's herbarium and house were burnt when his house was set fire to, and Dr. Hance's, which was not more than fifty yards off, might easily have shared the same fate, but very fortunately it was spared. Dr. Hance is extremely busy with official matters, and he thinks it will be a long time before he can resume botanical work. There is an encampment of 1000

Chinese troops in the foreign settlement at Canton, and five foreign and about a dozen Chinese gunboats in the river opposite to it: all these for the protection of the foreign residents and their property. The missionaries have left the country districts, and do not expect to be able to return for many months. These things will prevent any botanical work being done in China for some time. I hope something may be done in Formosa in the beginning of next year."

LARGE use is made at the Forth Bridge Works of electricity for lighting purposes. At South Queensferry the workshops are it up by sixteen arc lights, supplemented by a certain number of movable small incandescent lights. Outside twelve large are lights serve to illuminate the various lines of rails and the approaches to the workshops. The offices, canteen, and other buildings are lighted throughout with Swan incandescent lights of 20-candle power, over 200 being there alone required for the purpose. The staging, which, beginning near the Hawe's Pier, extends for nearly half a mile into the Firth, has, with its approaches, twelve large lights devoted to its illumination. On the island of Inch Garvie in mid channel, four large arc lights are in use outside, and small incandescent lights in the offices and workshops, in the old castle, and in the neighbouring buildings. At North Queensferry six large arc lights serve for the outside illumination, and a number of incandescent lights for that of the interior of the offices and workshops. Nowhere is a dangerous degree of electric pressure allowed; and in all interiors, workshops, or operations under water the limit is but little more than one-half of that permitted by the Board of Trade in their provisional orders for dwellings in towns.

THE mathematical magazine conducted under the name of the *Analyst* for the past ten years, by Mr. J. E. Hendricks, will, we learn from *Science*, be continued under the editorial charge of Ormond Stone, Professor of Astronomy, and William M. Thornton, Professor of Engineering, with the title, *Annals of Mathematics, Pure and Applied*. The numbers will be issued at intervals of two months, beginning February 1, 1884. In scope the journal will embrace the development of new and important theories of mathematics, pure and applied; the solution of useful and interesting problems; the history and bibliography of various branches of mathematics; and critical examinations and reviews of important treatises and text-books on mathematical subjects. The office of publication will be at the University of Virginia.

DR. HOLUB has left England on his expedition to the interior of Africa. He leaves for this journey of a year accompanied by his wife and eleven good servants, including a carpenter, a waggonmaker, a blacksmith, a gunmaker, a tailor, and a butcher, besides his black servant-girl and a dog. In South Africa he will increase his staff by nineteen, and afterwards in Central Africa by forty more black servants.

IT is reported from the Storelvdal, a valley in Central Norway, between 61° and 62° N. lat., that the snow during the night of November 17 became covered with a gray and black layer of dust. No scientific investigation of the phenomenon has as yet been effected.

THE report of the death of Julius Payer, the discoverer with Weyprecht of Franz Josef Land, is, we are glad to say, without any foundation.

THE Annual Report for 1882-83 of the Liverpool Geological Association reports favourably, we are glad to see, on the position and work of that society.

THE Report of the Smithsonian Institution for 1881 shows how admirably that many-sided organisation continues to carry on its invaluable work. The museum in its various departments is constantly increasing; the library will soon be almost without a rival; while a successful chemical laboratory has been added to the other resources of the institute. The appendix, containing as it does a record of progress in all departments of science by specialists, is of great utility; while the special papers on anthropology continue to be a well-known feature of the Report. The Report, like the Institution, reflects the greatest credit on its secretary, Prof. Spencer Baird.

THE additions to the Zoological Society's Gardens during the past week include a Moorhen (*Gallinula chloropus*), British, presented by Mr. T. E. Gunn; two Common Wolves (*Canis lupus* ♂ ♀), European, a Dufresne's Amazon (*Chrysotis dufresniana*) from South-East Brazil; a Bell's Cinixys (*Cinixys belliana*) from West Africa, two Carp (*Cyprinus carpio*) from British fresh waters, purchased; an Indian Gazelle (*Gazella bennetti*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—The following are Greenwich times of geocentric minima of *Algol*, during the first quarter of 1884: the later observations of Prof. Julius Schmidt have been brought to bear upon the predictions.

	h. m.		h. m.		h. m.
Jan. 10 ...	13 35	Feb. 2 ...	12 9	March 13 ...	15 38
13 ...	10 24	5 ...	8 58	16 ...	12 28
16 ...	7 13	8 ...	5 47	19 ...	9 17
30 ...	15 19	22 ...	13 53		
		25 ...	10 43		
		28 ...	7 32		

According to Mr. Knott's observations of U Cephei, 1881-1883, a minimum is indicated on January 5 at 15h. 21m. G.M.T., the period being 2d. 20h. 48·9m. The ephemeris published in the *Vierteljahrsschrift* gives it 1h. 10m. earlier; but it is not stated upon what elements this rests.

Minima of S Cancri occur on December 31 at 8h. 41m., January 19 at 7h. 57m., February 7 at 7h. 12m., and February 26 at 6h. 28m. G.M.T.

The fine variable R Leonis will be due at maximum on February 23, and *Mira Ceti* on March 11.

THE FIRST COMET OF 1798.—A recalculation of the elements of the orbit of this comet, made by Mr. Hind from Messier's observations on April 12, 13, 14, May 1, 2, 3, and May 20, 21, 22, as they are given in Zach's *Allgemeine Geographische Ephemeriden*, vols. i. and ii., does not lead to any suspicion of ellipticity, which is rather confirmatory of the view taken by Dr. Harzer as to its non-identity with the greatly perturbed comet of Brorsen (1846 III) to which reference was lately made in NATURE. The new orbit is as follows:—

Perihelion passage 1798, April 4·51482 Paris M.T.

	° ′ ″	
Longitude of perihelion	105 5 43	Mean
,, ascending node	122 7 22	Equinox
Inclination	43 48 1	1798·0
Log. perihelion distance	9·6857689	

Motion—direct.

The error in longitude for the second normal is − 19″; the latitudes agree.

THE GREAT COMET OF 1882.—We do not hear that this comet has been recognised since its conjunction with the sun. As was pointed out in this column, it was just possible that it might have been re-observed as the earth somewhat overtook it in its orbit, between the beginning of September and the end of last month. On November 30 the distance was at a minimum of 5·708, and is once more on the increase.

The comet was seen at the Observatory of Cordoba until June 1; the last complete observation for position was made there on May 26, when the distance from the earth was 5·048. There is no parallel to this in the whole history of cometary astronomy, except in the case of the very exceptional comet which was observed in 1729 and 1730; at the time of Cassini's last observation this body was distant from the earth 5·135.

Between the first accurate observation at the Royal Observatory, Cape of Good Hope, on September 7, 1882, and the Cordoba observation above referred to on May 26, 1883, the comet described an orbital arc of more than 340°. The ellipse deduced by Krentz from observations to November 14 assigns a period of 843 years; that by Fabritius, from observations to March 3, one of 823 years; but we may soon hope to see the result of a definitive discussion of the whole series of observations.

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY

THE Anniversary Meeting of the Royal Society took place as usual on St. Andrew's Day, November 30, when the President, Prof. Huxley, delivered his address; after which the Fellows elected the officers of the Society for the year, whose names we have already given in NATURE, Nov. 8, p. 43. The following is Prof. Huxley's address:—

It will be as much in consonance with your feelings as it is with my own that the first sentences of this address should give utterance to our sense of the calamity which befell us during the recess.

On June 27 our honoured and loved President, William Spottiswoode, fell a victim to that cruel malady, typhoid fever, which is at once the scourge and the reproach of modern civilisation; and we were bereaved of a chief of whom all those who had the highest interests of this Society at heart hoped that he would continue for many a year to discharge the responsible and laborious duties of his office with that broad intelligence, that faithful diligence, that inexhaustible patience and courtesy, which were so characteristic of the man.

Every one of the Fellows of the Society in whose hearing I speak knows that these are no words of conventional eulogy, as of a customary epitaph. But it is only those of us who worked with our late President in the Council, or as officers of the Society, who are in a position fully to appreciate his singular capacity for the transaction of business with clear judgment and rapid decision, and yet with the most conscientious consideration of the views of those with whom he was associated.

And I may add that it is only those who enjoyed Mr. Spottiswoode's intimate friendship, as it was my privilege to do for some quarter of a century, who can know how much was lost when there vanished from among us that rare personality, so commingled of delicate sensitiveness with marvellous self-control, of rigid principle with genial tolerance, of energetic practical activity with untiring benevolence, that it always seemed to me the embodiment of that exquisite ideal of a true gentleman which Geoffry Chaucer drew five hundred years ago:—

> ". . . He lovede chyvalrye,
> Trouthe and honour, fredom and curtesie.
> . . . . . .
> And though that he was worthy he was wys,
> And of his port as meke as is a mayde.
> He never yit no vilonye ne sayde
> In al his lyf unto no maner wight.
> He was a verray perfight gentil knight."

It is not for me to pass any judgment upon Mr. Spottiswoode's scientific labours; but I have the best authority for saying that having occupied himself with many branches of mathematics, more especially with the higher algebra, including the theory of determinants, with the general calculus of symbols, and with the application of analysis to geometry and mechanics, he did excellent and durable work in all; and that, in virtue of his sound and wide culture, his deep penetration, and the singular elegance with which he habitually treated all his subjects, he occupied a place in the front rank of English mathematicians.

The interment in Westminster Abbey of one who, though compelled to devote a large share of his time to business, was a born man of science, and had won himself so high a place among mathematicians, was doubtless grateful to us as men of science; it could not but be satisfactory to us as Fellows of the Royal Society that, on the rare occasion of the death of our President in office, the general public should show its sympathy with our bereavement; yet as men I think it is good to regard those solemn and pathetic obsequies as the tribute which even our busy, careless, cynical, modern world spontaneously pays to such worth and wisdom, to such large humanity and unspotted purity as were manifested in the "very perfect gentle knight" who so well represented the chivalry of science.

The total number of Fellows deceased during the past year amounts to twenty; a large inroad upon our ranks in mere numbers, an exceptionally severe mortality if we consider the scientific rank of many names in the death-roll. Almost at the same time with Mr. Spottiswoode's untimely death we lost, at the ripe old age of ninety, a very distinguished Fellow and former President of this Society, Sir Edward Sabine. It is said that the average age of Fellows of the Royal Society is greater than that of any body of men in Europe; and it is certainly a remarkable fact that one who so long presided over us in this generation should, as a man of thirty years, have been the contemporary of Sir Joseph Banks, who became our President more than a century ago. And nothing can give a more striking exemplification of the gigantic progress of physical science in modern times than the fact that the discovery of oxygen by Priestley, and that of the composition of water by Cavendish, fall within the period of Sir Joseph Banks's presidency, while Black's work was but a score years earlier. We are as it were but two Presidents off the budding of modern chemistry, as of many another stately growth of the tree of natural knowledge.

Sir Edward Sabine's long services to this Society, first as Treasurer and then as President, deserve more than a passing allusion; but for a due appreciation of them, no less than of his great labours in terrestrial magnetism, I must refer you to our obituary notices.

By the unexpected death of Prof. Henry John Stephen Smith the University of Oxford lost one of the most distinguished, as he was one of the most influential, among those who have guided its destinies during this generation, and a capacity of the first order, not yet weakened by the touch of time, has disappeared from the ranks of the foremost mathematicians of Europe.

As Chairman of the Meteorological Committee, Prof. Smith rendered invaluable services to that body; and we have all a grateful recollection of the readiness with which his knowledge and sagacity were brought to our aid in Council and in Committee.

For the rest, I dare add nothing to that which has been said of him by our late President in that just and loving appreciation of his friend, which is now touched with a sadder gravity and a deeper pathos.

It is difficult to say of Prof. Smith whether he was more remarkable as a man of affairs, of society, of letters, or of science; but it is certain that the scientific facet of his brilliant intelligence was altogether directed towards those intelligible forms which people the most ethereal regions of abstract knowledge. In Sir William Siemens, who but the other day was suddenly snatched from among us, we had a no less marked example of vast energy, large scientific acquirements, and intellectual powers of a high order, no less completely devoted, in the main, to the application of science to industry.

I believe I am expressing the opinion of those most competent to judge, when I say that Sir William Siemens had no superior in fertility and ingenuity of invention; that hardly any living man so thoroughly combined an extensive knowledge of scientific principles with the power of applying them in a commercially successful manner; and that the value of his numerous inventions must be measured, not merely by the extent to which they have increased the wealth and convenience of mankind, but by the favourable reaction on the progress of pure science which they, like all such inventions, have exerted, and will continually exert.

Time permits me to be but brief in alluding to the remainder of our long list of deaths. But I may not omit to mention that we have lost a distinguished mathematician in Prof. Challis; in Mr. James Young, a chemist whose skilful application of theory to practice founded a new industry; in Mr. Cromwell Varley, an ingenious inventor; in Lord Talbot de Malahide, a warm friend of science and a zealous promoter of archæological research; in Mr. Walker, an eminent engineer; in Mr. Howard, an eminent quinologist; and in the Rev. Dr. Stebbing, an accomplished and amiable man of letters, who for very many years filled the honourable, but not very onerous, office of Chaplain to the Society.

And it would ill become us, intimately connected as this Society always has been, and I hope always will be, with the sciences upon which medicine bases itself, to leave unnoticed the decease of the very type of a philosophical physician, the venerable Sir Thomas Watson.

Two well-known names have disappeared from among those of the eminent men who are enrolled upon our foreign list; the eminent physicist, Plateau, and the no less distinguished anatomist and embryologist, Bischoff.

I now beg leave to bring under your notice a brief general review of the work of the Society during the past year.

The papers printed in the *Transactions* for 1882 and 1883 will occupy two volumes, of which three parts, containing 1038 quarto pages and fifty-two plates, have already been published. Two parts more, to complete 1883, will shortly be published.

The *Proceedings*, which steadily increase in size from year to year, amount during the past year to 780 octavo pages, with four plates and numerous engravings.

You are aware that nothing is printed in the *Proceedings* or in the *Transactions* except by the authority of the Council, which, in the latter case, calls in the assistance of at least two carefully-selected and independent referees, by whose advice it is in practise, though not necessarily, guided. I am inclined to think that Fellows of this Society who do not happen to have served on the Council, are little aware of the amount, or of the value of the conscientious labour which is thus performed for the Society by gentlemen whose names do not appear in our records. And I trust I may be forgiven for stepping beyond precedent so far as to offer our thanks for work which is always troublesome and often ungrateful; but, without which, the contributions to our pages would not maintain the high average of excellence which they possess.

Among the points of importance, by reason of their novelty or general significance, which have been laid before us, much interest attaches to the result brought out in Prof. Osborne Reynolds's "Experimental Investigation of the circumstances which determine whether the motion of water shall be direct or sinuous, and of the law of resistance in parallel channels;" which shows that when the conditions of dynamical similarity are satisfied, two systems, involving fluids treated as viscous, may be compared (as regards their effects) even when the motions are unstable; and that if any one of the two systems is in the critical state separating stability from instability, so will be the other.

Last December, Dr. Huggins presented a note on "A Method of Photographing the Solar Corona without an Eclipse," which had so far proved successful, under the unfavourable circumstances in which he had put it in practice, as to lead to the hope that, under better conditions of atmosphere and elevation, the corona might be photographed, from day to day, with so much accuracy as to preserve a clear record of the changes which it undergoes. And, as the photographs taken during the eclipse at Caroline Island show a condition of the corona, intermediate between those exhibited by Dr. Huggins's photographs at periods antecedent and subsequent to the Caroline Island observations, there is reason to believe that this hope is well based, and that a new and powerful method of investigation has been placed in the hands of students of solar physics.

Lord Rayleigh and his sister-in-law, Mrs. Sidgwick, have made a very elaborate determination of the relation between the ohm and the British Association standard of electrical resistance.

With respect to those branches of knowledge on which I may venture to offer an opinion of my own, I may say that, though our records show much useful and praiseworthy work in biological science, the only event which appears to me to call for special remark is the opening of an attack upon a problem of very great interest, one which, in fact, goes to the root of the question of the fundamental unity of the two great embodiments of life—plants and animals.

The well-known phenomena presented by many plants, such as the sensitive plant and the sun-dew, our knowledge of which was so vastly extended by Darwin, abundantly prove that the property of irritability, that is, the reaction of a living part, by change of form, upon the application of a stimulus to that part, or to some other part in living continuity with it, is not confined to animals.

But, in animals, the connection of the part irritated with that which changes its form is always effected by a continuity of more or less modified protoplasmic substance, and reaction takes place only so long as that continuity is unimpaired; while, hitherto, the protoplasmic cell-bodies of plants have appeared to be isolated from one another by the non-protoplasmic cell-walls in which they are inclosed.

It is as if, in the one case, there was a continuous bond of conducting substance between the point of irritation and the point of contraction; while, in the other, there was a chain of pellets of protoplasmic substance, each inclosed in a coat of a different nature.

Now, Mr. Gardiner, in his paper "On the continuity of the Protoplasm through the Walls of Vegetable Cells," brings forward evidence, based chiefly upon the careful use of special reagents, that, in the sensitive cushions of certain plants and in other situations, the vegetable cell-wall is pierced by minute apertures, and that these are traversed by threads of protoplasm, which connect the cell-body of each cell with those of its neighbour, and thus establish, as in animals, a continuity of protoplasmic substance between different parts. Other observers are working at the same subject, and we may hope that, before long, great light will be thrown upon many hitherto puzzling questions in vegetable physiology.

The Committee of the Royal Society, in the hands of which the Lords of the Treasury have placed the administration of the funds devoted to the publication of the work of the *Challenger* expedition, report that, under the careful and vigorous direction of Mr. Murray, this great undertaking is making rapid progress.

Mr. Murray informs me that thirty-eight reports have, up to this time, been published, forming eight large quarto volumes, with 4195 pages of letterpress, 488 lithographic plates and other illustrations. Thirty-four of these memoirs are on zoological, four on physical subjects. Nine reports are now nearly all in type, and some of them partly printed off. These will be published within three months, and will form three zoological volumes, with 230 plates and many woodcuts, and one physical volume, with many diagrams and maps; this latter volume will contain the report on the composition of ocean water, the specific gravity and temperature observations.

A considerable part of the general narrative of the cruise is now in type, and nearly all the illustrations are prepared. The narrative will extend to two volumes, and it is expected they will be ready for issue in May or June, 1884.

The work connected with the remaining forty-two special reports is, in most instances, progressing satisfactorily. Portions of the manuscript for three of the larger memoirs have been received and put in type, and the manuscript of many oth is in a forward state. For these memoirs, 386 lithographic p have been printed off and delivered to the binders; 404 o are now on stone, and the drawings for many more are being prepared. It is estimated that the whole work connected with the Report will be completed in the summer of 1887.

In his Address, last year, the President gave the Society a full account of the changes which had taken place in the administration of the Government Fund—technically termed a grant in aid of this Society—though, as you are aware, the Royal Society, while willingly accepting the burden and the responsibility of administrator of the aid granted by the State to science, is in no sense pecuniarily benefited by the grant.

A somewhat novel and extremely useful employment has been given to part of the fund by deciding to defray the expenses of adequately skilled persons who have undertaken to visit distant countries for the purpose of investigating certain interesting biological questions on the spot, and of procuring and transmitting to observers at home specimens prepared and preserved by those refined modern methods which can be satisfactorily carried out only by persons who are well versed in the practice of such methods.

Mr. Adam Sedgwick has thus been enabled to proceed to the Cape of Good Hope for the purpose of completing our knowledge of the singular genus *Peripatus*, so well studied by Prof. Moseley, and afterwards by our lamented Fellow, Balfour; and Mr. Caldwell, similarly aided, is now in Australia, devoting himself to the elucidation of the embryology of the marsupial quadrupeds of that region, a subject of which at present we know little more than was made known in the *Transactions* of this Society half a century ago by Prof. Owen.

It certainly was high time that British science should deal with a problem of the profoundest zoological interest, the materials for the solution of which abound in, and are at the same time almost confined to, those territories of the Greater Britain which lie on the other side of the globe.

Many years ago the late Mr. Leonard Horner communicated to the Society the results of a series of borings which he had caused to be made in the upper part of the delta of the Nile, with a view of ascertaining the antiquity of the civilisation of Egypt. Since that time Figari Bey, an Italian geologist in the service of the Egyptian Government, made and published the results of a large series of borings effected in different parts of the delta, but his work is hardly on a level with the requirements of modern science.

It has been thought advisable therefore to take advantage o the presence of our troops in Egypt in order to carry out a series of borings across the middle of the delta, in the full expectation that such borings, if made with proper care and carried down to the solid rock, will afford information of the most important character, and will throw a new light upon the natural and civil history of this unique country. I am glad to say that the representations which the President and Council made to the War Office on this subject were most favourably received, and that instructions were at once sent to the officer commanding the Engineers to undertake the operations which they recommended. I trust that, before long, information will reach us which will be of no less interest to the archæologist than to the geologist.

While I am speaking of Egypt, I may perhaps be permitted to express a regret that the admirable energy of the Government in taking measures to make the recent advances of medical science available during the late outbreak of cholera in that country, was not extended beyond the purely practical side of the matter, or, perhaps, not so far as the practical side in the proper sense; for until we know something about the causes of that terrible disease, our measures for prevention and for cure will be alike leaps in the dark.

Those who have looked into the literature of cholera may, perhaps, be disposed to think that a new search after its cause will add but another to the innumerable wild hypotheses which have been set afloat on that topic; and yet devastating epidemics, like the pebrine of the silkworm, so similar in their fatality and their apparently capricious spread, that careful investigators have not hesitated to institute a detailed comparison of the phenomena of this disease with those of cholera, have been proved by Pasteur to be the work of microscopic organisms; and hardly less fatal epidemics, such as splenic fever, have been traced to similar agencies. In both these cases, knowledge of the causes and of the conditions which limit the operation of the causes, have led to the invention of effectual methods of cure. And it is assuredly, in the present state of science, something more than a permissible hypothesis, that the cause of cholera may be an organic living *materies morbi*, and that the discovery of the proper curative and prophylactic measures will follow upon the determination of the nature and conditions of existence of these organisms.

If this reasoning is just, it is certainly to be regretted that the opportunity of the outbreak of cholera in Egypt was not utilised for the purposes of scientific investigation into the cause of the epidemic. There are able, zealous, and courageous young pathologists in this country who would have been willing enough to undertake the labour and the risk; and it seems a pity that England should leave to Germany and to France an enterprise which requires no less daring than Arctic or African exploration, but which, if successful, would be of a thousand times more value to mankind than the most complete knowledge of the barren ice wastes of the Pole or of the sweltering barbarism of the equator.

It may be said that inquiries into the causation of cholera have been for some years conducted in India by the Government without yielding any very definite result. But this is perhaps rather an argument in favour of, than against, setting fresh minds to work upon the problem.

In December last year the President received from the Lords of the Treasury a letter, addressed to their Lordships by the Lords of the Committee of the Privy Council on Education, recommending to the favourable consideration of the Treasury a memorial from the Solar Physics Committee, suggesting the organisation of an expedition for the purpose of making observations during the solar eclipse of May 5, 1883; and the President was requested to communicate his views upon the subject to the Treasury.

After careful consideration, the President and Council reported in favour of the projected expedition; but they added that they did so on condition of its being possible to find some one, whose position in the scientific world would command the confidence of the public, to take charge of the expedition. Unfortunately, for one reason or another, none of the men of science who fulfilled this condition were able to go; and, at the meeting of Council of January 18, the projected expedition was abandoned. The President was, however, requested to place himself in communication with the American authorities, and to ascertain from them whether a photographer and assistant could be allowed to accompany their expedition to Caroline Island. On doing so, he at once received an invitation for two observers; who were accordingly sent out, their expenses being defrayed, partly by a contribution from the Government grant, and partly by a special sum of 500*l*. provided by the Treasury.

I am indebted to Mr. Lockyer for the following list of photographs taken by the observers:—

1. Six good photographs of the corona, exposures varying from two to sixty seconds, giving coronal detail from near the limb to end of streamers. That the limit of the corona has been photographed is shown by the manner in which the light of the sky has impressed itself on the plate.
2. Three large photographs showing the details of the corona close to the limb.
3. Good photographs of the spectrum of the corona, showing a great number of coronal lines and very faint Fraunhoferic lines.
4. Photographs taken on a moving plate in integrating spectroscope, from one minute before to one and a half minute after totality, showing the most prominent lines of the reversion spectrum. These lines belong mainly to hydrogen.
5. Photographs taken with first-order grating, before, during, and after totality. These show H and K, near the limb, throughout the whole of totality.
6. Photographs taken with a dense prism spectroscope before, during, and after totality. These photographs also give some of the prominent lines of the reversion spectrum.
7. Two photographs taken in the prismatic camera on plates sensitive to ultra-red rays. Results comparatively indifferent on account of the absence of prominences.

The arrangements made for obtaining a series of circumpolar observations in meteorology and magnetism were fully described in the Presidential address of last year. I am glad to be able to report that the English party, under Capt. Dawson, has successfully achieved its mission and has returned to this country. Capt. Dawson speaks very gratefully of the efficient assistance which he received from the Canadian authorities and from the Hudson Bay Company.

The responsibility for the transaction of the ordinary work of the Society rests with the Council and the officers, of whom the President is only one, and I may be allowed to say by no means the most important, the heaviest part of the burden of the executive resting upon the Secretaries. But your President is, in virtue of his office, a member of two public bodies whose functions in relation to science are of great importance; and I follow the excellent precedent set by my predecessor in considering it my duty to acquaint the Fellows of the Society with any occurrence, bearing on the interests of science, which has come under my cognisance, as a Trustee of the British Museum and as a member of the Council and Executive Committee of the City and Guilds Institute.

In the first-named capacity, I am glad to be able to announce that the transference of the vast zoological, botanical, geological, and mineralogical collections from Bloomsbury to the New Natural History Museum is now accomplished; and that it has been effected to the great credit of all concerned, with no greater mishap than the fracture of a bottle or two.

The advantages which will accrue to zoologists, botanists, and mineralogists from the re-arrangement of this vast assemblage of the objects of their studies, in such a manner as to be accessible to every investigator, cannot be over-estimated. The Natural History Museum at South Kensington is, in fact, a library of the works of nature which corresponds in value, in extent, and in the purposes to which it should be applied, to the vast library of the works of men which remains at Bloomsbury.

In making this collection of use to the world of science by the publication of complete catalogues of its contents, and of systematic monographs upon particular groups; and to the nation at large, by the composition of guide books calculated to afford the ordinary visitor an insight into the plan of the mighty maze of nature, the officers in charge of the Natural History collections have before them a task, the due performance of which, whatever their abilities, or their number, or their industry, will tax their energies to the utmost. It is in this way that, in the discharge of their proper duties, they may render services of the highest value alike to pure science and to the diffusion of knowledge among the people, out of whose resources the great institution to which they belong is supported. And I trust that no mistaken view of the functions of the officers of the Museum, which no more embrace oral instruction in science than those of the officers of the Library comprehend oral instruction in literature, may lead to the imposition of duties, foreign to their proper business, upon the already overburdened staff of keepers and their assistants.

In Francis Bacon's apocalypse of science, the "New Atlantis," the Father of Solomon's House—he, whose countenance was "as if he pitied men,"—declares that the end of that foundation is "the knowledge of causes and secret motions of things, and the enlarging of the bounds of human empire to the effecting of all things possible."

I think that the Chancellor would have acknowledged the New Natural History Museum to be a goodly wing of such a House, devoted to the former of the objects which he mentions; but, it may be, that his practical mind, looking always to fruit, and caring for light chiefly as something essential to fruit-bearing, would have been even better satisfied with another building hard by, which has been devoted to the encouragement of those applications of science through which human empire is directly extended, by the well-directed munificence of the City and Guilds of London.

This building, destined for a central Institution in which ample provision shall be made for thorough and practical training in so much of the principles and the methods of the physical sciences as is needful for those who aspire to take part in the development of arts and manufactures, has been completed at a cost of more than 70,000*l*., while 20,000*l*. has yet to be spent upon fittings and appliances, and the working expenses, if the scheme is to be fully developed, cannot be estimated at less than 10,000*l*. a year.

Having already been called upon to take an active part in the deliberations of the committees charged with the carrying out of this great work, I think I am justified in expressing the hope, and indeed the confident expectation, that, before long, this new Technical College will be in full activity; and that, for the first time in our history, there will be called into existence an institution in which, without leaving this country, masters, managers, and foremen of works will be enabled to obtain thorough instruction not only in scientific theory, but in the essential principles of practice; and a machinery will be created, by which the poorest working lad in a manufacturing town, if he have ability and perseverance, may be brought within reach of the best technical education that is to be had.

There can be no doubt that the founders of the Royal Society had prominently before their minds the intention of promoting the useful arts and sciences "that so (in the language of the draft of the preamble to the first charter, which is said to have been drawn up by Sir Christopher Wren) by laying in a stock, as it were, of several arts and methods of industry, the whole body [of the nation] may be supplied by a mutual commerce of each other's peculiar faculties, and, consequently, that the various miseries and trials of this frail life may be, by as many various expedients ready at hand, remedied or alleviated, and wealth and plenty diffused in just proportion to every one's industry, that is, to every one's deserts." It was the wish of King Charles the Second that all patents for inventions should be examined by the Royal Society; and, so late as the reign of George the Second, the Society actually performed this duty. The steam-engine itself may be said to have made its *début* before the Royal Society, when Savery exhibited his working model to the Fellows in 1699.

But the subsequent history of natural knowledge has shown that, as in the moral world, those who seek happiness through well-doing are less likely to obtain that reward than those who try to do well without thinking what may come of it; so, in the world of science, those whose vision is fixed on useful ends are often left poor and bare, while those who strive only after the advancement of knowledge, scatter riches along their path, for the whole world to pick up. The Royal Society has chosen the latter course, and I trust it may never swerve from it. But I think that our warmest sympathy is due to the efforts of those who translate the language of the philosopher into that of the workshop; and by thus ameliorating "the miseries and toils of this frail life," and "diffusing wealth and plenty," are executing that part of the first design of this Society, with which we, as a body, have long ceased to occupy ourselves.

It was not as your President, but as one of the Special Commissioners appointed by the Government, that I had some slight share in another considerable undertaking directed towards the improvement of industry. But the future of the fisheries is so closely connected with the advancement of certain branches of zoological science, that I may be permitted to advert to the great success of the International Fisheries Exhibition; and to express my belief that, in accordance with the intimation contained in the speech of H.R.H. the Prince of Wales at the closing of the Exhibition, there will grow out of it an organisation which will provide for the application of science to the improvement of the fisheries.

In conclusion, gentlemen, I think that it is proper on my own behalf, as it is certainly due to you, that I should advert to the exceptional circumstances which have brought about my present occupation of the Presidential office.

The eleventh section of the sixth chapter of the statutes provides for the occurrence of a vacancy in the Chair, whether by death or by resignation, as follows:—

"Upon any vacancy in the President's place occurring in the intervals of the anniversary elections, the Treasurer, or in his absence one of the Secretaries, shall cause the Council to be summoned for the election of a new President, and the Council meeting thereupon in the usual place, or any eleven or more of them, shall proceed to the said election, and not separate until the major part of them shall have agreed upon a new President."

This statute is substantially, and, to a great extent, verbally, identical with the twelfth section of the seventh chapter of the original statutes of 1663.

Before the present year, five occasions had arisen on which it became necessary to put the provisions of the statute into effect.

Sir Isaac Newton died while President in 1727; the Earl of Morton in 1768; Mr. West in 1772; and Sir Joseph Banks in 1820; while Sir Humphry Davy resigned in 1827. On each of these occasions a new President was at once appointed by the Council, endowed with all the privileges and powers of the office; and, like every other officer, however appointed, he vacated his office on November 30 following, when the Fellows sometimes elected him for the succeeding year, and sometimes did not.

These precedents were strictly followed on the present occasion. A Council had been summoned, in ordinary course of business, for June 28; but, as the President died on the 27th, it was deferred until the following Thursday, when it was supposed the interment would have taken place. In consequence of the delay inseparable from a public ceremony, however, it so happened that the funeral did not take place until noon of July 5; and I have known few sadder scenes than the gathering of the Council, fresh from the unclosed grave of their President, for the performance of the duty, imposed upon them by the statutes, of choosing his successor from their own number, before they should separate.

The Council did me the great honour of selecting me for the office; and now, on this next following St. Andrew's Day, my tenure, like that of the Treasurer and Secretaries, lapses, and it is for the Fellows of the Society to say who shall be their officers until the next Anniversary Meeting.

Having served several years, in another capacity, with three out of four of my present colleagues, and having every reason to believe that the Fellows of the Society, at large, see good reason to set the same high value upon the services of all of them as I do, I do not find myself able to imagine that you will fail to desire that those services shall be continued; but I have not the least difficulty in conceiving that the Fellows of the Society may think many of their number better fitted for the eminent place of the President than myself.

I should be extremely ungrateful to my colleagues of the Council, who have again honoured me by presenting me for election by the Fellows, if I were to let fall even a hint of the extent to which I share that opinion; but I think it may be permitted me to say that, should you think fit to give effect to it, there is no one who will more cheerfully acquiesce in your decision than I shall.

To a man like myself, who neither possesses, nor seeks, any other distinction than that of having done his best to advance knowledge and to uphold the dignity and the authority of science against all comers, the Presidency of this Society is the highest dignity which he can attain, whatever else may befall him.

But, gentlemen, as men of science, you know better than I can tell you, that there are things of more worth than distinction. I am within measurable distance of the end of my career; and I have long looked forward to the time when I should be able to escape from the distractions and perturbations of the multitudinous affairs in which I have been so long entangled, to that student life from which the Fates have driven me, but to which I trust they may, for a little space, permit me to return.

So that I am sure you will neither misunderstand me, nor mislike my directness of speech, when I say that, if it please you to believe that the interests of science and of the Royal Society will be advanced by maintaining me in the very distinguished position which I at present occupy, I will do my best to justify your confidence; but if, as may well be, you think that some other Fellow of the Society will serve these interests better, I shall, with a light heart, transfer to him the honourable burden, which I have already borne long enough to know its weight.

I now proceed to the presentation of the medals which have this year been awarded by the Council.

The number, the variety, and the importance of Sir William Thomson's contributions to mathematical and experimental physics are matters of common knowledge, and the Fellows of the Society will be more gratified than surprised to hear that the Council have this year awarded him the Copley Medal, the highest honour which it is in their power to bestow.

Sir William Thomson has taken a foremost place among those to whom the remarkable development of the theory of thermodynamics and of electricity in the last forty years is due; his share in the experimental treatment of these subjects has been no less considerable; while his constructive ability in applying science to practice is manifested by the number of instruments, bearing his name, which are at present in use in the physical laboratory and in the telegraph office.

Moreover, in propounding his views on the universal dissipation of energy and on vortex motion and molecular vortices, Sir William Thomson has propounded conceptions which belong to the *prima philosophia* of physical science, and will assuredly lead the physicist of the future to attempt once more to grapple with those problems concerning the ultimate construction of the material world, which Descartes and Leibnitz attempted to solve, but which have been sedulously ignored by most of their successors.

One Royal Medal has been awarded to Dr. T. Archer Hirst, F.R.S., for his investigations in pure geometry; and, more particularly, for his researches into the correlation of two planes and into the complexes generated by them.

The other Royal Medal has been awarded to Dr. J. S. Burdon Sanderson, F.R.S., for the eminent services which he has rendered to physiology and pathology; and, especially, for his researches on the electrical phenomena exhibited by plants, and for his investigations into the relation of minute organisms to disease.

In making this award, the Council desire not merely to recognise the merit of Dr. Burdon Sanderson's researches, especially those on the analogy between the electrical changes which take place in the contractile tissues of plants and those which occur in the like tissues of animals; but to mark their sense of the important influence which Dr. Sanderson has exerted upon the study of physiology and pathology in this country.

The Davy Medal has this year been again awarded in duplicate, the recipient being M. Marcellin Berthelot, Member of the Institute of France, and Foreign Member of the Royal Society, and Prof. Julius Thomsen, of Copenhagen.

The thermo-chemical researches of Berthelot and Thomsen have extended over many years, and have involved an immense amount of work, partly in the application of established methods to new cases, partly in devising new methods and applying them to cases in which the older methods were not applicable. Chemists had identified a vast variety of substances, and had determined the exact composition of nearly all of them, but of the forces which held together the elements of each compound they knew but little. It was known that certain elements combine with one another with great evolution of heat-forming products in which they are firmly united; while other elements combine but feebly, and with little evolution of heat. But the materials for forming any general theory of the forces of chemical combination were but scanty and imperfect.

The labours of Messrs. Berthelot and Thomsen have done much towards supplying that want, and they will be of the utmost value for the advancement of chemical science.

THE JAVA DISASTER

THE following letter from the Liverpool *Daily Post*, received from Capt. W. J. Watson, of the British ship *Charles Bal*, contains a graphic and interesting account of the recent terrible volcanic outburst in Sunda Straits. Capt. W. J. Watson was himself an eye-witness of what he describes. His vessel was actually within the Straits, and not far from Krakatoa when that island had become an active volcano:—

"*August* 22, 15° 30′ S., 105° E.—About 7 p.m. the sea suddenly assumed a milky-white appearance, beginning to the east of us, but soon spreading all round, and lasting till 8 p.m. There were some clouds (cumulus) in the sky, but many stars shone, and in the east to north-east a strong, white haze or silvery glare. This occurred again between 9 and 10 p.m., the clouds also appearing to be edged with a pinkish coloured light, the whole sky also seeming to have extra light in it, similar to when the aurora is showing faintly. On the 24th, in 9° 30′ S. 105° E., we had a repetition of the above. On the night of the 25th, standing in for Java Head, the land was covered with thick, dark clouds and heavy lightning. On the 26th, about 9 a.m., passed Prince's Island, wind south-west, and some heavy rain; at noon, wind west-south-west, weather fine, the Island of Krakatoa to the north-east of us, but only a small portion of the north-east point, close to the water, showing; rest of the island covered with a dense black cloud. At 2.30 p.m. noticed some agitation about the Point of Krakatoa; clouds or something being propelled from the north-east point with great velocity. At 3.30 we heard above us and about the island a strange sound as of a mighty, crackling fire, or the discharge of heavy artillery at second intervals of time. At 4.15 p.m., Krakatoa north half east, ten miles distant, observed a repetition of that noted at 2.30, only much more furious and alarming, the matter, whatever it was, being propelled with amazing velocity to the north-east. To us it looked like blinding rain, and had the appearance of a furious squall of ashen hue. At once shortened sail to topsails and foresail. At five the roaring noise continued and increased; wind moderate from south south-west; darkness spread over the sky, and a hail of pumice-stone fell on us, many pieces being of considerable size and quite warm. Had to cover up the skylights to save the glass, while feet and head had to be protected with boots and southwesters. About six o'clock the fall of larger stones ceased, but there continued a steady fall of a smaller kind, most blinding to the eyes, and covering the decks to three or four inches very speedily, while an intense blackness covered the sky and land and sea. Sailed on our course until we got what we thought was a sight of Fourth Point Light; then brought ship to the wind, south-west, as we could not see any distance, and we knew not what might be in the Straits, the night being a fearful one. The blinding fall of sand and stones, the intense blackness above and around us, broken only by the incessant glare of varied kinds of lightning and the continued explosive roars of Krakatoa, made our situation a truly awful one. At 11 p.m., having stood off from the Java shore, wind strong from the south-west, the island, west-north-west, eleven miles distant, became more visible, chains of fire appearing to ascend and descend between the sky and it, while on the south west end there seemed to be a continued roll of balls of white fire; the wind, though strong, was hot and choking, sulphureous, with a smell as of burning cinders, some of the pieces falling on us being like iron cinders, and the lead from a bottom of thirty fathoms came up quite warm. From midnight to 4 a.m. (27th) wind strong, but very unsteady, between south-south-west and west-south-west, the same impenetrable darkness continuing, the roaring of Krakatoa less continuous, but more explosive in sound, the sky one second intense blackness and the next a blaze of fire, mastheads and yardarms studded with corposants and a peculiar pinky flame coming from clouds which seemed to touch the mastheads and yardarms. At 6 a.m., being able to make out the Java shore, set sail, passing Fourth Point Lighthouse at 8; hoisted our signal letters, but got no answer. Passed Anjer at 8.30, name still hoisted, close enough in to make out the houses, but could see no movement of any kind; in fact, through the whole Straits we have not seen a single moving thing of any kind on sea or land. At 10.15 a.m. passed the Button Island one-half to three-quarters of a mile off; sea like glass round it, weather much finer looking, and no ash or cinders falling; wind at south-east, light. At 11.15 there was a fearful explosion in the direction of Krakatoa, now over thirty miles distant. We saw a wave rush right on to the Button Island, apparently sweeping right over the south part, and rising half way up the north and east sides. This we saw repeated twice, but the helmsman says he saw it once before we looked. The same wave seemed also to run right on to the Java shore. At the same time the sky rapidly covered in; the wind came strong from south-west by south; by 11.30 we were inclosed in a darkness that might almost be felt, and at the same time commenced a downpour of mud, sand, and I know not what; ship going north-east by north, seven knots per hour under three lower topsails; put out the side-lights, placed two men on the look-out forward, while mate and second mate looked out on either quarter, and one man employed washing the mud off binnacle glass. We had seen two vessels to the north and north-west of us before the sky closed in, adding much to the anxiety of our position. At noon the darkness was so intense that we had to grope our way about the decks, and although speaking to each other on the poop, yet could not see each other. This horrible state and downpour of mud, &c., continued until 1.30, the roarings of the volcano and lightnings being something fearful. By 2 p.m. we could see some of the yards aloft, and the fall of mud ceased. By 5 p.m. the horizon showed out in the north and north-east, and we saw West Island bearing east and north, just visible. Up to midnight the sky hung dark and heavy, a little sand falling at times, the roaring of the volcano very distinct, although in sight of the North Watcher, and fully sixty-five or seventy miles off it. Such darkness and time of it in general few would conceive, and many, I dare say, would disbelieve. The ship, from truck to water-line, is as if cemented; spars, sails, blocks, and ropes in a terrible mess; but, thank God, nobody hurt or ship damaged. On the other hand, how fares it with Anjer, Merak, and other little villages on the Java coast?"

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The Natural Science Scholarships at Christ Church have been awarded after examination to Mr. R. E. Scholefield, of Leeds Grammar School, and Mr. H. Bankes Price, of Christ's College, Brecon. The Brakenbury Natural Science Scholarship at Balliol College has been awarded to Mr. R. P. Baker, of Clifton College. The following gentlemen were distinguished in the examination:—Mr. W. H. Littleton, Royal School of Mines, Mr. T. H. J. Watts, of Llandovery School, and Mr. C. E. Rice, of Derby Grammar School.

An examination will be held on January 29 at Queen's College for the election of a scholar in Natural Science.

CAMBRIDGE.—The Special Board for Mathematics, in publishing, after the lapse of two-thirds of the present term, a list of professorial lectures on Mathematics, with a list of College lectures open to all members of the University, states that six associated Colleges, Peterhouse, Pembroke, Corpus, Queens', St. Catharine's, and Downing, provide no lectures on higher Mathematics this term, while none will be given during the year at Jesus, Trinity Hall, Magdalen, Sidney, Cavendish, and Selwyn. St. John's does not as yet open any of its advanced lectures to other than its own students. Trinity, on the contrary, has five advanced courses this term open to the University, viz. Mr. Thomson on Electrostatics and on Statics and Attractions, Mr. Ball on Higher Differential and Integral Calculus, Mr. Glazebrook on Geometrical Optics, and Mr. Glaisher on Elliptic Functions. At King's Mr. Stearn is lecturing on Electrostatics, at Christ's Mr. Hobson on Magnetism, at Clare Mr. Mollison on Fourier's Theory and Heat. Several subjects in higher Mathematics are unrepresented by lectures this year, such as Differential Equations, Calculus of Finite Differences, Calculus of Variations, Theory of Probability, Lagrange's and Bessel's Functions, Higher Dynamics, Newton's "Principia," Planetary Theory, and Precession. The Board regret that no conference of mathematical lecturers has been held, and that there is no uniformity of procedure between the different Colleges. In all the other chief departments of study, programmes of advanced lectures for the whole year were published last June. It is somewhat of a reproach to Cambridge mathematicians that no such list is published in regard to what was once so distinctively the characteristic study of Cambridge.

The following are the examiners for the Natural Sciences Tripos of 1884:—Prof. A. M. Marshall (zoology), Dr. F. Darwin (botany), Mr. Langley (physiology), Dr. R. D. Roberts (geology), Mr. L. Fletcher (mineralogy), Mr. W. N. Shaw (physics), Mr. A. Hill (human anatomy), Mr. Pattison Muir (chemistry).

The recommendations of the General Board of Studies as to the Professor of Pathology, new readers, University lecturers, demonstrators, grants for apparatus, &c., will be voted on December 6 at noon.

Prof. Foster has been appointed on the University Library Syndicate; Prof. Foster and Dr. Vines, the Botanic Garden Syndicate; Revs. Coutts Trotter and E. Hill, the Museums and Lecture Rooms Syndicate; Messrs. H. Darwin and J. J. Thomson, the Observatory Syndicate; Prof. Cayley, the University Press Syndicate; Dr. Gaskell and Mr. A. S. Lea, the Oxford and Cambridge Examinations Syndicate; Prof. Foster, the State Medicine Syndicate; Prof. Stuart and Mr. J. Ward, the Teachers' Training Syndicate.

The following appointments on Special Boards have been made:—Mr. A. S. Lea (medicine), Dr. Ferrers (mathematics), Prof. Stokes (physics and chemistry), Mr. J. E. Marr (biology and geology).

Prof. Macalister has been appointed Examiner in the 2nd M.B. in place of the late Mr. James Shuter.

Mr. W. Gardiner of Clare College has been approved as a Teacher of Botany for the purposes of medical study.

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology*, vol. xviii. part 1, October, 1883, contains:—On the development of the suspensory ligament of the fetlock in the fœtal horse, ox, roe deer, and sambar deer, by Prof. Dr. J. Cunningham, M.D. (plate 1).—On the action of infused beverages on peptic digestion, by Dr. J. W. Frazer (plate 2).—On a method of promoting maceration for anatomical museums by artificial temperature, by Prof. Struthers, M.D.—On the wax-like disease of the heart, by Prof. D. J. Hamilton, M.D. (plate 3).—On the relations of the dorsal artery of the foot to the cuneiform bones, by A. Hensman.—Researches into the histology of the central gray substance of the spinal cord and medulla oblongata, by Dr. W. Ainslie Hollis, part 2 (plate 4).—On some points in the anatomy of the chimpanzee, by J. B. Sutton.—Observations upon the osteology of *Podasocys montanus*, by Dr. R. W. Shufeldt (plate 5).—Short notes on the myology of the American black bear, by Prof. F. J. Shepherd, M.D.—Total absence of the left lobe of the thyroid body, by Dr. W. J. Gow.—Note respecting the course of the flexor longus digitorum pedis, by Dr. Sinclair White.—On the os centrale in the human carpus, by Prof. W. Gruber.

THE *Quarterly Journal of Microscopical Science* for October, 1883, contains:—Observations on the genus Pythium, by H. Marshall Ward, M.A. (plates 34 to 36).—On budding in Polyzoa, by Prof. A. C. Haddon, M.A. (plates 37, 38).—On the structure and relations of Tubipora, by Sydney J. Hickson, B.A., B.Sc. (plates 39, 40).—On the malleus of the Lacertilia and the malar and quadrate bones of the mammalia, by M. L. Dollo (plate 41).—Notes on Echinoderm morphology, No. 6; on the anatomical relations of the water-vascular system, by P. Herbert Carpenter, M.A.—Recent researches upon the origin of the sexual cells in hydroids, review by A. G. Bourne, B.Sc.—On the osteology and development of *Syngnathus peckianus* (Storer), by J. Playfair McMurrich, M.A. (plates 42, 43).

THE *American Journal of Science*, November, 1883.—Results of some months' examination of the spectra of sunspots with an instrument of high dispersion, by Prof. C. A. Young.—On the meteoric iron mass found by F. M. Anderson near Dalton, Whitfield County, Georgia, in 1879 (two illustrations), by Charles Upham Shepard, sen. The analysis gave iron 94·66, nickel 4·80, cobalt 0·34, with traces of phosphorus, chromium, and manganese.—Notice of some varieties of corundum recently found at Sungchang, Zanskar district, Western Himalayas, by the same author.—Phenomena of the Glacial and Champlain periods about the mouth of the Connecticut Valley, that is, in the New Haven region (two maps), by James D. Dana. The author concludes that two simultaneous movements existed in the glacier ice—a lower along the valley, an upper crossing it obliquely; that both transported drift material, and that on reaching Long Island Sound the lower changed its own direction of flow for that of the general glacier mass across the Sound and Long Island.—On a variety of descloizite from Zacatecas, Mexico, by Samuel L. Penfield.—On Hybocrinus, Hoplocrinus, and Bærocrinus (two illustrations), by Charles Wachsmuth and Frank Springer.—Note on Mr. Nipher's papers on the evolution of the American trotting horse (one illustration), by W. H. Pickering. The author holds that we may foretell the speed attained for a few years in advance, but not the ultimate s. eed, nor when it will be reached.—On the discovery of Utica slate graptolites on the west side of the Hudson River, a few miles north of Poughkeepsie, by Henry Booth.—On Becraft's Mountain, near Hudson, Columbia County, New York (one illustration), by William Morris Davis. After describing the district formations, and their relative and absolute positions, the author deals with the question of nonconformity between the Lower and Upper Silurian systems of the locality and the relations of these systems elsewhere. In another communication he discusses the question of nonconformity at Rondout, New York.—Notice of agricultural, botanical, and chemical results of experiments on the mixed herbage of permanent meadows, conducted for more than twenty years in succession on the same land, by D. P. Penhallow. The results are tabulated, and are valuable as showing the influence of different fertilisers upon the character of vegetation and the total produce.—Note on Mr. Backhouse's observations on physiological optics, by W. Le Conte Stevens.

Bulletin of the Belgian Académie Royale des Sciences, des Lettres, et des Beaux Arts, August 5, 1883.—Report on M. Gravis' anatomical researches on the vegetative organs and structure of the *Urtica dioica*, by MM. Ed. Morren and Gilkinet.—Report on M. Paul Albrecht's work on the pelvisternum of the Edentates, by MM. P. J. Van Beneden and Van Bambeke.—Note on a thunderbolt which fell near Gougnies on July 11, 1868, by M. D. Van Bastelaer.—Report on M. Delaey's steam engine of universal application, by M. Maus.—Remarks on some new fossils found in the Belgian Tertiary formations, by M. P. J. Van Beneden.—Note read to the Academy on presenting the two first parts of his work on the theory of the diurnal, annual, and secular movements of the axis of the globe, by M. F. Folie.—Observations on a recent note by M. P. J. Van Beneden, touching the discovery of the Bernissart fossil iguanodons, by M. E. Dupont.—Note on the influence of respiration on blood-pressure, by MM. Em. Legros and M. Griffé.—Report on M. G. Tiberghien's philosophic dissertation on time, by M. A. Le Roy.—Note on M. de Sonnaz's historical studies on the county of Savoy, by M. Rivier.—Communication on some autographs of Grétry, by M. Stanislas Bormans.

Archives Italiennes de Biologie, tome iv. fasc. 1, October 31, 1883, contains:—On the zoological station at Naples, by C. Emery.—On le charbon in birds, by E. Perroncito.—On a true diffused kidney in certain mollusca, by S. Trinchese.—On the optic lobes of birds, by J. Bellonci.—On the oscillations of the typhoid fever epidemic at Paris in connection with the rainfall and sewage of that city, by L. Pagliani.—On paraldehyde as antagonistic to strychnine, by V. Cervello.—On the active properties of *Nigella sativa*, by P. Pellacani.—On the genesis of Ptomaines, by F. Coppola.—Researches as to the poison of *Triton cristatus*, by A. Capparelli.—Embryological researches as to the mammalian kidney, by C. Emery.—Histological researches as to the nervous centres, by C. Golgi.—Obituary notices of P. Pacini, N. A. Pedicino, and Victor Colomiatti.

Zeitschrift für wissenschaftliche Zoologie, Bd. xxxix., Heft 1, September 28, 1883, contains:—Researches on the interstitial connective tissue in mollusca, by Dr. J. Brock (plates 1 to 4).—On the germinal layers of the tail end of *Lumbriculus variegatus*, with a contribution to the anatomy and history of this worm, by Dr. C. Bulow (plate 5).—On the histogenesis of the bones in Teleostei, by Carl Schmid-Monnard (plates 6 to 9).—Remarks concerning the blood lacunæ and the connective tissue in Najadæ and Mytilidæ, by W. Flemming.—Contributions to the histology of the Echinoderms, No. 1, the Holothuria (Pedata) and the nervous system of the Asteridæ, by Dr. Otto Hamann (plates 10 to 12).

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 15.—Sir John Lubbock, Bart., F.R.S., president, in the chair.—Messrs. Philip Crowley and J. Murray were elected Fellows of the Society.—Mr. Charles B. Plowright exhibited a young pear tree showing *Rœstelia cancellata*, Jacq., produced from *Podisoma sabinæ*, therefore supporting the observations of A. S. Œrsted in *Botaniska Notiser* for 1865; also examples of *Puccinia graminis* on wheat produced from Œcidium on *Mahonia aquifolia*; the Œcidiospores were sown June 2, 1883, the Uredospores were sown June 10, and the ripe *P. graminis* was gathered September 10, 1883. He likewise called attention to examples of *Œcidium rumicis* on *Rumex obtusifolius*, *R. hydrolapathum*, *R. conglomeratus*, and *Rheum officinale*, the same being produced from *Puccinia phragmitis*.—Prof. P. Martin Duncan showed a specimen of coral (*Desmophyllum crista-galli*) which had grown upon an electric telegraph cable off the shores of Spain; it possessed radicles, apparently due to the presence of a worm close beneath the base of the coral.—Mr. E. P. Ramsay exhibited a series of rare New Guinea birds, and Mr. R. B. Sharpe made remarks thereon.—Mr. T. Christy exhibited a fine living and healthy specimen of *Trevesia sundaica*, Miq. (the so-called *Gastonia palmata*), or probably a new species. This peculiar and handsome plant has rarely been seen in this country, and of late years almost been lost sight of.—Dr. J. Murie showed and made remarks on specimens of *Ascaris bicolor* from the living walrus at the Westminster Aquarium.—Mr. F. I. Warner drew attention to a series of specimens of *Orchis incarnata* from Hampshire.—A paper was read by Mr. A. W. Bennett, on the reproduction of the Zygnemaceæ, as a solution of the question, Is it a sexual character? De Bary twenty-five years ago, and since then Wittrock, have instanced what they have deemed sexual differences between the conjugating cells, though most later writers rather ignore essential physiological distinctions. Mr. Bennett has directed his investigations chiefly to the genera *Spirogyra* and *Zygnema*, and from these he supports the inference of the above-mentioned authors. He finds there is an appreciable difference of length and diameter in the conjugating cells, that deemed the female being the larger. The protoplasmic contents he also finds pass only in one direction, and change first commences in the chlorophyll bands of the supposed male cells, with accompanying contraction of the protoplasmic material. The genera *Mesocarpus*, *Staurospermum*, and the doubtful form *Craterospermum* have likewise been examined, and, though showing differences, yet on the whole substantiate the view above enunciated of cell sexuality.—There followed the reading of notes on the antennæ of the honey bee, by Mr. T. J. Briant, in which he describes the minute structure of the segments, the joints and certain rod and cone like organs, previously referred to by Dr. Braxton Hicks, of highly sensitive function.—A paper was read on the Japanese Languriidæ, their habits and external sexual characteristics, by Mr. G. Lewis. He remarks that a representative of the family has been found in Siberia, lat. 46° (*L. menetriesi*); there are none in Europe, and one is known from Egypt. Others inhabit the Malay Archipelago, Ceylon, and the American continent. The author infers from the geographical distribution of these beetles that they have emanated from a tropical area. Some in the imago state cling to the stems of brushwood; others sit on the leaves of the moist shade-loving plants in the forests, while still others frequent debris on hill sides. Their colours are all dull, their bodies elongate and not structurally adapted for boring. The sexes show peculiar differences in size, and monstrous enlargement and obliquity of the head, volume of tibia, &c.—A paper was read by Prof. P. Martin Duncan on the replacement of a true wall or theca by epitheca in some Serial Coralla, and on the importance of the structure in the growth of incrusting corals. After alluding to the discussions which have taken place regarding the value of epitheca in classification, the author states that one form of this structure is simply protective, and that another form is of high physiological value, for it replaces entirely the usual theca or wall. The anatomy of the hard structures of a Cœloria illustrates the second proposition, for the broad base is covered by an epitheca, within which is no wall or "plateau commun," the septa, remarkable nodular walls (described in detail), and the columellæ arise from the epitheca directly, and it limits the interseptal loculi inferiorly. In a Leptoria the the same replacement of a wall by epitheca is seen. In incrusting Porites and such Astræidæ as Leptastræa the majority of the corallites of the colony arise from this basal epithecate structure, and grow upwards, budding subsequently from their sides.

Royal Meteorological Society, November 21.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—The Earl of Dalhousie, K.T., T. H. Davis, D. C. Embleton, J. Hargreaves, and J. L. Lewington were elected Fellows of the Society.—The following papers were read:—Report on temperatures in two different patterns of Stevenson screens, by E. Mawley, F.R.Met.Soc. The screens employed were an ordinary Stevenson screen obtained from Casella, and a new Stevenson screen made in accordance with the recommendations of a committee appointed by the Council of the Society. The new screen is two inches wider and deeper than the old screen. It has also an upper sloping roof, and, at a little distance below, a flat, inner roof pierced with holes for ventilation; while the old screen has a single flat roof with only a narrow slit beneath on each side for ventilation. Observations were made during the three months July to September, and the results are given in the paper. From these it appears that the new screen is, of the two, slightly cooler and better ventilated, and retains the heat of the sun for a less time than the old screen; also, having a double roof and overlapping boards below, it is bettter suited for extreme climates.—On the storm which crossed the British Isles between September 1 and 3, 1883, and its track over the North Atlantic, by C. Harding, F.R.Met.Soc., of the Meteorological Office. This storm caused considerable havoc in the south-west and south of England, owing not only to its exceptional violence, but also to its occurrence before the completion of the harvest. The storm is traceable, in the first instance, to two centres of disturbance, one being first shown at about 450 miles to the south of Bermuda on August 26, and the other to the east of the Rocky Mountains on the 27th; these two disturbances afterwards merged on the 29th, at about 300 miles to the north of Bermuda, and formed one great and destructive gale, which continued to grow in violence as it crossed the Atlantic until it reached the coasts of the British Islands. The average speed at which this storm crossed the Atlantic was fully forty miles an hour, which is more than double the usual speed of storms which traverse that ocean.—On the influence of the moon on the height of the barometer within the tropics, by Robert Lawson, Inspector-General of Hospitals.—The great ice-storm of July 3, 1883, in North Lincolnshire, by J. Cordeaux. The direction of the storm was nearly south-east to north-west, and travelled from Caistor along the higher ridges of the hills to Barton-on-Humber. The storm commenced at about 9.20 p.m. with heavy drops of rain, and increased to a downpour, speedily followed, amidst the blaze of lightning and the constant roll of thunder, by the rush of hail, or rather lumps of ice. An eye witness remarked that they were not like hailstones, but "salt-cellars"; another that they resembled "ducks' eggs"; in fact they were solid lumps of ice of every shape and size, weighing from two to six ounces, and some were measured six inches in circumference. The injury done to the growing crops cannot be estimated at less than 20,000*l*.

Physical Society, November 24.—Prof. R. B. Clifton in the chair.—Prof. Reinold read a paper by Mr. J. W. Clark, on the purification of mercury by distillation in vacuo. The advantages of Mr. Clark's apparatus are—the small quantity of mercury in use at a time, and the fact that no auxiliary Sprengel pump is required. This is avoided by having a movable reservoir of mercury, on raising which the distiller is filled with mercury. The apparatus was described in detail, and illustrated by a figure. It is probable that zinc, cadmium, magnesium, &c., may be distilled and thus purified by the same apparatus.—Mr. A. P. Chattock then read a paper on a method of determining experimentally the constant of an electrodynamometer. In existing methods it is necessary to measure the areas of the coils, which is a difficult matter to do with a finished instrument; by the new method this is unnecessary. It depends on the accurate determination of the speed of the movable coil. Mr. Chattock exhibited an instrument whose constant had been determined by him in the laboratory of Prof. Foster, University College, with the assistance of Mr. Grant.—Prof. G. C. Foster then took the chair, and Prof. R. B. Clifton, president, read a paper on the measurement of the curvature of lenses. With very small lenses the spherometer cannot be used, and the author's method is based on the Newton's rings formed between the lens and a plane surface, or a curved surface of known radius. From the wave-length of the light employed in observing, and the diameter of a ring, the radius of curvature can be determined. He places the lens on a plane or curved surface under a microscope, and lights it by the sodium flame (wave-length 5892×10^{-7}); he measures the approximate diameters of two rings a distance apart (in practice the tenth and twentieth rings are found convenient), takes the difference of their squares, and divides it by the wave-length, and the number of rings in the gap between to find the radius of the lens. The formula is—

$$\rho^1 m \lambda = \left(x^2_{m+n} - x^2_n\right)$$

where x_{m+n} and x_n are the diameters of the nth and $(m + n)$th rings; λ is the wave-length of the light, and ρ^1 the radius of curvature of the lens. The method with proper care gives accurate results. Prof. Clifton has also used it to determine the refractive index of liquids in small quantities; Mr. Richardson having found it for water = 1·3335 by this method, which is usually correct to two places of decimals. It can also be used to determine if the lens is uniformly curved and spherical. Prof. Perry suggested that it might be also used to measure a surface without touching it, say the surface of a water drop, or a strip of glass when bent. In this way it might throw light on the laws of capillarity or bending.

MANCHESTER

Literary and Philosophical Society, October 2.—H. E. Roscoe, F.R.S., president, in the chair.—On the change produced in the motion of an oscillating rod by a heavy ring surrounding it, and attached to it by elastic cords, by James Bottomley, F.C.S.

October 16.—H. E. Roscoe, F.R.S., president, in the chair.—On the leaves of *Catha edulis*, by C. Schorlemmer, F.R.S.—Dr. Schuster, F.R.S., gave an account of meteoric dust, and exhibited some specimens found in Himalayan snow.—On the duality of physical forces, by James Rhodes, M.R.C.S.

October 30.—J. P. Joule, F.R.S., vice-president, in the chair.—On the action of water upon beds of rock salt, by Thomas Ward.

CAMBRIDGE

Philosophical Society, October 29.—On the structure of the cells of secretory glands, by Mr. J. W. Langley.—Note on the fibrin-ferment, by Messrs. A. S. Lea and J. R. Green.—On the structure of the epidermis of the ice-plant (*Mesembryanthemum crystallinum*), by Mr. M. C. Potter.—On the physiological significance of water-glands, by Mr. Walter Gardiner.

PARIS

Academy of Sciences, November 26.—M. Blanchard, president, in the chair.—On the treatment of plague-stricken swine by vaccination with the fatal virus itself in an attenuated form, by M. Pasteur and the late M Thuillier.—On the hydration of crotonic aldehyde, by M. Ad. Wurtz.—Propagation across the Indian and Atlantic Oceans of the great earthquake wave caused by the recent disturbances at Java, by M. de Lesseps. From the observations taken at Colon by the engineers engaged on the Panama Interoceanic Canal, the wave would appear to have made its way in about thirty hours from Java, round the Cape of Good Hope to the east coast of Central America.—Theoretical considerations on the action of floats kept in tow at divergent angles, by M. E. de Jonquières.—On the secular variation in the direction of the terrestrial magnetic force at Paris, by M. L. Descroix.—On the successive parthenogenetic reproduction of phylloxera for nine generations, and on the results obtained by various methods of treatment of vines attacked by phylloxera made by M. P. Boiteau.—Observations of the planets 233 and 234 at the Paris Observatory (equatorial of the west tower), by M. G. Bigourdan.—On a formula of M. Tisserand connected by the celestial mechanism, by M. O. Callandreau.—On the algebraic integration of linear equations, by M. H. Poincaré.—On an induction magnetic needle, by M. Mascart.—On the electric synchronism of two relative movements, and its application to the construction of a new electric compass, by M. Marcel Deprez.—A study of earth currents, by M. E. E. Blavier.—Measurement of the differences of potential of electric layers on the surface of two liquids in contact (four illustrations), by MM. E. Bichat and R. Blondlot.—Wave-lengths of the optical rays A and *a*, by M. W. de W. Abney.—Description of a micro-thermometer for gauging very slight variations of temperature, by M. F. Larroque.—Studies on the chemical action of light; decomposition of oxalic acid by the perchloride of iron (three illustrations), by M. G. Lemoine.—Dissociation of the anhydrous carbonate of ammonia caused by excess in one or other of its elements, by M. Isambert.—On the fusibility of salts; nitrates, by M. E. Maumené.—On hydronicotine and oxytrinicotine, by M. A. Étard.—On the relative velocity of the sensations of sight, hearing, and touch, by M. A. Bloch. This paper consists of three distinct parts, each dealing with the comparison of two sensations—(1) hearing and touch; (2) hearing and sight; (3) sight and touch. The author concludes that of the three sensations sight is the most rapid; then hearing, the transmission of which sensation lasts 1/72 of a second longer than that of sight; lastly, touch, the transmission of which takes 1/21 of a second more than sight.—On the nervous system and the classification of the Phyllodoceæ, a hitherto little-studied family of Annelidæ, by M. G. Pruvot.—On the axis of *Œnanthus crocata* and *fistulosa*, and on abnormal vegetable productions in general, by M. R. Gérard.—On the propagation of the earthquake waves caused by the late volcanic eruption at Java, by M. Bouquet de la Grye.—A contribution to the volcanic theory, by M. Stan. Meunier.

BERLIN

Physiological Society, November 9.—Dr. Friedländer two years ago had communicated to the Society how in eight different cases of genuine croupous pneumonia, which ended fatally on the disease reaching its height, he had constantly found in the lungs a micrococcus, mostly in the form of diplococcus, which seemed to be a characteristic of genuine pneumonia. Since then the cases of croupous pneumonia he had examined amounted to over fifty, and with but very few exceptions the same description of cocci had been found in all the lungs affected. The few cases in which pneumonic cocci failed to show themselves were regularly such in which death had set in after the eighth day of the disease, that is after the disease had finished its course. In all other kinds of pneumonia, such, for example, as follow in the train of typhus, or attack old persons, &c., diplococci did not appear. It was beyond doubt, therefore, that they were a characteristic of genuine croupous pneumonia alone. That micrococci had not been perceived by many observers in the case of genuine pneumonia was owing to the fact that it was difficult to make them visible in the tissues; for only when they were highly coloured while the surrounding tissue remained colourless did they become distinctly visible. To render them apparent it was of advantage to colour thin sections of the lungs with methylic-violet or gentian-blue, and then to apply a diluted solution of iodine by means of which the tissues which were at first also coloured would become clear and so bring out the strongly-coloured cocci. Quite recently two cases had been published in which pneumonic cocci had been found *intra vitam*—one case by Prof. Leyden, the other by Dr. Günther. The latter observer invariably found the cocci inclosed in a pale and sharply-defined envelope, which, on the application of colouring-matter, likewise became highly coloured. Cocci having in both the cases referred to been obtained by means of punction, and thus their presence in the fluid of the lungs demonstrated, Dr. Friedländer set himself also to examine the fluid of the lungs in the bodies of persons who had died from pneumonia, and found there large quantities of pneumonic cocci, which were particularly well adapted for examination, being in a free state. He was now in a position to prove that they all possessed envelopes, which, by their reactions (they came out most distinctly on being subjected to acids, and disappeared under distilled water or an alkali), appeared to consist of mucin, and to be very essential to the life and activity of the cocci. According to the experience acquired down to the present date, the pneumonic cocci were the only ones which possessed this kind of slimy capsule. The problem now presented was, by means of experiments in the way of cultivation and inoculation, to determine the distinguishing characteristics and the pathogenic nature of these cocci. This task Dr. Friedländer, in conjunction with Dr. Frobenius, had undertaken with positive results. According to the methods of Prof. Koch, the cocci taken from the lungs of persons who had died from genuine pneumonia were disseminated on stiffened gelatine (consisting of gelatine, an infusion of flesh and common salt). From these proceeded invariably and in all generations perfectly characteristic organisms distinguished from all other fungous products of cultivation by their peculiar nail-like shape. No other kind of micro-organism showed the same nail-like form under cultivation as did that taken from persons pneumonically affected who had died on the disease reaching its acme, and whose lungs were afterwards examined; nor did any other species of pneumonia ever yield this form of cultivated organism. Experiments in the way of inoculation had been made on mice, guinea-pigs, rabbits, and dogs. The mice were subjected to injections either of cultivated cocci which had been obtained by dissemination of fresh lung-fluid containing cocci. Almost all these mice died after twenty to twenty-eight hours, under symptoms of violent dyspnœa; and on a section being made, extensive pleurisy and pneumonia were observed in each case; in the blood, likewise, diplococci were found to be very abundant, as also in the pleural exudations and in the tissues of the lungs. Were the cocci thus found disseminated on gelatine, they then yielded the nail-like cultivated organisms already referred to, exactly in the same way as did the cocci of genuine pneumonia in the case of man. Were again these cultivated cocci injected into other mice, these mice died of pneumonia on the second day after the inoculation. If, however, the fluid containing cocci were heated to about 70° C. before being injected into the mice, it was thereby rendered inefficacious, and the mice received no harm from it. On the pleural cavity of the mice being examined, many cocci were indeed still found in the fluid, but when these were strewn on gelatine they either remained sterile or developed other than the nail-like cultivated organisms. Not only, however, by injection of pneumonic cocci through Pravaz's syringe could pneumonia be produced in mice, but likewise also by means of inhalation. If mice, shut up in a chest, were compelled to breathe an atmosphere saturated by means of a spray with pneumonic cocci, then did a number of the mice die under the same symptoms as followed injection, though in this case not till the fourth or fifth day after the operation: the blood in the lungs of those mice who had died from experimental genuine pneumonia also contained characteristic pneumonic cocci. The results obtained from analogous experiments in inoculation with guinea-pigs were less decisive. About a half of the guinea-pigs inoculated by means of injection of pneumonic cocci remained in a perfectly healthy state, showing that they were proof against cocci. The other half, however, perished of dyspnœa, and their blood, lungs, and pleural exudations were found to contain double micrococci, which being sown on gelatine produced the characteristic nail-like organisms, and on being injected gave rise to pneumonia in the creatures so inoculated. The same experiments were next tried on five dogs. Four of them remained unscathed, but one sickened and died of dyspnœa. On a postmortem being made, this last dog showed symptoms of pneumonia and the presence of the characteristic diplococci in its blood and lungs. In the four healthy dogs, on the other hand, the injected cocci had all suffered destruction. In the case of the rabbits the experiments in inoculation were wholly without effect. They showed themselves completely proof against pneumonic cocci, and the cocci injected into their lungs were, after a few days, no longer traceable. From the invariable discovery of diplococci in the lungs of bodies that had died of genuine pneumonia before the disease had run its full course, and from the experiments with cultivated cocci, as also by inoculation of mice, Dr. Friedländer drew the conclusion that the cocci found by him were the cause of the genuine croupous pneumonia which had also before been recognised as infectious. On a future occasion Dr. Friedländer will again take up this subject, so important both from a scientific and a practical point of view.

CONTENTS

THURSDAY, DECEMBER 13, 1883

PROFESSOR STOKES' WORKS

Mathematical and Physical Papers. By G. G. Stokes. (Cambridge University Press. Vol. I., 1880; Vol. II., 1883.)

THIS is the age of Reprints of the works of great living men, even in an hourly growing subject like Science. The pseudo-scientists have long been accustomed to galvanize into life again, for a few brief moments, their defunct prelections by collecting them in a volume with some catching title. But the real men of science are now building, during their life-time, each his *monumentum ære perennius, regalique situ Pyramidum altius.* Von Helmholtz and Kirchhoff have collected and reissued their scattered masterpieces. Clausius has joined one large series of his works into a connected treatise. At home Sir W. Thomson has given us a grand collection, *Electrostatics and Magnetism,* and the rest of his papers are to appear in a series of volumes, of which one is already before the public. But, heartily as we welcome all these splendid volumes, here is something at least as good as the best of them, and *much more imperatively required.*

There can be but one opinion as to the value of the collection before us, and (sad to say) also as to the absolute *necessity* for it. The Author, by common consent of all entitled to judge, takes front rank among living scientific men as experimenter as well as mathematician. But the greater part of his best work has hitherto been buried in the almost inaccessible volumes of the *Cambridge Philosophical Transactions,* in company with many other papers which deserve a much wider circulation than they have yet obtained. Stokes' well-deserved fame was thus practically secured by means of a mere fraction of his best work. And another inconvenience, which will *now* have some chance of being repaired, has arisen from the same cause. Science demands, at every instant, the solution of certain definite problems each suggested by the last-preceding advances :—and hosts of eager votaries are at work upon them. What is done as it were in a corner is thus sure to be done again :—done, even if not so well done; and this at the expense of unnecessary labour on the part of the second worker, who thus obtains the (temporary) award of the whole credit; while the entire process tends to the retardation of scientific progress.

The present publication will effect a very remarkable amount of transference of credit to the real author, from those who (without the possibility of suspicion of *mala fides*) are at present all but universally regarded as having won it. Two or three years ago, only, the subject for a Prize Essay in a Continental scientific society was *The nature of unpolarized, as distinguished from polarized, light.* But, all that science is even yet in a position to say, on this extremely curious subject, had been said by Stokes *thirty years ago* in the *Cambridge Philosophical Transactions.*

The malady, though grave, is simple, the cure easy. Every Society, whose Memoirs are worthy of appearing in print, ought to consider itself bound to disseminate them as widely as possible. Every University, every public library of any importance, alike in Europe and in America, should be regarded as a centre for such a purpose. The cost of the necessary additional copies should be regarded by a Society as a trifle compared with the priceless advantage of *placing* its own publications where they will be freely accessible to all who care to consult them.

And this altogether independent of the question of *exchange,* which can hardly be expected from a University, but which, in our own experience, is gladly (even eagerly) granted by almost every scientific Society worthy of the name.

Physical and Mathematical researches are the best record of the living intellectual progress of the day, and ought not to be made artificially scarce or dear. It is mere pandering to wealth and vanity which is displayed in advertisements such as "Impression strictly limited to 65 (numbered) copies. After these are printed, the type will be broken up (in presence of witnesses) and the plates destroyed."

Such advertisements are possible only in a world in which Sir Gorgius Midas, and others who have "struck ile," are the willing victims of those who prey on their selfishness, luxury, and ignorance. Education will, it is to be hoped, in time do away with such things.

To give anything like an adequate account of even one of the longer papers in these two volumes would require an entire article. And, when written, the account would in most cases be practically unintelligible to the general reader; while quite unnecessary for the student, who will of course prefer to repair to the fountain-head itself, now at last rendered easy of access.

Prof. Stokes has wisely chosen the chronological order, in arranging the contents of the volumes. Such a course involves, now and then, a little inconvenience to the reader; but this is much more than compensated for by the insight gained into the working of an original mind, which seems all along to have preferred a bold attack upon each more pressing scientific difficulty of the present, to attempts at smoothing the beginner's road into regions already well explored. When, however, Prof. Stokes does write an elementary article, he does it admirably. Witness his *Notes on Hydrodynamics,* especially that entitled *On Waves.*

Before that article appeared, an article as comprehensive as it is lucid, the subject was almost a forbidden one even to the best student, unless he were qualified to attack the formidable works of Laplace and Airy, or the still more formidable memoirs of Cauchy and Poisson. Here he finds at least the main points of this beautiful theory, disencumbered of all unnecessary complications, and put in a form intelligible to all who have acquired any right to meddle with it. It is quite impossible to tell how much real good may be done by even *one* article like this. Would there were more such! There are few, even of the most gifted men, who do not occasionally require extraneous assistance after the earlier stages of their progress :—all are the better for it, even in their maturer years.

The contents of these two volumes consist mainly, almost exclusively, of papers connected with the *Undulatory Theory of Light* or with *Hydrodynamics.* On the former subject at least, Stokes stands, without a living rival, the great authority. From the *Aberration of Light*, the *Constitution of the Luminiferous Ether*, the full explanation of the singular difficulties presented by *Newton's Rings*, to the grand theoretical and experimental treatise on the *Dynamical Theory of Diffraction*, we have a series of contributions to this branch of optics which, even allowing for improved modern surroundings, will bear comparison with the very best work of Newton, Huyghens, Young, or Fresnel in the same department.

Specially remarkable among the Hydrodynamical papers is that on *Oscillatory Waves*, to which a very important addition has been made in the reprint. The investigation of the "profile" of such a wave is here carried to a degree of approximation never before attempted.

Besides these *classes* of papers we have the very valuable treatise on *Friction of Fluids in Motion, and on the Equilibrium and Motion of Elastic Solids*. This was Stokes' early masterpiece, and it may truly be said to have revolutionized our knowledge on the subjects it treats. To mention only one point, though an exceedingly important one, it was here that for the first time was clearly shown the error of assuming any *necessary* relation between the rigidity and the compressibility of an elastic solid, such as had been arrived at from various points of view by the great Continental mathematicians of the earlier part of the present century.

Of the few purely mathematical papers in the present volumes the most important is the well-known examination of the *Critical Values of the Sums of Periodic Series*, a subject constantly forced on the physicist whenever he has to treat a case of discontinuity.

We need not say that the printing of these volumes is all that could be desired; the name of the Pitt Press is a sufficient guarantee. But the introduction, for the first time, of a *solidus* to save "spacing" and space in the printing of mathematical formulæ, was a bold step on the part of Prof. Stokes:—since amply justified by the testimony of the readers of the first of these volumes, and still more by its almost immediate adoption by thoroughly scientific as well as practical men, such as the Editors of what we still feel inclined to call by the well-known name of *Poggendorff's Annalen*.

P. G. TAIT

ROYAL ENGINEER PROFESSIONAL PAPERS

Professional Papers of the Corps of Royal Engineers. Edited by Major R. H. Vetch, R.E. Vol. VIII. 1882, 214 pp., 39 pl. (London: Stanford, 1883.)

SO many essays were contributed to these papers in 1882 that it was found necessary to publish two volumes for that year. This is a healthy sign of the interest taken by the Corps as a whole in their profession. Vol. VII. was devoted entirely to permanent fortification, a purely professional subject; whilst Vol. VIII. contains eleven papers, several of which are of general interest. This volume must have been an expensive one to get up, as it contains thirty-nine plates, some of them pretty large: the size and expense of the volume might have been considerably reduced if the contributors had prepared their plates in a more convenient shape; *e.g.* one plate, a mere genealogical table, and not really a large one (Appendix I.), has eight cross folds and one longitudinal one; this could easily have been much compressed.

Paper 3 is a careful and well got up study of the "Campaigns of Lord Lake against the Marattas," 1804-6 (92 pp., with nine plates), which will be read with interest by all students of military campaigns. A good illustration of the difficulty of ascertaining the truth about events of eighty years back occurs in the verification of the site of the "battle of Delhi" (1803); the supposed site is actually marked by a pillar with inscription; but, after careful collation of contemporary surveys and reports of marches, the author decides *against the site marked by the pillar*.

Paper 8 is an interesting account of the "Triangulation of Northern Afghanistan" carried out during the late war. It is worth notice here that the introduction of the heliograph into army signalling has thrown a difficulty in the way of the use of the heliotrope for survey (in the field), from the liability of confusing the signals; but there seems little doubt that in the future the army heliograph stations could be used for the survey, and be an assistance instead of a hindrance to the survey. The general result of the altitude observations has been to throw doubt on the efficiency of the aneroid, a result much to be regretted. The refraction, which in India is about ·067 of the contained arc, was found to amount to ·08 of the same in the Afghan hills; an unusual result, as refraction commonly decreases with altitude.

An interesting paper (No. 9), on "Organic Compounds in the Sun," by Capt. Abney (read in 1881), gives a popular *résumé* of the subject (up to 1881), ending with the author's spectroscopic researches showing the presence of hydrocarbons in the sun and probably in space itself; this last raises curious questions as to the constitution of the ether; can space be really full of hydrocarbons? This paper has suffered rather by the delay in publication.

Perhaps the most important (military) paper is No. 10, on "Railways for Military Communications in the Field." The author shows that the early attempts at introducing railways on field service all failed to be of much practical use from their unsuitability to the conditions, the first of which is lightness and portability of both rails and rolling-stock, and it is just herein that the English railways fail most, being amongst the heaviest in the world. A light railway largely used in the United States, which has been laid at the rate of four miles a day, is favourably mentioned. After recapitulating the various schemes which have been tried or proposed, the author gives his conclusions as to the conditions for a military railway; among the most important of these are that the gauge should be 2½ feet, the rails 10 lbs. per foot, and the line double. It is clearly impossible for any country to keep a *large* stock of railway plant specially for service: now it so happens that this 2½-foot gauge is already in use to some extent in Europe, so that the requisite plant could probably be obtained at short notice in Europe. In India, however, the metre-gauge is so largely in use that field railways in or near India will probably for many years perforce be of metre-gauge. The field railway laid for the use of the British army in South Afgahnistan (1879-80) is not mentioned; this railway was laid for a great length through a desert in hot weather at the rate of a mile a day.

The other papers in this volume are: No. 1, on "Provisional Fortification," a study of defensive works erected in a moderate time, and capable of extension and improvement, with examples from Adrianople and Tschataldscha. Paper 2, on "Graduated Arcs for Heavy Guns," contains an investigation of the errors in such arcs, and the mode of laying guns correctly, in spite of such errors. Papers 4 and 5 describe some blasting operations in Bermuda. Paper 6 describes bridges laid over the Cabul River during the war in 1879-80. Paper 7 is on "Railway Curves"; and Paper 11 contains "Tables of Ordnance Equipment." ALLAN CUNNINGHAM

OUR BOOK SHELF

Report on the Dyes and Tans of Bengal. By Hugh W. M'Cann. (Calcutta, 1883.)

THIS Report, which is issued under the direction of the Committee of the Bengal Economic Museum, originated in the efforts made by Mr. Thomas Wardle to collect information on the modes of dyeing the silks of India. This information was asked for so far back as 1875, and although the Indian Government were fully conscious of the importance of instituting an exhaustive inquiry upon the subject, it was not until 1880 that an instalment of the General Report was issued, and from this, for reasons which it is here unnecessary to enter into, the dyes of Bengal were omitted. Dr. M'Cann has doubtless done the best he could with the materials at his command, although there is a probability that the Report would have been fuller and more free from errors had it been possible to put together the information, which was mainly collected in 1875-77, at a time when the officers of the local governments and administrations through whom the information was obtained were still resident in their respective districts. As it is, the Report is avowedly incomplete, and in many points already out of date. The classification adopted is, in the main, the same as that already employed by Mr. Liotard in the Report on "Dyes of Indian Growth and Production" above referred to, but with the difference that Dr. M'Cann has preferred to give the methods of dyeing in connection with the accounts of the dye-stuffs themselves, instead of referring them to the fabrics which are dyed by them. The dyes are classed according to the colour they afford when used singly. One disadvantage of this arrangement is that some dye-stuffs which are used both alone and also in the preparation of compound colours are mentioned several times. Many of the dye-stuffs are called simply by their vernacular names, as they have not yet been botanically identified, and in many of the cases in which the scientific name of the specimen has been given there is nothing to show how it has been arrived at. In spite, however, of these imperfections, the Report adds considerably to our knowledge of the tinctorial resources of India, although it must be stated that owing to the delay in its compilation the original object of the inquiry has been in a great measure lost sight of. The primary object of the inquiry was, in fact, to obtain data upon which to base experiments with regard to the possibility of developing and improving methods of dyeing with native Indian dyes. Dr. M'Cann expresses the hope that this project may be revived. He is of opinion that among the vast number of Indian dyes there are many that might be developed into flourishing industries; but he is equally of opinion that this development will never take place through the native dyers themselves, who are content to follow the primitive methods handed down to them by their predecessors. Dr. M'Cann suggests that great results might follow if the Government would send out to India one or two trained chemists or scientific experts in dyeing to conduct experiments with the special object of developing native dyeing industries. The number of properly trained technical chemists already there is too small to hope for anything from them, nor is it likely that improvements will result from the private enterprise of European firms. As it seems nowadays the fashion to commend all such projects to the notice of the City Companies, it may not be out of place to draw the attention of the Worshipful Company of Dyers to the suggestion. T.

Lehrbuch der Vergleichenden Anatomie der Wirbelthiere. Von Prof. Dr. Robert Wiedersheim. Zweiter Theil. (Jena, 1883.)

WE have on a previous occasion (NATURE, vol. xxvi. p. 385) directed attention to the first part of Prof. Wiedersheim's text-book on the "Comparative Anatomy of the Vertebrata," which was published early in 1882. He has now, by the publication of the second part, completed the work, which forms a clearly printed and profusely illustrated volume of 906 pages, with 607 well executed woodcuts. The second part comprises a description of the alimentary, respiratory, circulatory, urinary, and generative organs of the Vertebrata, and the author tells us in his preface that the entire work represents the labour of six years. In his method of treating the anatomy of the viscera, described in this part, he has followed the same lines as in Part 1. The description of the modifications of each system of organs observed in the different classes of vertebrates is prefaced by a short chapter on the method of development of that system, and the subsequent description is then based on their developmental history. We can recommend the book as giving an excellent *résumé* of the subject written in a thoroughly scientific spirit.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Evolution of the Cetacea

IN the lecture by Prof. Flower "On Whales, Past and Present, and their Probable Origin," which appeared in your columns in June and July last, he contends for the evolution of these animals from the *Ungulata*, and points to the *Zeuglodons* of the older Tertiaries as predecessors of the *Balænoptera*, and as representing an intermediate stage in such evolution; and he insists on the absence of cetacean remains from any Mesozoic formations as strong evidence in support of this view.

I wish therefore to inquire whether Prof. Flower has considered the evidence afforded by *Palæocetus sedgwickii*, so named by Prof. H. G. Seeley from a set of anchylosed cervical vertebræ (one of which he figures), described by him in the *Geological Magazine* for February, 1865, p. 54.

Prof. Seeley states that the specimens were obtained from the boulder (chalky) clay near Ely, and that they were regarded both by the late Prof. Sedgwick and by himself as derived from either the Kimmeridge or the Oxford clay; and he quotes the opinion of Prof. Owen in the British Association reports, in his "British Fossil Mammals," and in his "Palæontology," that they belonged to an animal of the Dolphin group. Prof. Seeley himself regards this animal, for the reasons he assigns, as "not a cetacean of the Dolphin family, but a true whale, its affinity with the Balænoptera being, he says, singularly close"; and he concludes his description with a letter from a veteran student of the Cetacea, the late John Edward Gray, Keeper of the Zoological Department of the British Museum, who, after pointing out the characters in which the fossils agreed with, and those in which they differed from, *Balæna*, asserted that in those particular respects the animal to which the remains belonged agreed with a genus of whales which he had just described under the name of *Macleayius*, from a specimen in the Australian Museum in Sydney. Perhaps Prof. Flower regards these vertebræ as not those of a cetacean at all; but if he agrees with the authorities just named on that point, the case seems to resolve itself into this, viz. either this whale lived in Mesozoic times, or its remains have come from some Tertiary formation. If the former, and particularly if its age is, as regarded by Prof. Sedgwick and Prof. Seeley, Jurassic, Prof. Flower's hypothesis of the evolution of the Cetacea from the Ungulates is hardly probable, when we consider the known facts as to the development of that group during the Tertiary period, even if we allow for whatever weight *Stereognathus* may afford of an approach to an Ungulate type in Jurassic times. If the latter, and these remains came originally from some older Tertiary formation, it follows that such a formation has, though no traces of it are now to be found, once existed in the area between Ely and the eastern watershed of the Pennine, because the whole of the material of the clay in which the remains were found is made up of the wreck of formations from that area alone. SEARLES V. WOOD

Martlesham, near Woodbridge, December 6

"Cosmic Dust"

THE report on Baron Nordenskjöld's expedition to Greenland this year, recently given in NATURE, undoubtedly contains important results as to the physical geography of that country. Its statements, of course, will require a more detailed explanation than this preliminary report can give; one statement especially, on account of its significance, induces me to call the reader's attention to a fact which it will be necessary to take into consideration in discussing the question.

The statement is contained in the following words at the end of the article:—"I hope when this (viz. the dust found on the inland ice) has been exhaustively analysed, to be able to furnish fresh proofs in support of the theory that this deposit is, at all events partly, of cosmic origin, and thereby contribute further materials for the theory of the formation of the earth."

The fact to which I have alluded is this: Next to the observations furnished by travelling over the inland ice, it appears to me that an examination of the fresh and pure fragments of it from the very interior of the country, which are pushed out in the shape of icebergs, must give the best key to the solution of the problem. We know that the mass of which these bergs are fragments is formed of snow accumulated during hundreds of years, and it has taken hundreds of years for the ice thus formed in the central regions to travel to the seashore. Consequently the dust which during the lapse of centuries has fallen upon the surface of the glacier must have been mixed up with the snow, and thereby spread over or embedded in the chief mass that constitutes the bergs.

As to my own observations, I have always found the chief mass that constitutes the large bergs to exhibit the appearance of perfectly pure ice, only permeated with thin air-bubbles, and the earthy matters of the bergs distinctly confined to isolated dykes, layers, conglomerates, or even to entire smaller bergs issuing from certain fjords. But I confess that my attention never was directed to a more minute investigation of the chief berg ice, and still less to the problem here mentioned. I do not remember to have seen anything mentioned by my friends Steenstrup, Helland, and Hammer that could throw sufficient light upon this question. I therefore here present it to your readers who are experienced in Arctic researches and may feel inclined to communicate their opinions upon it.

Christiania, Norway, December 5 HENRY RINK

On the Incubation Period of Scientific Links

THE length of the dormant period during which a certain class of scientific discoveries has to remain unrecognised before they are made available is a subject that may form an interesting chapter in the history of science. I will cite one or two examples, in one of which I am personally interested, as illustrating my meaning, particularly as I think they will enable me to point out the cause of this strange anomaly at a time when so much attention is being given to original research, and yet which will leave the results of original research to lie dormant for years after they have been realised. As illustrating the fact that most important laws may remain for many years dormant, I have but to cite the law of Avogadro, which remained unnoticed for fifty years, until the investigations of Dumas proved it to be a most important aid in chemical research. The law of Dulong and Petit on the connection between the specific heat and the atomic weight of the elements had to pass through a dormant period of more than twenty years before it was resuscitated by the experiments of Regnault. More than forty years ago I announced a new law connecting the physiological reactions of inorganic substances with their isomorphous relations. This law, although founded on an extensive series of experiments, and since verified by the investigation of the action of the compounds of more than forty of the elements, has up to the present time remained entirely dormant, not having been noticed, as far as I am aware, by any writer on physiology. A French chemist, M. Rabuteau, has recently very cavalierly consigned it *aux baggages du passé*, apparently under the idea that it is a revival of the hypothesis that connected the action of poisons with the more or less acute angles of their crystals. Now, however, the important part played by these inorganic substances as physiological reagents is beginning to be recognised (see Ringer, *Journal of Physiology*, January and August, 1883; Brunton and Cash, *Proc. Roy. Soc.*, vol. xxxv.).

The question presents itself as to what there is peculiar in these laws which distinguishes them from those which find an immediate recognition by men of science. I think the distinction will be found in the fact that these hibernating laws generally form connecting links between two branches of science which had not, up to the time of the discovery of these laws, been of much mutual assistance. The law of Avogadro, for example, established a new link between chemistry and physics, and for its application the chemist had to be familiar with the manipulations required for the determination of the density of vapours and gases, a subject scarcely alluded to in treatises on chemistry at the beginning of the century. The law of Dulong and Petit forms another link between chemistry and physics, requiring for its verification methods which, at the time of its discovery, were almost exclusively in the hands of physicists. As for the law connecting the physiological action of a substance with its isomorphous relations, when it was first published the distance between chemistry and physiology was greater than that between physics and chemistry at the time of the discovery of Avogadro, and should the subject be already attracting the attention of physiologists, after a latent period of but forty-four years, this fact affords evidence that science is now advancing at a more rapid rate than formerly. The question is an interesting one as to the possibility of something being done to shorten the period during which these linking laws remain unrecognised. Offering, as they generally do, important aids for the advancement of science, it certainly is desirable that some means might be taken to prevent their being shelved amongst *les baggages du passé*, so that at some future period the whole subject has to be gone over *de novo*. In the case of physiological discoveries, it certainly would seem to be the duty of the Antivivisection Society to see that the many experiments which had been performed to verify them were made available, so that a great deal of vivisection might thus be avoided without the progress of science being retarded. JAMES BLAKE

San Francisco, November 13

Meteor

THIS afternoon, at 5.27 p.m., I observed here a meteor of great brilliancy, a note of which may be worth publishing. The moon, within three days of being full, was shining unclouded, and the western sky was still glowing with the fading tints of another gorgeous cloud-glow, when a bright light caused me to look up. It was due to a bright meteor a few degrees south of and below the moon. Its path was about 20° in length between south-east and south, inclined at an angle, roughly speaking, of 10° to the horizon, its mean altitude being probably 20°. Three minutes later, at 5.30 p.m., I heard a low, distant, rumbling sound, which was not improbably the report of its explosion.

G. M. WHIPPLE

Kew Observatory, Richmond, Surrey, December 11

Physical Society, November 10

UNDER the above heading in NATURE of Nov. 15, p. 71, I notice it is stated that I have found the velocity of sound in air to be about 320 metres per second. This is manifestly a misprint for 330 metres, but I should like to state that as far as my experiments have gone the value for free air is not determined, although 330·6, Regnault's value, is probably very nearly what my method would make it. D. J. BLAIKLEY

103, Iverson Road, West Hampstead, N.W., December 10

The Ophidian Genus "Simotes"

MY attention has just been drawn to a note by Mr. H. O. Forbes, published under the heading "The Genus Simotes of Snakes," in NATURE, vol. xxviii. p. 539, in which he states that, when describing a new species of *Simotes* discovered by him in Timor-Laut (*P.Z.S.* 1883) and which I observed was the first of the genus known to occur eastward of Java, I overlooked Krefft's *Simotes australis* from Port Curtis, described in *P.Z.S.* 1864. It is a well known fact, pointed out by Dr. Günther in 1865 (*Zool. Rec.* i.) and since admitted by Krefft himself ("The Snakes of Australia"), that *Simotes australis* is not a species of that innocuous genus, but belongs to a widely different family of *poisonous* snakes and to the genus *Brachyurophis*.

London, December 5 G. A. BOULENGER

THE REMARKABLE SUNSETS

WE have received the following further communications on this subject:—

HAVING been rather too persistently of late requested to explain both the why, and whence, and even the future influences, of the recent very red and brilliant sunsets, I gladly take the opportunity of addressing to NATURE the few remarks I have to make on the actual facts and their proximate causes.

In all truth the sunsets through the last week of November and first four or five days of December have been remarkably fine, and consecutively so numerous. But each one, in so far as I have observed, was but an intensification, and sometimes not much of that, of whatever goes to make up an ordinarily fine sunset, as customary to that season of the year and that direction of wind with its concomitant kind of clouds.

The season of the year not only causes the fiery show to last longer than at many other times but enables it to take place while pedestrians are still engaged in their constitutional afternoon walks in pleasant autumn temperature, and before they shut themselves up for the evening in their comfortable homes with artificial lights around them.

Some thirty years ago I used to spend every evening month after month, at the ordinary dinner hour of others, in the open air, watching for, and when seen making quick coloured drawings of, any exceptionally fine sunset; taking in this way three or four completely separate pictures on the same evening between the time of the sun vulgarly going down beneath the horizon, and at the last the stars coming out in the darkness after the last vestige of twilight or high illuminated cirrus-cloud had disappeared.

In this manner I came to know practically that the so-called after-glow, which has been alarming so many persons within the last few days, whenever the temporary disposition and arrangement of the clouds and vapour in the air allow it to appear, is always more richly coloured in reds of various kinds than any of the earlier glows and more luminous splendours; and that the number of modifications which any one sunset may go through, or the number of different pictures it may make up, according to changes in the clouds both above and below the horizon, is bewildering. But the grandest effects, the nearest approaches to the sublime, were always those when the general light in the air was either so faint, or so monochromatic, that the pigments in the colour box could not be distinguished one from another without the aid of artificial light.

On December 3 and 4 of this week, on setting myself to watch and note with my former apparatus, I found all these bizarre effects of colour and form in their old intensity and their old kaleidoscopic quickness of change. On the 3rd especially the reds were so powerful at certain times, and the air so clear between me and them, that the young crescent moon, though low down in the sky, shone by contrast to the scarlet cloudlets around it with a sort of supernatural lustre of blue silver; while the gas-lights under the same contrast, though in reality a gross beery brown in colour, appeared of a delicate sulphur, almost greenish, yellow. Those clouds, therefore, were so red in consequence of something that had happened to the sunlight illumining them which had not happened to that illumining the moon. What was it then? Simply that the lower atmosphere of the earth was so particularly clear of dust, haze, vapour, fogs, and positive obstructions of lower clouds that the sun, though at the time a long way below the horizon, was enabled to send its rays through an unusual length of atmospheric path without experiencing any other diminution than merely the specific elimination of those particular rays in its spectrum-quiver to which the atmosphere, in that particular condition, is antagonistic, leaving the field of glory to others alone.

Had the wind been *south*-west, the stoppage would have been chiefly amongst and of the red rays of light, where the black water-vapour lines are so numerous, chiefly below D, near C, and especially about the region of little "*a*," which then becomes of giant size. But the wind having been really *north*-west, the air was dry, water-vapour lines practically absent, and, as Col. Donnelly most correctly remarked in this week's NATURE (p. 132), the dry air band above D in the citron, and usually called the low sun band in meteorological spectroscopy, was at an immense maximum. Red light was therefore practically unimpeded, green and blue much interfered with, and more and more with every successive instant of further descent of the sun below the horizon. So thus it was that the spectroscope told at any instant through all the varied displays that that coloured light so much admired was simply sunlight that had passed through an extra length of extra-dry air, and was being reflected at the last from thin clouds at an extra height in the atmosphere, where water-vapour is always at a minimum.

But the sunset of December 5 was very different. In the course of the evening there were two or three distinct attempts, as it were, for the clouds to assume red hues, but they lasted for only a few seconds each; and though some aspects of the scene were very fine pictorially, it had to be classed as a "yellow sunset." Next day showed the cause of that in the wind below, as well as above, turning round to east of north. December 6 and 7 had poorer and poorer sunsets of both a yellow and sickly type, and December 8 with a south-west wind has brought in rain.

Thus seems to have ended for the time this fine series of Nature's evening pyrotechnic displays in the west (a similar set having also been witnessed during the mornings in the east); but demands are still made for an explanation of why, and to what end? If we should reply that, given a clear air, not too many clouds, and these high up in the atmosphere and with surfaces well constituted for reflection, the sunsets will always be fine; and that they will be varied exceedingly in their beauty even from moment to moment, according to the exquisite manner in which clouds and cloudlets of cirrus streamers form and dissolve and form again in all varieties of shape and size and density, according to mere temperature changes and other ordinary meteorological conditions of the air; that is not enough to satisfy the present temper of the public, who seem screwed up to a pitch of nervous alarm that what they have been seeing, though to them it has been like "music which gives delight and hurts not," may yet have something to do with the green and blue suns seen in India last September, and they with the great volcanic explosions in Java last August, so destructive of human life!

The said green and blue suns were, however, quite a different phenomenon to our red sunsets. For, instead of appearing extra bright and contrasted in colour with clouds near them, like the crescent moon of December 3 just mentioned, they were abnormally faint, and uniformly tinged with both clouds and fog, and moon and stars at night. Moreover, the spectroscope, in the able hands of Prof. Michie Smith of Madras College, showed that the intervening medium, through which the sun's light was struggling towards these Indian observers, was extra damp instead of extra dry. And in the west of India since then, as we have just heard from private sources, no less than 140 inches of rain have fallen, and the country was in a temporarily impassable condition from sloppy softness of soil.

Prof. Michie Smith has indeed entertained the idea that the particular state of the watery vapour which cut off so largely the red, but passed on the green light of the sun's spectrum in a weakened condition, may have been owing in some degree to particles of pumice dust from the Javan volcanoes. And such dust, once up in the air, may circulate around the earth, after the manner which Commander Maury, U.S.N., was so earnest in teaching with respect to the trade winds and their spiral paths through either hemisphere.

But how long such dust would remain suspended, how high it would rise, and when and where it would fall, are questions that can hardly be answered positively and with exactitude *a priori*. It did not fall, so far as we have heard, in India, where, if present at all, it must have been comparatively low and dense. And it was not falling here during the recent red sunsets, for the lower air was particularly clear, while the supposed criminating redness was too manifestly due to the extraordinary height, as well set forth by Prof. Helmholtz, of the uppermost cloud stratum, a thin kind of cirrus haze, according to my observation, combined with the discriminating action of the atmosphere on the compound coloured solar light.

Why that cloudhaze was so high, and whether dust, and if so what dust, had any part in its constitution, are questions which may worthily be discussed, but no very certain answers expected for years to come. But having been myself much struck during a rather long residence on the Peak of Teneriffe in 1856, with the general and apparently normal existence of dust strata in the atmosphere, higher or lower, but often far above the level of ordinary water-vapour clouds,—and as the meteoric researches of Prof. Newton, corroborated by Prof. C. A. Young, in America, show that not less than 100 tons of meteoric stones (of which the earth encounters nearly 3,000,000,000 in the course of a year) must be dissipated in our upper atmosphere on the average *every day*, as impalpable dust,—it seems more probable that Prof. Helmholtz's very high clouds, if they were assisted in putting in an appearance as clouds by dust of any kind, must have derived it from such disintegrated and sublimed meteor-masses coming down day by day in the regular way of nature from above, or outside, rather than from a supposed continued ascent of one particular charge of volcanic dust from Java, full three months after the cessation of all violent disturbance there.

In fact while it is to be earnestly hoped, as an outcome of the late remarkable sunsets, and the great numbers of the public by whom they have been witnessed,—that our painters will no longer be content to give us so generally mere afternoon pictures slightly yellow ochred and "light red"-ed near the horizon before the sun goes down, as sunsets,—but will more frequently paint the deep red afterglows at their richest;—it is equally desirable that our scientists should gauge the ordinary constitution of the atmosphere at much greater heights than those to which observatories are usually confined.

C. Piazzi Smyth,
Astronomer Royal for Scotland
15, Royal Terrace, Edinburgh, ♄ December 8

The following summary of atmospheric effects seen before sunrise and after sunset between November 25 and December 11 may be useful for comparison with phenomena observed in other parts of the world:—

November 24.—After sunset, yellowish-green striæ in west.

November 25.—Sunset in amorphous apparent cirro-stratus or cirrus haze. Green light above it, and bright greenish-white arc growing from about ten minutes after sunset; above the greenish-white, pale red. Lasted about forty-five minutes after sunset. The sky shone with a strange light somewhat as on November 9, but much feebler, and there was no sharply marked aggregation of cloudy reflecting material as then.

November 26.—Fine clear sunset, followed by phenomena like yesterday, but much stronger, and lasting nearly an hour bright red. No high clouds seen as light receded from the sky. A few rounded morsels of cumulus fringed with green against the red sky. Very strange effect, the greenish-white light in the west, and pink above.

November 27.—Sunset effect like yesterday, beginning to glow about fifteen minutes after sunset, and growing slowly in apparent brightness. Lasted till about 5.20. Slight, thin cirrus.

November 28.—Slight cirrus. Clear sunset. About twenty-five minutes after sunset green and pink glow began and grew bright and finely-coloured till about 4.40. Then slowly receded till about 5.10, when it disappeared, and was succeeded by a faint brass-coloured after-glow reaching high above the horizon. Time of sunset, 3.55.

November 29.—Extraordinary red glow, said to be seen in London from 5.30 to 7.30 a.m. Cloudy evening. At 4.55 a dull faint red glow observed through a small break in the clouds. Time of sunrise, 7.43.

November 30.—At 6.5 a.m. (and probably a few minutes before) a fine deep red glow in the east and overhead, where small quantities of cirro-cumuli seemed to be touched by the reflected light. At 6.15 a faint, deep red glow had spread from north-north-east to south-east, and up to about 40° above the horizon in the north-east, covering a vast portion of the sky. Then gradually became whiter and less striking. The blood-red band in darkness at 6.10 most remarkable. The glow continued (slowly changing in colour and growing in extent), and was evidently independent of ordinary clouds. The bright stars appeared through it. At 6.24 a faint red light extended to the zenith. At 6.40 the red had gone, and was replaced by a primrose colour, the flocks of cirro-cumuli, however, still remaining tipped with bright red, and retaining that colour till sunrise (7.44). There was no cirrus visible, and the reflecting haze was invisible both by night and in full daylight. The cirro-cumulus was moving moderately fast from west-north-west. The red bank in the east was not crowned with shafts of rays or prominences as in the sunsets of November 26, 27, and 28, but the intensity of the light diminished continuously upwards from near the horizon. The afternoon being cloudy, the only thing observed was a dull greenish light about half an hour after sunset.

December 1.—Sunrise cloudy. Sunset (3.53) in cloudy sky, except near horizon. At 4.25 slight tinge appeared on fringes of clouds overhead. Then densely clouded. At 5 the sky had cleared largely, and a fine amber light could now be seen from near the west horizon to about 40°. This gradually sank, following the sun, and grew less bright, finally disappearing about 5.35. Sky clear and starlight, except low strips of cloud near the horizon.

Centre of maximum brightness followed the sun, as usual. The light as it sank near the horizon was quite without definite outline or the ray shafts which appeared on previous evenings with a clear sky.

December 2.—Sunrise cloudy. Cloudy at sunset, but clouds partially clearing off. Thin fog on low ground. Bank of clouds in west. Sunset 3.53. At 4.20 faint amber glow above cloud-bank, growing in strength as darkness came on. At 4.10 the sky towards the zenith from the west was crossed by spokes of light as from the thinnest possible cirrus streaks, diverging from the sun's place as centre, and some of these nearly overhead became somewhat bent after a few minutes. The thin clouds scattered about evidently caught some light from a hidden source. At 5 p.m. the light was pale yellow, and had moved northwards. At 5.10 disappeared behind cloud-bank.

December 3.—Cloudy.

December 4.—Very fine and clear morning at 5 a.m. At 6.5 a.m. the first blush of red appeared over the plantation (about 400 yards off) due east, and by 6.10 was quite bright, like the reflection of a fire. It grew quickly upwards, and by 6.15 must have been 15° above the horizon. It appeared uniform and amorphous. By 6.30 the red had changed slowly to saffron, and being seen less in perspective, the colour seemed less concentrated. The reflecting material, or a part of it, was now seen to consist of ill-defined streaks and patches of very thin misty cloud of some sort, in which after long watching from suitable positions no motion could be detected, though distinct streaks nearly overhead were chosen. At 6.45 some of these streaks were illuminated nearly overhead southwards of a pale straw-colour and bluish white, and their outlines were distinct. Most of the streaks stretched about west-south-west to east-north-east, and towards the north-east the appearance was like a fretwork of the lightest wavy mist. From 6.30 to 6.50 the coloured arc was of a sickly yellowish green, with a pale pink towards the zenith and a rather ghastly steel-white glare below. At 6.53 a second glow much brighter than the first appeared in the east-south-east by south, of a deep red colour, quickly turning to orange. This glow was in a bank or arc much better defined than the first. At 7.10 it had turned quite yellow and had grown up many degrees. At 7.16 the last star disappeared in the bright light now cast on all objects towards the west, the clear sky as the light touched the thin high mist appearing progressively veiled with opaque cloud. Just before the advent of the second glow the thin cloudy streaks had nearly vanished into pure blue sky. At 7.12 the upper part of arc No. 2 was pinkish yellow, with a greenish-white centre below. At 7.20 the part below the arc and along the horizon south and north for some distance was a peculiar steely-bluish white, the lower part of the arc yellow, and the upper pink (at an altitude of about 50°). These effects slowly diminished, but the steely hue remained till sunrise. At 7.23 the sky overhead and towards the west was faint pink, with large billowy streaks and patches, without fibrous structure. In full daylight only faint traces of this cloudiness could be seen, but the rising sun, like the first and second glow, made it manifest. The sun rosé (7.50) of a red colour, but after about half an hour was pale bluish white, and surrounded by a silver-white glare. As the sun was setting (3.53), the high haze again appeared by reflection to cloud over the sky. Nothing otherwise very remarkable appeared till about 4.12, when it was evident the phenomenon would recur, the central spot above the sun's place being bright steel or lead colour, and the parts round it a metallic pink. This has been the usual preliminary. The sky in the east was rosy. The rose colour quickly passed over towards the west, and about 4.20 the whole sky between the west horizon and the zenith was flushed with red. At 4.25 or thereabouts the crescent moon appeared blue in this pink haze, but in a few minutes was left behind by it, and looked much as usual. The small, greasy scud from north was lighted up pink in the east against a deep blue and greenish sky. As the glow sank westwards, the sky above seemed perfectly clear. At 4.35 the light was very bright, and at 4.45 was lost to view behind low clouds. As soon as it approached the horizon, the sky again became streaked with the reflecting haze, which assumed a straw-coloured tint. This pale light sank westwards and disappeared soon after 5. The moon and stars gave no indication of a haze canopy.

December 5.—Exactly at 6.5 a.m. the first faint red blush grew up quickly from east-south-east, and in seven or eight minutes had increased largely in brightness and extent. The night was very fine and clear, and the soft, crimson glow hanging above the horizon in the darkness produced an interesting effect. It grew rapidly up towards the zenith, and at 6.18 formed an arc of which the highest point was about 40° above the horizon. After this it quickly changed to orange and yellow, and the colours went off. The arc was more southerly than yesterday, and the peculiar light reached from south-south-west to east-north-east. At 6.55 the second glow began, and rising up quickly, produced a fine red arc, less bright than yesterday's. At 7.6 the arc was olive-green below, yellow in the central, and pink in the outer parts, and hardly any cloudy structure could be discerned. What there was, however, resembled the film of yesterday. The upper edge of the glow was pretty well marked as it advanced, and at 7.12 it crossed the zenith and passed north-westwards, covering a bright star with a thin pink veil. This star remained visible till 7.21. After this the sky was pale yellow, and soon little remarkable remained, except the greenish light in the south-east. Sunrise 7.51; red sun, turning silvery white later. Sunset 3.50 in hazy striæ. Clear sky, except slight cirrus. At 4.15 yellow glow, which went through changes as usual. The light was pink overhead, and the margin passed the zenith about 4.26. At this moment it may be supposed the sun was sinking below the horizon at the altitude of the reflecting material. At 4.30 the moon looked blue in a pink haze. Spokes of rays from the glowing bank at 4.45. Some threatening cirro-stratus passed over at 4.45. Horizon misty. Crescent moon greenish all the evening.

December 6.—Sky very clear 6 a.m. First rose colour 6.10. Much fainter than previously. Second glow 6.58. Detached scud from 6.45 tinged with red on blue sky. Sunset clear, except small detached scud. The light in the west was fine, and went through changes, but was red from 4.20 to 5.5 p.m. The glow seemed to be reflected from some strips of apparent cirrus about 15° above the horizon. During all this time the small clouds scattered in all parts of the sky were of a pink colour against a greenish and later a deep blue sky.

December 7.—Cirrus streaks in west turned *black* against pinkish yellow glow, 4.24. Sun looked quite green through telescopic dark glass fifteen minutes before sunset.

December 11.—Fine sunrise and sunset phenomena, the secondary glow after sunset lasting till 5.33. Steel and pink halo from 12.45 p.m. Sky clear blue, at first glance, by night and full daylight, but, examined with light from below at a certain angle, seen to be quite covered with hazy billows or striæ, stretching away from north-north-east to south-south-west, very much higher than the cirrus present, and after long watching showing extremely slow tranverse motion from about west-north-west. Unlike cirrus fibres, whichever way looked at they appeared nearly parallel, without radiant point, even the lines just above the horizon showing their true direction almost exactly. Sun green through dark glass.

It seems pretty clear that the secondary light which has always succeeded the primary after sunset, and preceded it before sunrise, is due to reflection from the first when this is at a proper angle near the horizon. The interval between the same stages of the secondary and the primary before sunrise, when conditions are most favourable for accurate observation, is about fifty-on minutes, and the interval between the more conspicuous primary and the actual sunrise about fifty-six minutes. The first red colour of the primary glow may be caused by the incidence of the sun's first rays upon the material. It seems that the reflecting material directly overhead receives the sun's rays about thirty-nine minutes earlier at sunrise, and loses them as much later at sunset, than the surface of the earth. I have not found the colour effects in many cases to be subjective. A green cloud remains green when cut off from surrounding light. May not atmospheric sifting produce the surviving colour?

F. A. R. RUSSELL

THE Hon. A. P. Hensman, Attorney-General of West Australia, writes to me as follows, under date of Perth, West Australia, October 27:—"The captain of a ship lately engaged in a survey of our north-western coast at the time of the eruption in the Straits of Sunda told me that the deck was covered to a depth of an inch or more with a fine dust. We are having, and have had for many weeks, very remarkable sunsets. After the sun has set, a glow commences somewhat high up above the horizon, a brilliant rose-colour; this continues for nearly an hour, gradually descending to the horizon, and becoming deeper in colour. It has never been seen here before, and has given rise to much speculation amongst learned and unlearned, both here and in the other colonies; some suggesting that it is caused by the presence of volcanic dust in the atmosphere." This extract may be of interest to your readers, as showing that all over Australia similar phenomena have been observed to those discussed in your pages.

As I am engaged in making a comparative study of the dust which fell at different points during the Krakatoa eruption, I shall feel greatly obliged to any of your readers who can supply me with samples of such dust, accompanied by a note of the time and place of the fall.

JOHN W. JUDD

Science Schools, South Kensington, S.W., Dec. 8

THE uncommon phenomenon witnessed in various parts of India, Ceylon, and the Cape of Good Hope, has made its appearance here. The sun, immediately it sets behind the ridge of Possilipo, throws upwards a group of red rays somewhat irregular in arrangement; the sky begins then to assume a greenish tint. These rays soon disappear, and then the whole horizon for 180° is lit up by a bright orange-red light, which gradually deepens in tint. The height of this light does not usually extend above 25° or 30° at its centre, and gradually descends to the level of the horizon at its two extremities. So far as I can make out, the centre or most brilliant point of this is quite 20° more to the south than the setting sun. All the south-west sides of the houses are suddenly lit up by this peculiar lurid glare, which is best compared to the colour of incandescent iron, and reflected from the surface of the sea makes the gulf look like a veritable lake of molten lava. The effects last at the maximum only an hour after the setting of the sun. On Sunday last the moon, shining through this red glare, had a bluish tinge of the arc electric light colour. The same phenomena precede sunrise. These effects are quite independent of clouds, which, when present, have a deep lead colour, and their edges are not illuminated. The weather is cold, the wind variable, chiefly north or north-east. The magnetic instruments at the observatory show no disturbances, which excludes the possibility of an aurora, as also its presence *only* when the sun is just below the horizon. I send these notes, hoping they may be an addition to the other observations already published in NATURE, to aid in an explanation of this remarkable and widespread phenomenon.

H. J. JOHNSTON-LAVIS

Naples, December 6

SIR ADAM BITTLESTON presents his compliments to the Editor of NATURE and ventures to send him an extract from a letter written by Sir Adam's son at Umballa (lat. 30° N.) on October 30. There seems a long interval of time between the appearances at Ongole (September 10) and those noticed at Umballa.

87, Linden Gardens, Bayswater Road, W., December 10

Extract from a Letter from Lieut. G. H. Bittleston, R.H.A., dated Umballa, October 30, 1883

"There has been *for some time* a remarkable appearance in the sky every night. The sun goes down as usual and it gets nearly dark, and then a bright red and yellow and green and purple blaze comes in the sky and makes it lighter again. It is most uncanny, and makes one feel as if something out of the common was going to happen."

THE inclosed from the *Hawaiian Gazette*, October 3 may interest students of meteorology.

F. J. S.

"*Maui.*—With regard to the extraordinary sunsets, a correspondent in Wailuku writes:—'I do not know what kind of sunsets you are having in Honolulu, but here for some time past they have been most extraordinary. Fiery red, spreading a lurid glare over all the heavens, and producing a most weird effect.'

"*Kauai.*—The peculiar sunsets have been noticed and commented on by the Kauai people. No one has ventured on a theory here."

THE line of green suns is carried further west to Panama, where, according to the *Star and Herald*, the phenomenon was observed on September 2 and 3, and it is suggested to be in connection with Krakatoa.

HYDE CLARKE

32, St. George's Square, S.W., December 8

I SEND you a bottle of volcanic dust which Capt. Robert Williams of the bark *Arabella* obtained under the following circumstances. He says:—"On Tuesday morning, August 28, 1883, it commenced to rain something like sand (some of which I collected from off the decks), which kept on all this day and the next day. Lat. at noon of the 28th, 5° 37′ S., long. 88° 58′ E., wind light from the west-south-west, and calm at times. Java Head bearing east half south, distant about 970 miles." Can this shower be connected with the Java eruption?

Falmouth, December 6 HOWARD FOX

AS accuracy of observation is before all things desirable in the elucidation of natural phenomena, I hope you will allow me to point out an error into which some of our physicists appear to have fallen in connection with the green moon which was visible in the evenings of Tuesday and Wednesday of last week. Mr. Norman Lockyer, in his admirable article in the *Times* of Saturday last, refers to "the subjective colouring which cast a green glamour over moon and cloud if one did not take the precaution of preventing the eye being flooded by the rosy pink visible in the zenith long after sunset;" and a writer on recent solar phenomena in the *Daily News* says, "This latest phenomenon has caused a greater amount of astonishment than the earlier ones, but, unlike them, admits of very easy explanation, for a moment's reflection will show that on a pink background a white moon could scarcely appear anything but green," thus, like Mr. Lockyer, attributing the phenomenon to the presence of a complementary colour. What I wish to point out is that there is no foundation for this theory. I observed the effect most carefully on both evenings. On the second evening especially I looked with the object of ascertaining whether the effect was due to a complementary tint, and am thoroughly convinced it was not. At four o'clock, or a little after, the moon was distinctly green on a blue-gray sky-ground, with very thin gray cloud-drift floating over it. At the same time the whole of the western sky was lit up with a very pale whitish-yellow, to whieh neither blue nor green would be complementary. There was not a vestige of crimson or rose colour at that time in any part of the sky. Later, when the crimson supervened, the green tint of the moon was only very slightly intensified, so slightly indeed as to leave me still in doubt whether there was any change at all. It stands to reason, moreover, that if the result were due to the presence of crimson in the sky we should frequently see a green moon. Some other cause must therefore be sought in explanation of this new phenomenon. If we may accept Mr. Lockyer's conclusions with regard to volcanic action—and he certainly establishes a very strong case—the cause is not far to seek. It would be especially interesting to ascertain over how wide an area the effect was visible. Some records from observers at a distance would be very valuable.

Ealing, December 10 SYDNEY HODGES

P.S.—In quoting my letter to the *Standard* last week you gave a wrong name—Hooper instead of Hodges.

THERE is one point in connection with this subject to which much attention has not been given, namely, the increase of light, especially in the morning. Having slept out of town lately, I have been able to watch the sunrises, and to be exact I will describe in few words what occurred on Wednesday last, December 5. The eastern horizon is bounded by a hill some 50 feet high as seen from my house. At 6 a.m. I saw, rising in a semicircular form above the horizon, and tolerably defined in outline, a beautiful red coloration of the sky. The colour spread along the horizon in a westerly direction, and at 6.30 the entire vault of heaven was suffused with this red colour. When it was first noticed, namely at 6 o'clock, the light was sufficient to illumine the garden, as in the early morning in summer. At 6.15 the light was sufficiently strong to enable me to read the figures on my pocket-watch at the head of my bed, namely eighteen feet away from the window. The sun rose above the horizon at 8h. 5m., and at 10° farther west than the first burst of colour which I noticed. As the sun rose, the red colour disappeared, and it was entirely lost before the sun was fully in view. I am told by friends who were in Düsseldorf on November 30 that at 6 o'clock on that morning their rooms were lighted up so that everything was plainly visible. They at first supposed that the light was produced by a large fire opposite; but they soon discovered that it arose from this red light which you have now so well explained.

December 10 B. E. BRODHURST

NOT having noticed any letter in NATURE stating that the remarkable red glow seen in so many places after sunset was also observed in Ireland, perhaps you will permit me to mention that during the past fortnight, and especially since the 24th ult., it has attracted much attention here. This day week my steward insisted that the heather was on fire on the hills and that we were only watching its reflection. Since then the phenomenon has been even more remarkable, and the farm labourers have been enabled to remain at work in the fields ten to fifteen minutes later than usual. A bank of cloud generally separates the red glow from the horizon. Before sunrise the sky has sometimes a strange reddish look, and at 4 a.m. on the 29th ult. the brilliant roseate hue (referred to in the *Times* as having been seen in London at 5 a.m.) was witnessed here. RICHARD M. BARRINGTON

Fassaroe, Bray, Co. Wicklow, December 2

ACCORDING to a letter from my brother, dated Yokohama, September 22 last, the sun was completely obscured there two days after the earthquake took place in the Straits of Sunda. He writes:—"What a terrible earthquake that must have been in the Straits of Sunda. Incredible as it may appear, two days afterwards the sun here was completely obscured, and, on its reappearance, was quite *blood red*, while every now and then jets that looked like smoke passed across its disk. This lasted for two days," and he adds that "it is conjectured that this is caused by the volcanic smoke and ashes having been driven up here by the south-west monsoon."

32, Fenchurch Street, E.C., Dec. 8 W. HAMILTON

A FEW days since I was mentioning to my family that I remembered how splendid the colouring of the sky was at Malta after sunset in the year that "Graham's Island" appeared. In this morning's *Times* that island is alluded to, and I think you may be interested in the perusal of the accompanying pamphlet (printed for private circulation only). My father (Capt. Sir le Fleming Senhouse, K.C.H.), you will see, landed on the island, and named it after the then First Lord of the Admiralty. The great beauty of the sunsets we have been having have forcibly reminded me of the colouring I saw so many years since at Malta.

Hillside, Guildford, Dec. 8 ELIZABETH M. PITMAN

A correspondent sends the following:—

IT may interest your readers to know that in reference to the splendid sunsets we have seen in England lately I received in a letter from Lieut. C. K. Hope, R.N. (*en route* by inshore passage to the Cape of Good Hope) the following account of an extraordinary phenomenon witnessed by him on October 26 soon after crossing the equator:—"H.M.S. *Orontes*, October 26.—Last evening shortly after sunset the sky bearing from us between north-west and south-west suddenly burst into a red glowing light; the highest point attained an altitude of probably 35° or 40°, and from there tapered gradually away on both sides to the horizon. It showed brightest about 7.15, it being nearly dark at the time, and lasted till 7.30, gradually dying away till about 8 o'clock, when very little of it was left. I could have understood the phenomenon if we had been 40° further north or 20° further south, but on the edge of the tropics such a thing is very strange."

December 5

THE JAVA ERUPTIONS AND EARTHQUAKE WAVES

THE following communications have been sent us for publication by the Hydrographer of the Admiralty:—

Extract from a letter of Commander the Hon. Foley C. P. Vereker, of H.M.S. *Magpie*, dated Labuan Island, October 1, 1883:—

". . . The noise of the detonations caused by Mount Krakatoa, resembling distant, heavy cannonading, was distinctly heard by us and the inhabitants of this coast as far as Bangney Island on August 27. The weather at that time was also much unsettled, with thick hazy weather, and peculiar clouds to the southward, and the sun while at a low altitude assumed a greenish hue for several days. . . ."

Extract from a letter of Staff-Commander Coghlan, R.N.:—

"*Western Australia, Perth, September* 14, 1883.—This coast has been visited by waves and volcanic disturbances (sounds as of the firing of guns inland, &c.), apparently associated with the Sunda Strait outbreak.

"News is anxiously looked for from our north-west coast, as a wave 15 feet high, coming at high water, would lay Cossack, the mouth of De Grey River, Carnarvon (north of Gascoyne), and other places under water. In Champion Bay a wave rose 8 feet above the usual high-water mark. At Fremantle, King George's Sound, and along the south coast, a wave of less height was experienced

"The *Meda*, on our passage down from Ashburton River (when distant from 50 to 100 miles off the west coast of Australia, and about 1000 miles south-south-east of Sunda Strait), was visited by a shower of volcanic dust (in appearance like prepared "fuller's earth"), which fell some time between sunset of August 30 and sunrise of August 31, the wind being on-shore at the time.

"If the dust were associated with the disturbances in Sunda Strait of August 27 and 28, it must have travelled 1050 miles in three days."

BICENTENARY OF BACTERIA

[WE have received the two following communications on this subject:—ED.]

AT the present time, when so many anniversaries of great men and great events are celebrated, it seems opportune to remember that exactly two centuries have passed since a discovery of the greatest consequence was made in the Netherlands. In a letter dated September 14, 1683, from Delft, to Francis Aston, F.R.S., of London, Antony van Leeuwenhoek gives notice to the Royal Society that with the aid of his microscope he has discovered in the white substance adhering to his teeth very little animals moving in a very lively fashion ("animalcula admodum exigua jucundissimo modo sese moventia." "Arcana naturæ detecta," Delft, 1695: "Experimenta et Contemplationes," p. 42). *They were the first Bacteria the human eye ever saw.* Among them Leeuwenhoek distinguishes several species, the descriptions and drawings of which are so correct that we may easily recognise them. The rods, with rapid movement penetrating the water like fishes, are *Bacilli;* the smaller ones rotating on the top are *Bacterium;* one undulating species is *Vibrio rugula;* the parallel threads of unequal length but of equal breadth are *Leptothrix buccalis;* though motionless, they belong to the moving Bacilli. Leeuwenhoek wonders how, notwithstanding the scrupulous care with which he cleans his teeth, there could live more animalculæ in his mouth than men in all the provinces of the States-General. Some years later, not perceiving again the movements of the Bacteria between his teeth, he supposes he had killed them by taking hot coffee at breakfast; but very soon he discovers anew the old species, and the new drawings of Bacillus and Leptothrix which he sends to the Royal Society in the middle of September, 1692 (*l.c.*, p. 336) are still more accurate than those of 1683. They have not been surpassed till within the last ten years. It deserves our highest admiration that the first discoverer of the invisible world could already reach a limit which has never been overstepped, though the members of the Royal Society, when considering two hundred years ago the curious communications of the philosopher of Delft, may have scarcely foreseen that his astonishing discovery had opened to science a new path which only in our own days has led to the most important revelations about fermentation and disease. FERDINAND COHN

Breslau, November 27

IT cannot be a matter of indifference to English men of science, and especially to the Fellows of the Royal Society, that the bicentenary of the discovery of those immensely important agents of putrefaction, fermentation, and disease, the Bacteria, is at hand.

It was to the Royal Society of London that Antony van Leeuwenhoek communicated his discovery, and we may be sure that neither he nor the Royal Society of that day anticipated the extraordinary interest which would attach itself in two centuries' time to the organisms discovered by the patient and accurate student of minute life.

Leeuwenhoek's "discovery" is a remarkable example of that unexpected giving of rich gifts to future generations of men which marks the progress of scientific research in all its branches. It is for the Royal Society to devise some means of celebrating this bicentenary in such a fashion as to use the great interest and even fascination which Bacteria have at this moment for the English public, so as to excite sympathy with pure and unremunerative scientific research. Antony van Leeuwenhoek is the type of the single-minded student of living structures. The investigation of the properties and life-history of Bacteria, although commenced by him two hundred years ago, is still in its infancy. Schwann, Pasteur, Lister, Cohn, Nägeli, and Koch have brought us within the last fifty years far beyond Leeuwenhoek's first discovery, but a hundred such men are needed to carry on the work of discovery. Who will employ them? Are we to wait two centuries more for knowledge about Bacteria which lies, as it were, ready to our hands, waiting to be picked up? knowledge which will probably save many thousands of lives annually—if we may judge by the results already attained by the discovery of the relation of Bacteria to the suppuration of wounds and to the production of diseases.

The Royal Society could not better celebrate the bicentenary of its Dutch correspondent's discovery than by taking steps to urge on the English Government the expenditure of ample funds upon a new and vigorous prosecution of the study of the relations of Bacteria to disease, in fact upon the foundation of a national laboratory of hygiene. L.

THE UPPER CURRENTS OF THE ATMOSPHERE

ALL winds are caused directly by differences of atmospheric pressure, just in the same way that the flow of rivers is caused by differences of level; the motion of the air and that of the water being equally referable to gravitation. The wind blows from a region of higher towards a region of lower pressure, or from where there is a surplus to where there is a deficiency of air. Every isobaric map, showing the distribution of the mass of the atmosphere over any portion of the earth's surface, indicates a disturbance more or less considerable of atmospheric equilibrium, together with general movements of the atmosphere from regions of high pressure towards and in upon low-pressure areas. All observation shows, further, that the prevailing winds of any region at any season are merely the expression of the atmospheric movements which result from the disturbance of the equilibrium of the atmosphere shown by the isobaric maps as prevailing at that season and over that region. All observation shows, in a manner equally clear and uniform, that the wind does not blow directly from the region of high towards that of low pressure, but that, in the northern hemisphere, the region of lowest pressure is to the left hand of the direction towards which the wind blows, and in the southern hemisphere to the right of it. This direction of the wind in respect of the distribution of the pressure is known as Buys Ballot's Law of the Winds, according to which the angle formed by a line drawn to the centre of lowest pressure from the observer's position, and a line drawn in the direction of the wind is not a right angle, but an angle of from 60° to 80°. This law absolutely holds good for all heights up to the greatest height in the atmosphere at which there are a sufficient number of stations for drawing the isobarics for that height; and the proof from the whole field of observation is so uniform and complete that it cannot admit of any reasonable doubt that the same law holds good for all heights of the atmosphere.

In low latitudes, at great elevations, atmospheric pressure is greater than it is in higher latitudes at the same height, for the obvious reason that owing to the lower temperature of higher latitudes the air is more condensed in the lower strata, thus leaving a less pressure of air at great heights. It follows that the steepest barometric gradients for the upper currents of the atmosphere will be formed during the coldest months of the year. At Bogota, 8727 feet in height, where the temperature is nearly uniform throughout the year, the mean pressure for January and July are 22·048 and 22·058 inches. On the other hand, at Mount Washington, 6285 feet high, where the January and July mean temperatures are 6°·4 and 48°·2, the mean pressures for the same months are 23·392 and 23·875 inches. Similarly at Pike's Peak, 14,151 feet high, the mean temperatures are 3°·1, and 39°·7, and the mean pressures 17·493 and 18·069 inches; and since the sea-level pressures in the region of Pike's Peak are nearly 0·500 inch higher in January than in July, it follows that the lowering of the pressure on the top of Pike's Peak due to the lower temperature of January is upwards of 1·000 inch. From the greatly steeper barometric gradients thus formed for upper currents during the cold months of the year from equatorial to polar regions, these currents attain their maximum strength in winter and converge upon those regions of the earth where the mean temperature is lowest.

As is now well known, atmospheric pressure in summer is lowest in the central regions of the continents of Asia, Africa, and America; and highest in the Atlantic between Africa and the United States, and in the Pacific between the United States and Japan, the absolutely lowest being in Asia, where temperature is relatively highest with respect to the regions immediately surrounding, and absolutely lowest in the Atlantic, which is most completely surrounded with highly-heated continental lands. Again, in winter the lowest atmospheric pressures are found in the north of the Atlantic and Pacific Oceans, where temperature is relatively highest, latitude for latitude; and the highest pressures towards the centres of the continents, some distance to southward of the regions where at this season abnormally low temperatures are lowest.

The causes which bring about an unequal distribution of the mass of the atmosphere are the temperature and the moisture considered with respect to the geographical distribution of land and water. Owing to the different relations of land and water to temperature, the summer temperature of continents much exceeds that of the ocean in the same latitudes; and hence results the abnormally high temperature of the interior of Asia, Africa, America, and Australia during their respective summers, in consequence of which the air becoming specifically lighter ascends in enormous columns thousands of miles in diameter. Winds from the ocean set in all round to take the place of the air thus removed, raising the rainfall to the annual maximum, and still further diminishing the atmospheric pressure. On the other hand, since in winter the temperature of the continents and their atmosphere falls abnormally low, the air becomes more condensed in the lower strata, and pressure is thereby diminished in the upper regions over the continents. Upper currents set in all round upon the continents, and thus the sea-level pressures become still further increased. Hence the absolutely highest mean pressure occurring anywhere on the globe at any season, about 30·500 inches, occurs in Africa in the depth of winter.

Now observation conclusively proves that from the region of high pressure in the interior of Asia in winter, from the region of high pressure in the Atlantic in summer, and from all other regions of high pressure, the winds blow outwards in all directions; and that towards the region of low pressure in Asia in summer, towards the region of low pressure in the north of the Atlantic in winter, and towards all other regions of low pressure, whenever and wherever they occur, the winds blow in an in-moving spiral course.

Since enormous masses of air are in this way poured into the region where pressure is low without increasing that pressure, and enormous masses of air flow out of the region where pressure is high without diminishing that pressure, it is simply a necessary inference to conclude that the masses of air poured all round into the region of low normal pressure do not accumulate over that region, but must somehow escape away into other regions; and that the masses of air which flow outwards on all sides from the region of high normal pressure must have their place taken by fresh accessions of air poured in from above. Keeping in view the law of the barometric gradient as applicable to all heights of the atmosphere, it is evident that the ascending current from a low-pressure area, the air composing which is relatively warm and moist, will continue its ascent till a height is reached at which the pressure of the air of the current equals or just falls short of the pressure over the surrounding regions at that high level. On reaching this height, the air, being no longer buoyed up by a greater specific levity than that of the surrounding air, ceases to ascend, and thereafter spreads itself horizontally as upper currents towards those regions which offer the least resistance to it. The overflow of the upper currents is thus in the direction of those regions where pressure at the time is least, and this again we have seen to be towards and over that region or those regions the air of which in the lower strata of the atmosphere is colder and drier than that of surrounding regions.

The broad conclusion is this: the winds on the surface of the globe are indicated by the isobaric lines showing the distribution of the mass of the earth's atmosphere near the surface, the direction of the wind being from regions where pressure is high towards regions where pressure is low, in accordance with Buys Ballot's law. On the other hand, the low-pressure regions, such as the belt of calms in equatorial regions, the interior of Asia in summer, and the north of the Atlantic and Pacific in winter, with their ascending currents, and relatively higher pressure at great heights as compared with surrounding regions, point out the sources or fountains whence the upper currents flow. From these sources the upper currents spread themselves and flow towards and over those parts of the earth where pressure is relatively low. These directions are, speaking generally, from equatorial to polar regions; but more particularly towards and over those more restricted regions where in the lower strata of the atmosphere the air is colder and drier than in neighbouring regions, such as the Atlantic between the United States and Africa in summer, and Central Asia in winter.

This view of the general movements of the upper currents of the atmosphere is in accordance with the observations which have been made in different parts of the globe on the motions of the cirrus cloud, and with observations of the directions in which ashes from volcanoes have been carried by these upper currents. In further corroboration of the same views, reference may be made to the researches made in recent years, particularly by Prof. Hildebrandsson and Clement Ley, into the upper currents of the atmosphere, based on observations of the movements of the cirrus cloud in their relation to the cyclones and anticyclones of north-western Europe.

An important bearing of cyclonic and anticyclonic areas on the distribution of temperature may be here referred to. The temperature is abnormally raised on the east side of cyclonic areas and abnormally depressed on their west sides; but, on the other hand, temperature is abnormally raised on the west sides of anticyclonic areas, and depressed on their east sides—the directions being reversed in the southern hemisphere.[1] Since the temperature is lower in the rear than in the front of a cyclone, it follows that, relatively to the sea-level pressures, pressure will be lower in the upper regions in the rear of a cyclone than in front of it, a result which the Ben Nevis observa-

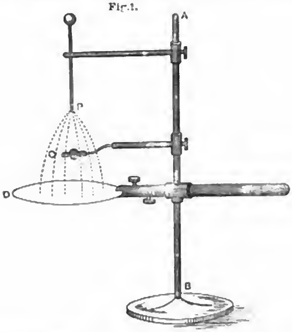
[1] See "Reviews of Weather Maps of the United States," *Nature*, vols xxi., xxii., and xxiii.

tions strongly confirm. Hence relatively warmer and moister upper currents will flow backward over the colder and drier air immediately in the rear of the centres of cyclones; and upper currents also presenting contrasts of temperature and vapour will overlap the outskirts of anticyclones. These considerations suggest how very diverse interpretations of the movements of the cirrus cloud in their relation to cyclones and anticylones have originated, and may also indicate lines of research into some of the more striking optical scenic displays of the atmosphere.

ELECTRIC SHADOWS

THE brilliant researches of Crookes upon the electric discharges in highly attenuated vacua, which some four years ago culminated in the discovery of the phenomena of "radiant matter," revealed, amongst other singular and curious effects, the existence of electric shadows. In the tubes employed by Crookes, wherein the rarefaction had been carried to millionths of the normal air pressure, objects cut out in sheets of metal or other good conductors of electricity were found to cast shadows against the glimmering surfaces of the glass

Fig. 1.



when interposed in the path of the discharge. The deflection of these shadows by the magnet was also observed by Crookes. About eighteen months afterwards some analogous phenomena were observed and described by Prof. W. Holtz of Berlin; the main difference between the phenomena observed by Crookes and by Holtz being that in the experiments of the latter the shadows were obtained at the ordinary pressure of the air by means of the discharge from a Holtz's influence machine. Of these researches some account was given at the time in NATURE (vol. xxiv. p. 130) by the writer of this article. It will be sufficient here to recall the more salient points. In the place of the usual discharging knobs of the Holtz machine were fixed a wooden disk covered with silk on the one side, and a metallic point on the other. The discharge from the latter causes the surface of the former to assume a faint, phosphorescent glow, visible only in complete darkness; and on this faintly illuminated surface shadows were cast when conducting bodies—such, for example, as crosses or rings cut from thin brass or foil, strips of damp cardboard, wires, and other similar objects. It was also noticed by Holtz that these shadow-figures could be temporarily fixed by dusting upon them some fine powder, such as lycopodium. In preparing the notice of these researches for NATURE in 1881, I made the following remark:—"These dust-figures have an obvious relation with those obtained by Wiedemann from the discharge of Leyden jars through a pointed conductor against the surfaces of various bodies. It would be interesting to ascertain whether by this process also shadow-figures can be produced." The suggestion then thrown out has not been lost, for during the current year a memoir has appeared on the subject of electric shadows from the pen of Prof. Augusto Righi, of Padua, giving

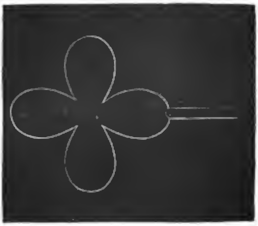


Fig. 2.

the results of an investigation of shadows produced by this very method. I propose to give here a *résumé* of the phenomena observed by Righi.

Righi discusses in an introductory way the suggestion of Crookes as to the relation between the length of the mean free path of the molecules and the distance to which the "radiant" discharge can be traced from the electrode. He observes that even in cases where the mean free path (as determined by the temperature of the

Fig. 3.

gas) be very short, as in air at ordinary pressure, the motion of the gaseous molecules as a whole may yet be in nearly straight lines of considerable length, owing to the fact that the electric force in the space where discharge is taking place will necessarily tend to urge an electrified molecule along the lines of electric force, and will act in the same direction whether the charge on any single molecule remain upon it or whether it be shared with other molecules against which it may impinge in its flight. The only question was whether the velocity impressed by the electric action could be made relatively sufficiently great. This depended upon the magnitude of the electric density at the surface of the electrified body, and for this reason Righi used a very sharp point for the discharge. Fig. 1 shows the arrangements for obtaining the electric shadows by Righi's process. A B is an ordinary retort-stand of iron, and upon it are clamped three adjustable arms of ebonite. The uppermost of these carries a short metal rod, pointed below and terminated above in a metal ball. The intermediate support carries the object, C, which is to cast the shadow. The lowermost arm is fashioned as a clip in which can be held a disk, D, to receive the shadows. This disk is preferably of ebonite backed on its under side with brass or tinfoil. In certain cases a metal disk varnished on the upper surface is used. Fig. 2 shows a favourite form of object for casting a shadow—a floral or cruciform design cut from thin metal and mounted on a stem of ebonite or glass. To produce the shadow-figures a Leyden jar is charged to such a potential as to be able to yield a spark of 1 to 2 centimetres' length. The outer coating is put in communication with the lower surface of the disk D, and the knob of the jar communicating with its inner coating is then brought into contact with the top of the pointed rod. The jar discharges itself rapidly and almost noiselessly. Then there is immediately sifted over the disk, from a box covered with muslin, some mixed powders of minium and flowers of sulphur, in the usual manner of

Fig. 4

procuring Lichtenberg's figures. A shadow of the interposed object is at once revealed by the powders. If the discharge has been a positive one, the shadow of the cross will appear in red surrounded by a neutral region, outside which there will be a region tinted yellow with sulphur. The colours will be reversed with a negative discharge. The shadow is depicted in Fig. 3. The size of the shadow varies with the distance of the object. Righi recommends that the object should be three centimetres above the disk, and the point twelve centimetres, or less, above the object. The lines of discharge appear to be hyperbolic in form. If a disk of ebonite only be placed at D, and the brass disk below it be lowered down, the effects are less distinct. If a narrow strip of foil or thin brass be placed below the ebonite disk, the shadow becomes compressed laterally and shows itself only on the region over the strip, and takes the form shown in Fig. 4. Similar shadows can be obtained according to Righi, on metallic disks covered with non-conducting varnish, but in this case by the use, not of the Leyden jar, but of an influence machine. This method is identical with one of Holtz's suggestion. Righi also finds that if the metal disk be previously coated with a conducting powder, such as finest zinc filings, minium, or even powdered glass, a shadow can be obtained. This method affords indeed very sharp shadows, so that thin wires and even wire gauze can be projected in shadow on the disk. Righi has gone still further, and by substituting a sensitive gelatino-bromide plate, has photographed the shadows produced during a five or ten minutes' discharge. In this experiment two figures showed themselves: one, the genuine electric shadow; the other, the genuine photographic shadow cast by the opaque object under the faint star of light emanating from the electrified point above.

If the object whose shadow is to be thus obtained is itself electrified, a curious effect is observed. If it be electrified with a charge of the same sign as that of the point above it, the shadow swells out. If electrified with a charge of opposite sign, the shadow becomes attenuated. Connecting the object to earth has the same effect as in the latter case. The presence of an electrified body on the right or left of the region in which the discharge is taking place has the effect of causing the shadow to be displaced. In fact the presence of such a body alters the equipotential surfaces, and therefore alters the lines of electric force in the field. If the discharge takes place through two points placed side by side at a short distance apart over two objects respectively beneath them, the two electric shadows are mutually repelled from the positions where their geometrical shadows lie. Similar observations of electrostatic influence were made two years ago by Messrs. Fine and Magie of Princetown, New Jersey.

Much as has been done of late years, especially by the late Mr. Spottiswoode in conjunction with Mr. J. F. Moulton, by Drs. De La Rue and Hugo Müller, by Crookes, by Goldstein, and others, to elucidate the phenomena of electric discharges, there probably still remains much to be discovered, and to be explained. The phenomena of electric shadows are amongst the matters best worthy of study in this rapidly progressing department of science. SILVANUS P. THOMPSON

NOTES

WE give this week a further instalment of notices of the strange coloured effects recently observed in the skies, and our readers in all parts of the world will render a service if they will communicate any similar facts they may have observed, giving, as far as possible, accurate dates. In an article in Saturday's *Times*, Mr. Norman Lockyer shows that the body of evidence already to hand connects them with the eruption of Krakatoa but, to place the matter beyond doubt, further information is required. The study of direction and of dates, and the facts touching the variation in the phenomena from August to December, all point in the same direction.

No one will be surprised, though all must regret, that his state of health and advanced years have compelled Prof. Owen to resign his appointment as Superintendent of the Natural History Department of the British Museum. Prof. Owen's preeminent services to science, pure and applied, are too well known to require recapitulation in these columns, especially as very recently we referred to them in detail in connection with his portrait as one of our "Scientific Worthies." Advanced in years as he is, the venerable naturalist's interest in science seems as strong as ever; to each of the last two meetings of the Royal Society he contributed an important paper: we hope they will be by no means the last of such contributions.

WE learn with the greatest pleasure that Prof. Sylvester has been appointed to succeed the late Prof. Henry Smith in the Savilian Chair of Geometry at Oxford. No more worthy successor to the late Savilian Professor could have been found, and it is satisfactory to know that at last the services of one of our greatest living mathematicians have been permanently secured for his native country.

THE ceremony of distributing the prizes to the successful students of the Finsbury Technical College and the South London Technical Art School took place on Monday evening in the Hall of the Clothworkers' Company, Mincing Lane. The Lord Mayor presided, supported by the President of the Royal Society, the Sheriffs, Sir

F. Bramwell, Sir F. Abel, the newly-elected chairman of the Society of Arts, and a large number of gentlemen interested in promoting technical education, the hall being filled with students. The prizes were delivered by Prof. Huxley, who afterwards gave an address. After speaking of the progress in technical education which had been made since 1877, and speaking in high terms of the system pursued at the Finsbury Technical College, Prof. Huxley said that all his life he had been trying to persuade people that if they wanted to teach physical science it was no use to attempt to proceed by filling the minds of the students with general propositions which they did not understand, from which they were to deduce details which they comprehended still less. If they went to the Exhibition Road, South Kensington, they would see a very splendid pile of buildings which had already cost 75,000*l.*, and which he sincerely trusted would cost a very great deal more. That building was the mere bricks and stones of the Central Institute, and the business upon which Sir Frederick Bramwell, the Chairman of the Committee, he (Prof. Huxley), and his colleagues had lately been so largely occupied was making a soul for this body. It was an immensely difficult operation, as they were always in danger, like Frankenstein in the story, of making something which would eventually devour them instead of being useful to them. Their great anxiety had been to make it good and useful, so that the great scheme of technical education might be thoroughly carried into effect. He was perfectly sure that they had in the system of technological examination, and in such institutions as Finsbury College, the Kennington School, and the Central Institution, something which would most indubitably be the nucleus of a vast growth of similar organisations. He had not the smallest doubt that, before this generation had passed away, instead of 150 centres at which such examinations were conducted, they would be counted by hundreds, and instead of the two or three high-class places of technical instruction which had been enumerated they would be counted in different parts of this island by the score, and that they would have in the Central Institute the great uniting point for the whole of this network through which the information and the discipline which were needful for carrying the industries of the country into operation would be distributed into every locality in which such industries were carried on. He regarded it as even a more important function of such organisations that they would be places to which every young artisan of industry and ability could look to gratify his legitimate ambition. His study of history had led him to the conclusion that there never had been, and there never was likely to be, any great cause of widespread social discontent except hunger of some kind or other. There was physical hunger of the body, and there was intellectual hunger arising in the minds of capable and energetic men who were prevented by the accidents of life, or the organisation of society, from taking the places for which they were fitted. Everything which spreads a knowledge of technical processes among our industrial classes tended to fit them to fight better that great battle of competition in which they had hitherto maintained themselves victoriously in virtue of the inward natural powers and capacity of the race, but in which the struggle became more difficult, not only because on the continent of Europe training and discipline were supplementing whatever might be lacking of energy and capacity, but because on the other side of the Atlantic there was a people as numerous as ourselves, of the same stock, blood, race, and power, who would run us harder than any competitors had hitherto done. If we were to hold our own in this great world competition, it must be because the native force and intelligence were supplemented by careful training and discipline, such as were proposed to be given by the system of technical education.

At the meeting last week in connection with the memorial to the late Mr. Spottiswoode, a committee was formed for the purpose of procuring a portrait or bust for presentation to the Royal Society, and also to consider the question of establishing a further memorial of his connection with the Society. Prof. Huxley, Mr. W. De La Rue, Mr. Bowman, Dr. Evans, the Astronomer-Royal, and Mr. F. Galton, were appointed as members of the committee.

We have received from the publishers, Messrs. De la Rue and Co., a sample of their pocket-books, date cards, and pretty Christmas cards, which each year seem to become more and more attractive. The pocket-book, a *spécialité* which Messrs. De la Rue have brought to great perfection, is indeed a *multum in parvo*. Not only does it contain the usual almanac, but also much useful information. The mean time of high water in all parts of the world, the length of a degree of latitude and longitude, a table of magnetic elements, which, as inferred for next year, are declination 18° 12′ W., inclination 67° 32′, horizontal force 3·92, vertical force 9·50, total force 10·27, a table of specific gravities, the various tables of weights and measures together with the French measures, the dates of eclipses, and the mean time of the sun's southing, &c., all given with the usual exactness which has caused this pocket-book to be looked to by many scientific men as a help in their daily work. The date cards are in all shapes and sizes, for hanging on an office wall or to stand on the writing table in the study. The Christmas cards are now produced with such care in drawing and colour as to have become veritable works of art, and it is truly a difficult task to select from amongst the different series before us those which may be considered to carry off the prize. Mention must, however, be made of the beautiful etchings on satin and the coloured drawings of child and bird-life, the latter particularly showing both artistic and scientific knowledge, and it was a happy thought to produce these on such a material as satin, which gives a wonderful softness and finish to the pictures, and makes them suitable for adorning screens, panels, sachets, and the various dainty trifles which will be eagerly sought for this Christmas. The hunting series is drawn with great spirit, and many a child, both old and young, will be charmed with the novel idea of the introduction of the persistence of vision by building up a hunting scene by the hunters and hare on one side and the horses and dogs on the other of a rapidly spun card. Other cards too are arranged to introduce Wheatstone's principle of the wheel of life. The flower series, which is drawn with the same delicacy that we noticed in the colouring of the birds' plumage, is this year enriched by some Alpine favourites, which will carry many of us back to our summer haunts, and cause us to thank Messrs. De la Rue for enabling us to recall at this inclement season one of the many enjoyments of our yearly holiday.

The *Times* of Friday last contains an account of the results obtained in the *Dacca* and *International*, which were sent out to take soundings in the Atlantic for the purpose of laying a cable between Spain and the Canaries. Mr. Buchanan accompanied the expedition, and his observations on the corals, which seem to be creating a "coming Atlantis," are of much interest. The precise information obtained about some of the banks which stud this part of the Atlantic is a valuable addition to existing knowledge on the subject.

The naturalist Petit has returned to France from the Congo region, where he has spent several years, especially between the Gaboon and the Congo. He brings home large collections, especially in ornithology.

One necessary result of the scattered population of the United States of America has been the co-education of the sexes. Other countries have inquired as to the effect of the mixing together of boys and girls not only in schools but also in classes, and this has led the Bureau of Education to take the opinions of the school officers of 144 towns of less than 7000 inhabitants, and 196 larger cities, as to the good or evil result therefrom. There is an almost uniform reply in its favour. Only 19 out of the whole number separate the sexes, and only 12 out of these speak decidedly against it. The general morality and tone of society in America prevent its having any mischievous effect, while their innumerable small schools necessitate a large supply of female teachers who are the better qualified by their early competition and parallel education with boys. The Bureau, however, calls attention to the fact that both advantages may be absent in an older and more thickly populated country where concentration and division of labour is more practicable.

The Report of the Manchester Public Free Libraries is a very satisfactory one, showing that since 1876-77, when the issues of books had been decreasing for several years, a steady revival has set in and their circulation has increased more rapidly than the population. Nothing also speaks so well for the successful work, present as well as prospective, of both central and district libraries as the new catalogues of first one and then another which have followed each other at average intervals of six months only.

On November 22, at about 9 a.m., a remarkable phenomenon was observed at Alfta in the province of Helsingland. The weather was mild and calm, and the sky clear, when from the north the rays of an aurora began to develop, and soon bathed the northern heavens. Down by the eastern horizon a heavy dark cloud rested, from which a magnificent meteor suddenly darted forth. It traversed almost the entire heavens, spreading a deep lurid light over every object, before which even the aurora paled. The simultaneous observation of a starlight sky, a flaming aurora, and a splendid meteor in the depth of winter is described as very striking.

The *Revue Positive*, which has been edited by the late M. Littré, and latterly by M. Wirouboff, has published its last number. The reason alleged is the want of interest now felt in France for merely theoretical questions, and the success obtained in a number of special directions by the principles of positive philosophy. It has lived fifteen years.

Part III. Vol. II. of the *Memorie della Società Geografica Italiana* is entirely occupied with the working out of the zoological collections made during the Italian Expedition to Equatorial Africa. Signor Vinciguerra treats on the freshwater fishes, M. A. de Bormans on the Orthoptera, M. C. Oberthür on the Lepidoptera, and M. Lethierry on the Hemiptera; in all cases there were new forms to describe, and the most interesting Lepidoptera are illustrated on a large folded plate. These memoirs appeared originally in the *Annali del Museo Civico di Storia Naturale di Genova*, but will be useful in their collected form.

Earthquakes are reported (1) from Steinbruck (Styria), where a severe shock was felt on November 7 at 3 p.m., and a second one six minutes later, both in a vertical direction; (2) from Kaltenbach, near Müllheim, where a loud subterranean noise was heard, accompanied by a shock on November 11 at 9 p.m. The phenomenon was also observed in the surrounding villages, and was preceded in the daytime by a severe thunderstorm; (3) from the neighbourhood of Trawnik (Bosnia), where, on November 15 at 9.45 p.m., a violent undulatory earthquake was felt, accompanied by subterranean noise. The phenomenon lasted five seconds, and its direction was from north-west to south-east. An earthquake is also reported from Patra (Greece), where a violent shock occurred on November 14 at 3.40 a.m.

In connection with the Quekett Microscopical Club, six demonstrations upon elementary subjects connected with microscopy will be given at University College, in Class Room No. 8, at 7.30, on the following evenings:—December 14, 1883, Cutting Sections of Hard Tissues, by T. Charters White, M.R.C.S.; January 11, 1884, Microscopical Drawing, by J. D. Hardy; February 8, the Sponge Skeleton as a means of recognising Genera and Species, by J. G. Waller; March 14, How to Work with the Microscope, by E. M. Nelson; May 9, Polarised Light, by Charles Stewart, F.L.S.; June 13, Staining Vegetable Tissues, by W. H. Gilburt.

On the Zuiderzee interesting experiments were recently made with fog-horns of a novel construction. They are sounded by steam, and are worked after the fashion of Morse telegraphs with long and short sounds. Two ships were provided with the fog-horns; on each there were telegraphists working the horn, and the signals were distinctly heard and understood even if the distance between the ships was such that they lost sight of each other.

A German Meteorological Society was founded at Hamburg on November 18 last, when many eminent men of science were present. Dr. Neumayer was elected president; the object of the Society was defined as—"The cultivation of meteorology as a science and in its relations to practical life." The Society will support meteorological research and publish a meteorological serial. At the first meeting Dr. Hellmann spoke on twilight phenomena, Dr. van Bebber on barometrical minima with erratic movement, and Dr. Köppen on his method of testing the results of weather forecasts.

The additions to the Zoological Society's Gardens during the past week include two Lesser White-nosed Monkeys (*Cercopithecus petaurista*) from West Africa, presented respectively by the Rev. W. C. Willoughby and Mr. S. E. Sims; twenty Barbary Turtle Doves (*Turtur risorius*) from India, presented by Mr. A. T. Hirsch, F.Z.S.; two Bearded Titmice (*Panurus biarmicus*), European, presented by Mr. H. D. Astley, F.Z.S.; a Water Rail (*Rallus aquaticus*), British, presented by Mr. E. G. B. Meade Waldo; an Indian Crocodile (*Crocodilus palustris*) from India, presented by Sir Joseph Fayrer, K.C.S.I., F.Z.S.; two Scaly-breasted Lorikeets (*Trichoglossus chlorolepidotus*), from New South Wales, a St. Thomas's Conure (*Conurus xantholæmus*) from St. Thomas, West Indies, four West African Love Birds (*Agapornis pullaria*) from West Africa, two Undulated Grass Parrakeets (*Melopsittacus undulatus*), a Cockateel (*Calopsitta novæ-hollandiæ*) from Australia, two Indian Crocodiles (*Crocodilus palustris*) from India, deposited; a Hairy Porcupine (*Sphingurus villosus*) from Brazil, on approval; two Cirl Buntings (*Emberiza cirlus*), British, purchased.

OUR ASTRONOMICAL COLUMN

Encke's Comet.—On October 16 M. Otto Struve presented to the Imperial Academy of Sciences of St. Petersburg a new memoir on the motion of Encke's comet, by Dr. Backlund, of the Observatory at Pulkowa, who has continued the researches commenced by the late Dr. von Asten. Shortly before the decease of the latter, in August, 1878, he had completed a memoir upon this comet, in which it was proved that the appearances between 1819 and 1858 might be comprised, so to say, under a single formula, adopting one value for the effect of a resisting medium; or an acceleration of 0″·104 in the mean motion in each revolution. Nevertheless the observations at the different returns were not represented with such a degree of precision as to exclude a probable error of 9″·0 for each co-ordinate of a normal position, and for certain appearances the agreement with the formula was so little satisfactory that a suspicion arose of the existence, besides gravitation and a resisting medium, of other agents which had affected the motion of the comet. The suspicion was further increased when it was found by Asten that the appearance in 1871 could in no way be included under the general formula, without admitting that the resisting medium had ceased to operate, or that the comet during the revolution immediately preceding had undergone a sudden retardation through the intervention of some unknown force. Following up at first the latter hypothesis, he was able to assign approximately the time when such perturbation must have taken effect, and found that at this time the comet was traversing the region of the small planets between Mars and Jupiter. This circumstance led Asten to conjecture that the attraction of one of these bodies, which the comet had encountered, might have occasioned the retardation.

A similar retardation was indicated again by the last appearance of the comet in 1881, and, following a similar method, Dr. Backlund was able to fix the time and the approximate place, which was again found to be in the midst of the zone of small planets. Thus, as M. Otto Struve remarks in his report upon Dr. Backlund's memoir, there was reason to think that we were upon the traces of a very interesting discovery, which added much to the interest attaching to his new researches on the last four appearances of the comet, as a complement to the investigations of Asten for the period 1819–1868. This additional work has not, however, led to a confirmation of the above-named hypothesis, but has replaced it by results of a more positive character and of greater scientific importance.

Dr. Backlund had found, on following rigorously the rules of calculation adopted by his predecessor, that the last four appearances, and particularly those of 1871 and 1881, could not be represented without admitting that the acceleration had diminished considerably, and had even disappeared for the last two returns. But on a closer examination it was discovered that a strange error had entered into the combination of the appearance of 1868 with the two preceding ones; in one of these revolutions where the observations made after perihelion were combined with those made before the succeeding one, Asten, though he supposed he had taken into account the resistance, had in fact not done so. This being rectified, the errors of 1871 and 1881, which amounted to many minutes, were destroyed in great measure, and the discordances reduced to tolerable though still unsatisfactorily large quantities. After a revision of the formulæ employed, Dr. Backlund succeeded in reducing the probable error remaining in each co-ordinate of a normal position to 4″·1. The introduction of the mass of Jupiter, according to the determination of Bessel-Schur, further reduced this probable error to 2″·8, assigning for the acceleration during the period in question 0″·054 for each entire revolution, and M. Struve considers that Dr. Backlund's researches have thus put us in possession of a theory of the comet for its later returns which leaves little or nothing to be desired.

It has been mentioned that for the period 1819-1868 the probable error in the normal positions given by Asten amounted to 9″·0. Partly, perhaps, the larger error is attributable to the inferiority of the instrumental means available in the first half of the century, but probably in a greater degree to imperfections detected in the theory adopted for this earlier period, upon which M. Struve's report enters into some detail. For this reason Dr. Backlund has charged himself with the construction of a new theory for the interval 1819-1868, in which he will be much assisted by the earlier work of Asten, described as having been left in admirable order, and thus admitting of being followed and verified at every step.

While awaiting the results of these further investigations, M. Struve draws attention to a very singular fact, which will not be affected by them. He remarks there is no reason to doubt that the acceleration has much diminished in the interval between the mean epochs of the two periods referred to above. He asks: Is it that the volume of the comet has diminished in the interval? The observations afford no trace of such diminution. Or again,—has the matter of which the comet is composed been increased? On this we can say nothing. There is, further, the supposition that the so called resisting medium has altered in density, or again, that the acceleration attributed to the effect of a resisting medium is produced by forces of a totally different nature.

All this for the moment must remain enigmatical, but the fact is established that the acceleration has diminished; we cannot say whether this diminution has been produced instantaneously or gradually; it is a point upon which the new researches undertaken by Dr. Backlund may enlighten us.

Encke's comet returns to perihelion in March, 1885.

GEOGRAPHICAL NOTES

THE eleventh number, 1883, of Petermann's *Geographische Mittheilungen* opens with a minute account of the archipelago of Chiloe, by Dr. C. Martin, who in former numbers of the *Mittheilungen*, in the *Revista cientifica de Chile*, and in other publications, has already communicated important information on this part of the earth's surface. The present contribution has special reference to vol. viii., recently published at Santiago, of the *Anuario de la Marina de Chile*. The next article gives an interesting sketch of the progress of the knowledge of Kafiristan by Europeans from 1829, when it first became known to Elphinstone, down to the present year, when Mr. McNair, the Indian Government surveyor, penetrated as far as the Dorah Pass; and an account of the present state of the inhabitants ethnographically, ethologically, socially, morally, and religiously, according to the reports of the Rev. Mr. Hughes and other recent visitors. The third article traces the route of the Russian Embassy of 1878-79 through Afghanistan and the Khanate of Bokhara, following the descriptions of Dr. J. Jaworski, member of the Russian Geographical Society, who as physician accompanied the Embassy, and has recently published an account of the expedition in two thick octavo volumes in Russian. In a long paper illustrated by a map by Bruno Hassenstein, which also embraces Dr. Junker's expedition through those parts, Dr. Emin-Bey prosecutes his travels to the west of the Bahr-el-Jebel in October and November of last year. Starting from Bedden, on the White Nile, on October 9, he penetrated south-westwards as far as Janda, the extreme southern post in the Kakuák country, whence he proceeded north-westwards through the Fadjelu Land, the station Kabajendi, the region of the Makraka and of the Abuka, as far as the station of Gosa. From this point Dr. Emin-Bey turned south-eastwards through the Abukaja country, and the Makraka-Ssgaire stations, and on November 26 arrived at the station of Wandi. The Makraka are described as a people dowered, both men and women, with a remarkable profusion of hair, which by means of fat, the sap of trees, &c., they studiously arrange in plaits, pigtails, &c., producing very surprising effects. The name Makraka, though now universally applied to the people of that region, was, it appears, not the original name, but, signifying cannibals, was at first used by the natives to designate a body of invaders of the Iddo race from the south. Dr. K. Zöppritz, in the next following article, discusses Dr. Emin-Bey's measurements of heights and atmospherical pressure at Lado.

WE have also received the *Mittheilungen* of the Geographical Society in Hamburg for 1880–81. It contains a very copious account of the Island of Chios (or Scio) geographically, geologically, ethnologically, and commercially; a lecture on the cola-nut, delivered before the Geographical Society of Hamburg on January 5 of last year, and an instructive description of the "sacred" Japanese town of Kioto. Next follows a very careful and comprehensive account in 250 pages, by Dr. H. Sieglerschmidt, of the results of the North Polar expeditions of this century. After summing up our knowledge of the North Polar regions in the year 1818, the review traces the history of North Polar investigation since that date, taking stock, in particular, of our knowledge of East Greenland, Spitzbergen, the Siberian glacial sea, and other hyperborean tracts. Lastly, it draws up the total results down to the present date in respect of hydrography, meteorology, magnetism, astronomy, &c. In the next article Herr E. R. Flegel gives the first of a series of sketches intended to comprise (1) the mangrove swamps of the delta of the Niger; (2) the mountains of Cameroon; and (3) the banks of the lower Niger. In this first sketch we are introduced to the long and narrow sandy strip of land rising but little above the level of the sea, and running parallel with the coast of the Bight of Benin.

THE *Verhandlungen* of the Berlin Geographical Society, Band x., No. 7, contains a very copious article on Wisconsin; and the *Zeitschrift* of the same society, No. 105, gives the conclusion of Dr. Richthofen's account of his travels in China, as also, among other valuable papers, a contribution to the ethnography of the extreme north-east of Asia, by Herr G. Gerland.

WE have further received the *Bulletin de la Société de Géographie* for the second and third quarters of this year. An article by M. Grandidier briefly describes the province of Imerina, the central, as also the most populous and important, province of Madagascar. The province is mountainous, traversed by numerous water-courses, entirely bare of tree or shrub, or often even of cultivated plant, scarcely inhabited in the hilly grounds, but thickly peopled in the valleys. The hills covering most of the country, of hard and compact red clay, through which blocks of granite crop largely up, are not fertile. To the west of the capital, in the very centre of the province, is a large plain, about 30 km. long by as many broad, formerly a lake or marsh, now an immense field of rice, where emerge hamlets and houses like so many islets. There is also an interesting account of the Fuegians. The fluctuations of the Indian population in the United States are discussed by M. de Semalle in an article to which M. Simonin shortly replies. The kingdom of Perak, the Peninsula of Malacca, is described by M. De La Croix. Commandant Gallieni, of the French Naval Infantry, furnishes a mass of information on the races and populations of the Upper Niger, while Dr. Audray relates at considerable length his personal impressions and reminiscences of Hué during the eighteen months he passed there at the French Legation. M. Fernandez also communicates a paper on the Argentine Republic.

THE *Bulletin of the American Geographical Society* has a paper on the Philippine Islands by Dr. Kneeland, and another on the currents of the Pacific Ocean, by Dr. Antisell.

IN an article in the last number of the *Bremen Geographical Journal* on the inhabitants of the Chukche Peninsula, in the north-east extremity of Asia, Dr. Aurel Krause, after a brief sketch of voyages of discovery and scientific expeditions to that region, sums up the views of the different authorities with reference to the population of the peninsula, and endeavours to reconcile and supplement them with immediate observations of his own. As the result of his studies he distinguishes two different races on the peninsula—the Chukches and the Eskimo. The Chukches, again, are either nomadic or settled. The nomadic Chukches, who are also distinguished by the possession of reindeer, are scattered over the country to the west of Behring Strait, as far as Chaun Bay and the sources of the Great and Little Anjui, and south to the Anadyr River, some 5000 (German) square miles of land, with a population hardly numbering over 2000. The settled Chukches dwell on the shores of the Arctic Ocean from Chaun Bay to Behring Straits, and in some spots on the east coast in villages counting up to forty huts. There is also a third class of Chukches, intermediary between the aristocratic reindeer proprietors and the fishers, a class of merchants. A different race, looked down upon by the Chukches, occupy the south coast from Point Chaplin (or Indian Point) to Anadyr, as also parts of the east coast. That these are of the same race as the Eskimo of the opposite American coast their mode of living, their language, and bodily structure testify beyond all doubt, according to Herr Krause, his opinion on this point differing from that of the *Vega* staff. According to Dall these Eskimo are slowly drifting southwards towards Kamtschatka. The Eskimo on the Asiatic side of Behring Straits, including those of St. Lawrence Island and of the Diomedes Islands, should hardly exceed 2000. An ethnographical map and a list of Chukche and Eskimo words in connection with the Chukche Peninsula are appended to this valuable paper.

DR. EMIL RIEBECK of Halle, the well-known traveller, is preparing for a second African journey, which will be directed to the Niger. He will be accompanied by the naturalist Herr G. A. Krause, well known as an excellent linguist and mathematician.

THE NOVEMBER MEETING OF THE NATIONAL ACADEMY OF SCIENCES[1]

FOR the first time in nineteen years, and the second time in its history, the National Academy held its mid-year meeting in New Haven, November 13–16. Thirty-three of the ninety-three members were in attendance, and during its four days' session twenty papers were presented.

The meeting was conspicuous for the discussion which most of the papers called forth, and for the general participation of the members in these discussions. It was interesting also, for the report of the committee on the solar eclipse of last May, which included the detailed reports of the expedition to Caroline Island, undertaken under the auspices of the Academy, by the principal participants, Profs. Holden and Hastings. It will further be remembered by the members from other cities for the marked hospitalities they received at the hands of their *confrères* of New Haven, and for its many social pleasures, culminating in the brilliant public reception given them by the president, Prof. Marsh, at his residence. The new buildings recently finished, or in process of erection, for the furtherance of scientific research and instruction in Yale College, were also examined with interest, together with the treasures of the Peabody Museum, where the finely-mounted collections of Profs. Verrill and E. S. Dana, and the fossil vertebrates of Prof. Marsh, called forth much admiration.

[1] *Science.* From advance sheets; favoured by the Editor.

The generous discussion to which the papers gave rise was provoked at the very start by the paper of Dr. Graham Bell upon the formation of a deaf variety of the human race, which had a broad, practical interest, and which consumed the entire morning session of the first day. Mr. Bell claimed that, from purely philanthropic motives, we were pursuing a method in the education of "deaf-mutes" distinctly tending to such a result, supporting his assertions by statistics drawn from the published reports of the different institutions in this country devoted to the care of these unfortunates. They are separated in childhood from association with hearing-children, and taught what is practically a foreign language—a practice which isolates them from the rest of the community throughout their lives, and encourages their intermarriage. Such marriages were increasing at an alarming ratio, and with calamitous results. As a remedy for this danger, Dr. Bell would have the children educated in the public schools, thus bringing them into contact with hearing-children in their play, and in instruction wherever they would not be placed at a disadvantage, as in drawing and blackboard exercises. He would also entirely discard the sign-language, and cultivate the use of the vocal organs, and the reading of the lips.

The report on the solar eclipse covered a variety of topics, and will fill some hundred and fifty printed pages. In presenting it, Prof. E. S. Holden merely touched upon the principal points, and gave the leading results, in much the same form as they have already been given in this journal. The objects of the expedition were successfully carried out; and Prof. Holden regarded his special work—the search for a possible planet interior to Mercury—as proving the non-existence of the small planets reported by Profs. Watson and Swift.

Dr. C. S. Hastings read in full the greater portion of his report upon the spectroscopic work, which concluded with a critical review of the generally-received theories of the solar atmosphere, and suggested, instead, that the corona was a subjective phenomenon, largely due to the diffraction of light.

The presentation of these reports occupied the entire morning session of Wednesday, and their discussion the greater part of the afternoon session.

In criticising the current use of the word "light" in physics, Prof. Newcomb opened a long and interesting discussion. He urged that photometric measurements were comparatively valueless, because they estimate a part only of the radiant energy of the sun; whereas the quantity which should be determined was the number of ergs received per square centimetre. Prof. Langley, however, asserted that it would be impossible to estimate the radiant energy received from the stars with our present appliances; not all the stars combined would produce deflection, even in so sensitive an apparatus as the bolometer.

Another feature of marked interest was Prof. Rowland's exhibition of photographs of the solar spectrum, obtained by his new concave gratings, by which he had prepared a map of the spectrum much more detailed than heretofore secured, and free from the defects of scale found in previous photographs.

Prof. Asaph Hall communicated the results of his researches upon the mass of Saturn, based upon new measurements of the distances of the outer satellites. He determines the mass of the sun to that of Saturn to be as 1 to 1/3482.

Prof. Brewer took the occasion of the Academy's meeting in the city of his residence to exhibit samples of his experiments of many years' duration upon the subsidence of particles in liquids. They showed the action of saline and organic matter, of acids and of freezing, upon the precipitation of sediments. Most of the samples had been undisturbed for five or six years, and showed varying degrees of opalescence, resulting from the suspension of matter in the fluid.

We have mentioned only the more important papers, or those which provoked a fuller discussion than usual. The following complete list will show how largely the physical side of science predominated at the meeting. In astronomy, besides the reports on the eclipse of May 6, papers were read by A. Hall, on the mass of Saturn; by S. P. Langley, on atmospheric absorption;

and by O. T. Sherman (present by invitation), on personality in the measures of the diameter of Venus: in mathematics, by S. Newcomb, on the theory of errors of observation, and probable results: in physics, by S. Newcomb, on the use of the word "light"; by W. H. Brewer, on the subsidence of particles in liquids; and by H. A. Rowland, on a new photograph of the solar spectrum: in meteorology, by E. Loomis, on the reduction of barometric observations to sea-level: in geology, by T. S. Hunt, on the Animikie rocks of Lake Superior; by J. D. Dana, on the stratified drift of the New Haven region; by B. Silliman, on the mineralogy and lithology of the Bodie mining district; and by J. S. Newberry, on the ancient glaciation of North America: in chemistry, by W. Gibbs, on phospho-vanadates, arsenio-vanadates, and antimonio-vanadates, and on the existence of new acids of phosphorus: in physiological chemistry, by R. H. Chittenden (present by invitation), on new primary cleavage forms of albuminous matter: in palæontology, by J. Hall, on the Pectinidæ and Aviculidæ of the Devonian system; and by O. C. Marsh, on the affinities of the dinosaurian reptiles: and in anthropology, by A. G. Bell, on the formation of a deaf variety of the human race; and by J. W. Powell, on marriage institutions in tribal society.

The report of the Committee on Glucose, appointed by the President in conformity with a request from the Government, was accepted by the Academy, and will be transmitted to Congress with the President's report. This will also embody the proceedings of recent meetings of the Academy, the report of the Committee on Alcohol, and that on the eclipse of the sun, together with the thanks of the Academy to the Secretary of the Navy and the officers of the *Hartford* for their cooperation in the expedition to Caroline Island. It will also include an expression of the approval of the Academy of the efforts now making to secure a system of uniform time.

The next stated session of the Academy will be held in Washington in April next, and it is probable that the following mid-year session will be held in Cambridge.

RIPPLE-MARKS[1]

IN the first series of experiments a cylindrical vessel, like a flat bath, with upright sides, was placed on a table, which was free to turn about a vertical axis. Some fine sand was strewn over the bottom to a depth of about an inch, and water was poured in until it stood three inches deep over the sand. It was found that rotational oscillation with a jerking motion of small amplitude gave rise almost immediately to beautiful radial ripples all round the bath. If the jerks were of small amplitude the ripples were small, and if larger they were larger. The radiating ripples began first to appear at the outer margin of the bath and grew inwards; but the growth stopped after they had extended to a certain distance. If the jerking motion was violent, ripples were not formed near the circumference, and they only began at some distance inwards.

An analysis of the observations was made on the hypothesis that the water remained still, when the bath oscillated with a simple harmonic motion. The problem was to find whether λ, the wave-length of ripple (in inches) was directly proportional to v, the maximum velocity of the water relatively to the bottom during the oscillatory motion; also to find the values of v_1 and v_2, the least and greatest velocities of the water compatible with the formation of ripple-mark.

It appears that, for the particular sand used, v_1 is half a foot per second, and v_2 a foot per second; and that the wave-length of ripple, λ, is $\cdot 00245v$ when v is measured in inches per minute. The several results were as fairly consistent with one another as could be expected. The hypothesis that the water as a whole executes a simple harmonic oscillation relatively to the bottom is not, however, exact, and does not give the maximum velocity of the water in contact with the sand relatively thereto. The quantity called v is not in reality the maximum velocity of the water in contact with the bottom relatively thereto, but it is $6\cdot 283$ times the amplitude multiplied by the frequency. Thus we cannot conclude that a current of half a foot per second is just sufficient to stir the sand. In the state of oscillation corresponding to v, it is probable that part of the water at the bottom is moving with a velocity much greater than half a foot per second relatively to the sand.

[1] "On the Formation of Ripple-mark in Sand." Abstract of a paper by G. H. Darwin, F.R.S., Plumian Professor and Fellow of Trinity College, Cambridge, read before the Royal Society on November 22, 1883.

It was after making these experiments that what appears to be the key-note of the whole phenomenon was discovered.

A series of ripples extending inwards for some distance having been made by oscillation, and the water having come to rest, the bath was turned slowly and nearly uniformly round. The uniform current flattened the tops of the ripples, but made the lee-side steeper.

It was conjectured that there would be eddies or vortices on the lee-side, and in fact minute particles lying on the surface of the sand were observed to climb up the lee-slope of the ripples apparently *against* stream. This proved conclusively the existence of the suspected vortices.

If when the bath was at rest a sudden motion was given in one direction, the sand on the lee-side of each ripple was observed to be churned up by a vortex. By giving a short and sudden motion the direct stream might be seen to pile up the sand on the weather-side and the vortex to pile it up on the lee-side. The sand so displaced formed two little parallel ridges, that on the lee-side being a little below the crest of the ripple-mark.

For the purpose of examining the vortices a glass tube was drawn out to a fine point and fitted at the other end with a short piece of india-rubber tube. With this a drop of ink could be squirted out at the bottom of the water. This method was adopted in all subsequent observations, and it proved very valuable. It may be worth mentioning that common ink, which is heavier than water, was better than aniline dye.

A drop of ink was placed in the furrow between two ripples; as soon as the continuous stream passed, the ink was parted into two portions, one being sucked back apparently against stream up the lee-side of the ripple-mark, and the other being carried by the direct stream towards the crest. These points being settled, it remained to discover how the vortices were arranged which undoubtedly must exist in the oscillatory formation of regular ripples.

The observations were made in two ways, first with a glass trough so arranged that it could be gently rocked by hand, and secondly with an oscillating sheet of glass.

When the trough is half filled with water, and sand is sprinkled on the bottom, it is easy to obtain admirable ripple-marks by gently rocking the trough.

When a very small quantity of sand is sprinkled in and the rocking begins, the sand dances backwards and forwards on the bottom, the grains rolling as they go.

Very shortly the sand begins to aggregate into irregular little flocculent masses, the appearance being something like that of curdling milk. The position of the masses seems to be solely determined by the friction of the sand on the bottom, and as soon as a grain sticks, it thereby increases the friction at that place.

The aggregations gradually become elongated and rearrange themselves. As soon as the formation is definite enough to make the measurement of the wave-length possible, it is found that the wave-length is about one-half of what it becomes in the ultimate formation.

Some of the elongated patches disappear, and others fuse together and form ridges, the ridges then become straighter, and finally a regular ripple-mark is formed, with the wave-length double that in the initial stage.

If, after the formation of regular ripples, and the deposition of a drop of ink at the bottom, a very gentle oscillation be started, the layer of ink on the crest of a ripple becomes thicker and thinner alternately, swaying backwards and forwards; then a little tail of ink rises from the crest, and the point of growth oscillates on each side of the crest; the end of the tail flips backwards and forwards. Next the end of the tail spreads out laterally on each side, so that a sort of mushroom of ink is formed, the stalk of the mushroom dancing to and fro. The height of the mushroom is generally less than a millimetre.

The elongated hollows under the mushroom are the centres of vortices, and the stem is the upward current. If the ink be thick, these spaces are clouded, and the appearance is simply that of an alternate thickening and thinning of the ink on the crest. The oscillations being still gentle, but not so gentle as at first, streams of ink from the two mushrooms on adjacent crests creep down the two slopes into the furrow between the adjacent ridges, and where they meet a column of ink begins to rise from the part of the water whose mean position is in the centre of the furrow.

The column is wavy, and the appearance is strikingly like that of smoke rising from a fire in still air.

The column ascends to a height of some five, ten, or perhaps twenty times the height of the ripple-marks, according to the violence of the agitation. It broadens out at the top on each side, and spreads out into a cloud, until the appearance is exactly like pictures of a volcano in violent eruption; but the broad flat cloud dances to and fro relatively to the ascending column. The ink continues to spread out laterally and begins to fall on each side. In this stage if the ink is not thick it is often very like a palm-tree, and for the sake of a name this appearance is called an ink tree. The branches (as it were) then fall on each side, and the appearance becomes like that of a beech tree, or sometimes of an umbrella. The branches reach the ground, and then creep inwards towards the stem, and the ink, which formed the branches, is sometimes seen ascending again in a wavy stream parallel to the stem.

Perhaps a dozen or twenty oscillations are requisite for making the ink go through the changes from the first growth of the tree.

The descending column of a pair of trees comes down on to the top of the mushroom, but the successful manufacture of the tree necessitates an oscillation of sufficient violence to render the simultaneous observation of the mushroom very difficult.

With violent oscillation, when the stem of the tree is much convoluted, it cannot be asserted that the mushroom vortices exist, and the author is inclined to believe them to be then evanescent.

Each side of the ink tree is clearly a vortex, and the stem is the dividing line between a pair, along which each vortex contributes its share to the ascending column of fluid. The vortex in half the tree is clearly in the first place generated by the friction of the vortex in its correlated mushroom, and is of course endued with the opposite rotation. The ascending stem of the tree is a swift current, but over the mushroom the descending current is slow until close to the mushroom, when the current is seen to be impelled by pulses.

If the adjoining crests are of unequal height, the stem of the tree is thrown over sideways away from the higher crest; and indeed it requires care to make the growth quite straight. The ink in the stem ascends with a series of pulses, and it is clear that there is a pumping action going on which renders the motion of each vortex intermittent, and the two halves of the tree are pumped alternately.

The amount of curvature in the stem of the tree depends on the amplitude of the oscillation of the water.

The ink is propagated along the convolutions of the stem of the ink tree, but the convolutions are themselves propagated upwards, and each convolution corresponds to one oscillation. The motion of the ink along the convolutions soon becomes slow, but the convolutions become broader and closer. Thus the upper part of the tree is often seen to be most delicately shaded by a series of nearly equidistant black lines.

In the transition from the mushroom stage to the tree stage it appeared that it was very frequent that only half the ink tree was formed.

If the agitation is very gentle, the sand on the crests of the ripple-marks is just moved to and fro; with slightly more amplitude, the dance is larger, and particles or visible objects, such as minute air-bubbles in the furrow also dance, but with less amplitude than those on the crests. The dance is not a simple harmonic motion like that of the main body of the water relatively to the bottom, but the particles dash from one elongation to the other, pause there, and then dash back again.

As the amplitude further increases, the furrows are completely scoured out, and the sand on the crests is dashed to and fro, forming a spray of sand dancing between two limits. With violent agitation, this dance must have an amplitude of more than half a wave-length. If the agitation be allowed to subside, the dance subsides, and when the water is still the ripple-mark is left symmetrical on both sides. With extremely violent oscillation, all the water becomes filled with flying dust, and it is no longer possible to see what is happening. This seems to be the condition when the agitation is too strong for the formation of ripple-mark. It is probable that the rush of water sweeps away the existing ripple-mark, and there is then no longer anything to produce a systematic arrangement of vortices.

The author illustrates the dance of the vortices by a succession of figures.

It is hardly possible to explain the series of changes in words, but we may here state that the mechanism by which the ripples are made and maintained depends on the fact that the upward current of a pair of vortices lingers over the ripple crest, and then darts across with extreme rapidity to the adjoining crest. Thus each pair of vortices is associated with two crests, spending nearly half the time over one, and half the time over the other.

As above stated, it has seemed that only one of each pair of tree vortices is set up at first, and the author is disposed to regard this as the transitional state from the mode of oscillation, which produces the half wave-length with small height of ripple-crest, to the fundamental wave-length with considerable height.

The results of the observations may be summarised as follows:—

The formation of irregular ripple-marks or dunes by a current is due to the vortex which exists on the lee of any superficial inequality of the bottom; the direct current carries the sand up the weather slope and the vortex up the lee slope. Thus any existing inequalities are increased, and the surface of sand becomes mottled over with irregular dunes. The velocity of the water must be greater than one limit and less than another, the limiting velocities being dependent on the average size and density of the particles. Existing regular ripple-mark is maintained by a current passing over it perpendicular to the ridges. A slight change in form ensues, the weather slope becoming less steep and the lee slope steeper. The ridges are also slowly displaced to leeward. The regular ripple-mark may also thus be somewhat prolonged, so that although a uniform current probably cannot form regular ripple-mark, yet it may increase the area over which it is to be found.

Regular ripple-mark is formed by water which oscillates relatively to the bottom. A pair of vortices, or in some cases four vortices, are established in the water; each set of vortices corresponds to a single ripple crest and the vortices oscillate about a mean position, changing their shapes and intensities periodically, but not with a simple harmonic motion.

The successive changes in the vortex motion, whilst ripple-mark is being established, and when the amplitude of oscillation over existing ripple-mark varies, are complex, and we must refer the reader to the original paper for an account of the phenomena.

It is important to note that when once a fairly regular ripple-mark is established, a wide variability of amplitude in the oscillation is consistent with its maintenance or increase. No explanation of ripple-making can be deemed satisfactory which does not satisfy this condition.

The last section gives some account of the valuable papers of MM. Hunt,[1] Casimir de Candolle,[2] and Forel[3] in this field. The author agrees in the main with these observers, but considers that some of their conclusions are open to criticism.

He next remarks that it is not easy to understand precisely the mode in which the oscillation of the water over the undulating bottom gives rise to vortices, but that there are familiar instances in which nearly the same kind of fluid motion must occur.

In the mode of boat propulsion called sculling, the sailor places an oar with a flat blade through a rowlock in the stern of the boat, and, keeping the handle high above the rowlock, waves the oar backwards and forwards with an alternate inclination of the blade in one direction and the other. This action generates a stream of water sternwards. The manner in which the blade meets the water is closely similar to that in which the slopes of two ripple-marks alternately meet the oscillating water; the sternward current in one case, and the upward current in the other are due to similar causes. We may feel confident that in sculling, a pair of vortices are formed with axes vertical, and that the dividing line between them is sinuous. The motion of a fish's tail gives rise to a similar rearward current in almost the same way. These instances may help us to realise the ripple-making vortices.

Lord Rayleigh has considered the problem involved in the oscillations of a layer of vortically moving fluid separating two uniform streams.[4] At the meeting of the British Association at Swansea in 1880 Sir William Thomson read a paper discussing

[1] "On the Formation of Ripple-mark." *Proc. Roy. Soc.*, April 20, 1882 vol. xxxiv. p. 1.
[2] *Archives des Sciences Physiques et Naturelles Genève*, No. 3. vol. ix., March 15, 1883. "Rides formées," &c.
[3] "Les Rides de Fond." *Archives des Sciences Physiques et Naturelles Genève*, July 15, 1883.
[4] "On the Stability or Instability of certain Fluid Motions" *Proc. Lond Math. Soc.* (February 12, 1880), vol. xi. p. 57.

Lord Rayleigh's problem.[1] He showed that, in a certain case in which the analytical solution leads to an infinite value, there are waves in the continuous streams in diametrically opposite phases, and that the vortical stratum consists of a series of oval vortices. The uniform current flowing over existing ripple-mark exhibits almost a realisation of this mode of motion, one of the streams of fluid being replaced by the sandy undulations. The same kind of motion must exist in air when a gust of wind blows a shallow puddle into standing ripples.

It seems probable that what is called a mackerel sky is an evidence of a mode of motion also closely similar to that described by Sir William Thomson. M. de Candolle's suggestion that cirrus is aërial ripple-mark may then be regarded as substantially correct.

If two horizontal currents of fluid exist one above the other, the layer of transition from one to the other is dynamically unstable, but it is probable that if a series of vortices be interpolated, so as to form friction rollers as it were, it becomes stable. It is likely that in air a mode of motion would be set up by friction, which in frictionless fluid would be stable.

The formation of clouds is probably due to the saturation with moisture of one current and the coldness of the other.

The direction of striation and velocity of translation of mackerel clouds require consideration according to this theory.

It appears that if a mackerel sky be formed beween two aërial currents, the striations are parallel to that direction in which the two currents have equal component velocities, and the component velocity of the clouds parallel to the striations is equal to the component velocity of either current in the same direction.

The resultant velocity of the clouds is equal to a half of the resultant velocity of the two currents, and the component velocity of the striations perpendicular to themselves is the mean of the components of velocity of the two currents in the same direction.

The account which is given in this paper of the formation of ripple-marks shows it to be due to a complex arrangement of vortices. The difficulty of observation is considerable, and perhaps some of the conclusions arrived at may require modification. It is to be hoped that other experimenters may be induced to examine the question.

The reader is referred to the original for the figures, which are necessary to an adequate explanation of the phenomena and conclusions.

NOTE ON DEAFNESS IN WHITE CATS[2]

THIS curious occurrence has long been a matter of interest to me, originally because cats have always been very favourite pets in my household, and still more because the occurrence amongst them of deafness was used by Mr. Darwin in his first edition of "Animals and Plants under Domestication" as an illustration of correlated variability. He was under the impression that white cats with blue eyes were invariably deaf.

I had collected a number of observations which I had personally made, and I found that some white cats were deaf which had the ordinary yellow eyes, and that some white cats with blue eyes could hear perfectly well. I have never heard of deafness in any but a white cat, and all the deaf white cats I had personally examined were males. Therefore, in NATURE, 1873, I published a brief note pointing out Mr. Darwin's error. In his second edition Mr. Darwin established two cases of deafness in female white cats, so that the conclusions of both of us were upset, and this wholesale destruction of theories has been completed by the birth in one of my feline families of a white kitten, female, with perfectly yellow eyes, and absolutely deaf. She lived with us for two years, and her misfortune was quite permanent. My conclusions from the facts observed by myself now may be formulated in this way, that congenital deafness is not known to occur in any animal but the cat, though I am not quite sure but that one white mouse I had some years ago was deaf, and that no cats but those entirely white are ever deaf. As female cats are far more common than males (and this seems to be true of white cats as well as those of other colours), and as I have known only one deaf female cat for some twenty deaf males, I think I may assume that deafness is more common among males than among females. The colour of the eyes has evidently nothing to do with the deafness, though it has with the colour of the fur, and seems to be dependent on the same process—an arrest of development. The eyes of nearly all kittens are blue for some weeks after birth, and the same cause which arrests the pigmentation of the fur arrests in a very much smaller number the pigmentary growth in the eye. I have been told of two cases of complete absence of pigment in the eyes of two cats (albinism) as is seen so commonly in rabbits, guinea-pigs, rats, and mice, but I have not been able properly to authenticate them. These cats were said to be not deaf.

In 1872 I obtained a cat from Hertfordshire as an example of the polydactilism which is very common there, and when he arrived I found that he was white, that he had one eye a bright blue and the other a bright yellow, and that he was profoundly deaf. He was by far the most interesting cat I have ever possessed, and must be well remembered by many members of this Society who have favoured my house with their presence as "Old Pudge," possessed of all the feline virtues, and many of a more human type—and free from vice of every kind. He lived with us for eleven years, and died last winter of peritonitis. Whilst living with us we made many observations concerning his deafness, and I easily determined that it was purely tympanic—that is, he was deaf to impressions conveyed through the air, but his intelligence could be reached by impressions conveyed through solid media. When I wanted him to come to me I gave a peculiar sharp stamp on the floor, and he immediately responded to the signal, even if he was on a chair or table. It is very remarkable that this congenital deafness is in no way associated in the cat with mutism. Human deaf-mutes generally are those in whom deafness is cochlear as well as tympanic, and the result of such disease as scarlet fever in very early life. One other peculiarity he had is that for about four years he suffered from occasional fits of epilepsy of a very severe kind. They came on always during his sleep, and for their first indication had the painful peculiarity that the cat seized the tip of his tail and bit it off, and in this way his tail was shortened considerably. Every kind of white animal I have kept as a pet has been the subject of epilepsy, and the association is suggestive when we are told, as I have been frequently, that the disease is unknown amongst negroes.

I sent the body of my old cat to Prof. Flower for the purpose of having an investigation made into the cause of his deafness. Prof. Flower had a most careful investigation of the condition of his ears made by two most competent investigators—Dr. Cumberbatch and Dr. Heneage Gibbs. The result, briefly stated, is that all the structures in the ears were normal save the tympanic membranes, in which there were triangular gaps extending from the roof to just below the centre, the bases of the gaps being directed upwards, and their anterior side being formed by the handles of the mallei. The gaps appeared to be congenital, and were quite symmetrical; all the other apparatus of the ears was normal, and the auditory nerves were of normal size and structure.

The only congenital defect known in the human tympanum is a very minute aperture, of rare occurrence, and due to the patency of the fissure of Rivinus. The tympanic deficiency in the white cat seems to be in no way associated with this form of arrest.

The results of the observation are interesting, though the subject may perhaps be regarded as trivial, as by it the point raised by Mr. Darwin is finally established. It really is a case, and a very well marked one, of correlated variability, and its great interest is that the three structures affected—the fur, the iris, and the tympanic membrane—have a common origin from the epiblast. Had the defects observed in this cat been cochlear, the difficulty of understanding them would have been very great, as the structures of the internal ear arise from the mesoblast, according to Balfour.

LAWSON TAIT

[1] NATURE, November 11, 1880, pp. 45-46, and see correction on p. 70.
[2] Read before the Birmingham Philosophical Society, October 11.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The recent recommendations of the General Board of Studies have all been passed. These include the appointment of a Professor of Pathology next term, of Readers in several subjects, including Comparative Philology and Botany, of University Lecturers in connection with Special Boards, including Medicine (four), Mathematics (five), Biology and Geology (six), History and Archæology (five), Moral Science (one), and of a number of Demonstrators and Assistants. Plans for new buildings for Comparative Anatomy, Botany, and Mechanism are to be obtained.

Dr. Besant will lecture on Analysis (Schedules II. and III.) during two terms; Mr. Pendlebury on Analytical Optics, next term, and on Laplace's and Bessel's Functions in the Easter Term; Mr. Webb on Elementary Rigid Dynamics in the Easter Term, and on Higher Dynamics in the Long Vacation.

Inasmuch as the University Table at the Naples Zoological Sation has been constantly occupied by students of animal morphology, and there are students in physiology and botany for whom study at Naples is very desirable, it is proposed to extend the advantages of s udy to students of biology generally. Dr. Dohrn has unofficially expressed his willingness to receive, when desired, two members of the University at a time for a payment of 100*l*. instead of 75*l*. a year.

It is hoped that the new Biological and Physical Laboratory, connected with Newnham College, which is being fitted up in Downing Place, may be ready for use by the beginning of next term. The nearness of the site to the new museums will enable students of Newnham to attend professors' lectures there and carry out practical study at the laboratory with the least possible loss of time.

With regard to the statement made last week that "St. John's does not as yet open any of its advanced lectures to other than its own students," we are informed that the advanced lectures have for a long time been open to members of the University, and lectures are provided in some subjects not lectured on elsewhere. The sentence in the report was to the effect that the list for next year was not yet issued. It has now appeared, and no less than six courses of open lectures are announced for the remainder of the academical year.

NEW ZEALAND.—The Queen has been pleased to direct Supplementary Letters Patent to be passed under the Great Seal granting and declaring that the Degrees of Bachelor and Doctor in Science granted or conferred by the University of New Zealand shall be recognised as Academic distinctions and rewards of merit, and be entitled to rank, precedence, and consideration in the United Kingdom and in the Colonies and Possessions of the Crown throughout the world, as freely as if the said Degrees had been conferred by any University of the United Kingdom.

SCIENTIFIC SERIALS

THE *American Naturalist* for November, 1883, contains:—The Pre-cambrian rocks of the Alps, by T. Sterry Hunt.—The achenial hairs of Townsendia, by G. Macloskie.—The hibernacula of herbs, by Aug. J. Foerste.—The hair-sac mite of the pig, by Prof. R. Ramsay Wright.—The geology of Central Australia, by Edward B. Sanger.—The number of segments in the head of winged insects, by A. S. Packard, jun.

Gegenbaur's Morphologisches Jahrbuch, Bd. ix., Heft 1, contains:—Researches on marine Rhipidoglossa, by Dr. Béla Haller, No. 1 (plates 1 to 7).—On developmental relationships between the spinal marrow and the spinal canal, by Dr. W. Pfitzner.—Contribution to the comparative anatomy of the posterior limbs in fishes, part 3, Ceratodus, by Dr. M. Davidoff (plates 8, 9).—On some anatomical marks of distinction between the house dog and the wolf, by Prof. H. Landois.

Rivista Scientifico-Industriale, October 23, 1883.—On the influence of static electricity on the needle, by Prof. Michele Cagnassi.—Experiments with the radiometer (continued), by Prof. Constantino Rovelli.—On the conditions which determine the least and greatest deviation of a ray passing through a prism, by Prof. G. Buzzolini.—On the employment of copperas in testing iodides blended with alcoholic bromides and chlorides, by Dr. Alfredo Cavazzi.—On the advantages that may be derived by medical jurisprudence from entomological studies, especially in determining the approximate date and cause of death, by P. Megnin.—Note on the *Titanophasma fayoli*, a new fossil insect found in the carboniferous formations of Commentry, Allier, by the Editor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 15.—"On *Sceparnodon ramsayi*," a fossil mammal from Australian Pleistocene deposits, by Prof. Owen. The first indication of this species was transmitted to the author, in 1881, in the form of casts of detached teeth, all representing an anterior incisor, the most entire specimen being 5½ inches in length, 35 mm. in breadth, with uniform thickness of 8 mm., the tooth, slightly curved, with persistent pulp-cavity at the base, and a sharp chisel-shaped cutting margin at the opposite end. The author deferred notice of this indication in hope of receiving a specimen of the tooth itself. This was needed in order to make the requisite microscopical researches as to structure, the wombat and some small rodents alone possessing, in Australia, ever-growing scalpriform incisors, but markedly differing in shape as well as size from the fossil. Prof. Owen was favoured by receiving, in the present year, from the bed of King's Creek, Queensland, a tooth, identical in character with the cast, and the present paper records the results of his scrutiny of structure. They led to the conclusion of the former existence in Australia of a mammal with rodent upper incisors, as in the wombat, but of distinct shape, and indicative of a species as large as a tapir. The microscopic characters of both dentine and enamel weighed in favour of the marsupial affinities of *Sceparnodon*. The author referred to the fact that the first indication of the genus *Thylacoleo* was a single carnassial tooth submitted to him in 1833 by Sir Thomas Mitchell, and a similar evidence of *Diprotodon* was an incisor brought by the same explorer from the caves he had discovered in the district named, after the Colonel's old commander, "Wellington Valley."

At the same meeting Prof. Owen gave a minute description of a fossil humerus which had been transmitted to him by Mr. Ramsay, F.L.S., who had discovered it in the breccia cave in "Wellington Valley." The bone was partially mutilated, but gave sufficient evidence of its having come from a Monotreme, with so close a conformity, save in size, with that of the existing *Echidna hystrix*, as to lead to its reference to an extinct species of that genus. It, however, far surpassed it in size, exceeding, as it did, the corresponding bone in the larger Monotrematous ant-eaters which have been found living in New Guinea. Drawings of the subjects of both papers accompanied the text.

Geological Society, November 21.—J. W. Hulke, F.R.S., president, in the chair.—The following communications were read:—On the skull and dentition of a Triassic mammal (*Tritylodon longævus*, Ow.) from South Africa, by Prof. Owen, C.B., F.R.S. The specimen described in this paper formed part of a collection containing remains of some of the known South-African Triassic reptilian genera, and agreed with them in its mode of fossilisation. It was submitted to the author by Dr. Exton, of Bloemfontein. The specimen is a nearly entire skull, wanting only the hinder part, and it measures about 3¾ inches in length, from the broken end of the parietal crest to the point of the united premaxillaries. The upper surface shows the anchylosed calvarial portions of the parietals, and the frontal bones divided by a suture; the contiguous angles of these four bones are cut off, so as to leave an aperture, occupied by matrix, which may be a fontanelle, or a pineal or parietal foramen. The frontals form the upper borders of the orbits, which are bounded in front by the lacrymal and malar bones, and were not completed behind by bone. Each frontal is narrowed to a point at the suture between the nasal and maxillary. The nasals are narrow, but widen in front to form the upper border of the exterior nostril, which is terminal; and is completed by the premaxillaries. The maxillaries are widened posteriorly, then constricted, and again widened before their junction with the intermaxillaries. The teeth include a pair of large round incisors, broken off close to the sockets and showing a large pulp-cavity, surrounded by a complete ring of dentine, which is covered by a thin coat of enamel on the front and sides. At 2 mm. behind each of these teeth is the socket of a smaller premaxillary tooth; this tooth apparently had a thin wall and a pulp-cavity relatively larger than in the anterior tooth. It is separated by a ridged diastema from the series of six molar teeth on each side, the first of which has a sub-triangular crown with the base applied to the second tooth. The latter and the four following teeth are nearly similar, subquadrate in form, with the crowns "impressed by a pair of antero-posterior grooves, dividing the grinding surface into three similarly disposed ridges, and each ridge is subdivided by cross notches into tubercles. Of these there are, in the second to the fourth molar inclusive, four tubercles on the mid-ridge, three on the inner ridge, and two on the outer ridge." The author discussed the relations of this new form of mammal, especially as indicated by the structure of the teeth, which he showed to resemble those of *Microlestes*, from the Keuper of Würtemberg and the Rhætic of Somersetshire, and those of the Oolitic genus *Stereognathus*, the former having on each tooth two multituberculate ridges, and the latter three ridges, but with only two tubercles on each. The fossil presents no characters to show definitely whether the animal it represents was a placental or a non-placental mammal.—Cranial and vertebral characters of the crocodilian genus *Plesiosuchus*, Owen, by Prof. R. Owen, C.B., F.R.S. In this paper the author, with the view of showing that the Kimmeridgian *Steneosaurus manselii*, Hulke, really forms the type of a distinct genus, discussed the characters by which Cuvier divided the fossils referred by him to the Crocodiles into three principal groups, to which Geoffroy St.-Hilaire gave generic names, and those by which the latter author afterwards distinguished his genus *Steneosaurus*, including Oolitic forms, from the Liassic genus *Teleosaurus*. From his exposition of these characters the author concluded that the above-named species does not belong to *Steneosaurus*, Geoff., and he proposed to make it the type of a new genus, *Plesiosuchus*, characterised by the convergence of the frontal bones to a point nearer the apex of the skull than in *Steneosaurus*, by the extension of the gradually attenuated nasal bones into a point penetrating the hind border of the nostril, and by other peculiarities of the skull, teeth, and vertebræ. The author pointed out that this form, like *Steneosaurus*, helped to bridge over the space between the Liassic Teleosaurs and the Tertiary and recent Crocodiles, even approaching nearer to the latter than the older Oolitic type.—On some tracks of terrestrial and fresh-water animals, by Prof. T. McKenny Hughes, M.A., F.G.S. The author's observations have been made on certain pits in the district about Cambridge which are filled with the fine mud produced in washing out the phosphatic nodules from the "Cambridge greensand"—a seam at the base of the chalk marl. As the water gradually dries up, a surface of extremely fine calcareous mud is exposed. This deposit is often very finely laminated, and occasionally among the laminæ old surfaces can be discovered, which, after having been exposed for some time to the air, had been covered up by a fresh inflow of watery mud into the pit. The author described the character of the cracks made in the process of drying, and the results produced when these were filled up. He also described the tracks made by various insects, indicating how these were modified by the degree of softness of the mud, and pointed out the differences in the tracks produced by insects with legs and elytra, and by Annelids, such as earthworms. The marks made by various worms and larvæ which burrow in the mud were also described. Marks resembling those called *Nereites* and *Myrianites* are produced by a variety of animals. The groups of ice-spicules which are formed during a frosty night also leave their impress on the mud. The author concluded by expressing the opinion that *Cruziana*, *Nereites*, *Crossopodia*, and *Palæochorda* were mere tracks, not marine vegetation, as has been suggested in the case of the first, or, in the second, the impression of the actual body of ciliated worms.

Anthropological Institute, November 27.—Prof. Flower, F.R.S., president, in the chair.—Dr. J. G. Garson read a paper on the cranial characters of the natives of Timor-Laut. The osteological remains described in this paper were obtained by Mr. H. O. Forbes from the district of Larat, and consist of a series of eleven skulls and crania. The four male skulls are all of a round form, and resemble one another in general appearance; of the females, five correspond in form to the male skulls in being short and broad, but the sixth differs markedly from the others in being narrow in proportion to its length.—Mr. H. O. Forbes read a paper on the ethnology of Eastern Timor, referring especially to the great intermixture of race that has taken place, and to the occurrence of a red-haired, blue-eyed race in the interior; to the numerous dialects, many of them unintelligible at a short distance from the district in which they are spoken; to the religious rites of the people of certain regions, conducted by a priest in what is called the Uma Lulik (or Taboo House) with an intricate and imposing ceremonial; to their marriage ceremonies and customs, which in some districts remind one of the Australian totem system in the occurrence of husband clans and wife clans; to their death and burial rites; to their system of law and justice, under which, though the chief was king and judge, each freeman had the right—or took it—of private war, retaliating on the wrong-doer with his own hands for loss in his property or person. "Eye for an eye" ran their code, like our own Old English one, "and life for life, or for each fair damages." Mr. Forbes had directed special inquiries into the alleged habit of the Timorese in intentionally artificially distorting their infants' heads. No such custom was found to prevail in the districts traversed by him.

The Victoria Institute, December 3.—A paper on recent Egyptological research in its Biblical relations was read. In it the author, the Rev. H. G. Tomkins, described the results up to the present of those researches which are now being made in Egypt, alluding in warm terms to the assistance rendered him in the preparation of his summary of these results by M. Naville and Prof. Maspero.

The Institution of Civil Engineers, November 27.—Mr. Brunlees, president, in the chair.—The paper read was on the new Eddystone lighthouse, by Mr. William Tregarthen Douglass, Assoc.M.Inst.C.E.

CAMBRIDGE

Philosophical Society, Nov. 26.—The following communications were made to the Society:—On the measurement of electric currents, by Lord Rayleigh. The author referred to the method of measuring currents by the silver voltameter as suitable for currents from ·05 ampere to 4 amperes, and stated that the electrochemical equivalent of silver as determined at the Cavendish Laboratory was $1{\cdot}119 \times 10^{-2}$. A second method was described, suited for larger currents; it consists in balancing the difference of potential between two points in the circuit through which the current is running against the effects of a standard cell working through a large resistance such as 10,000 ohms. The author suggested as a third method the use of the rotation of the plane of polarisation of light passing through a piece of heavy glass, round which the current circulates in a coil of thick wire. A current of 40 amperes will produce a rotation of 15° if the coil have one hundred turns.—On the measurement of temperature by water-vapour pressure, by Mr. W. N. Shaw.—On some measurements of the well-known dark rings of quartz, by Mr. J. C. McConnel.—On the origin of segmentation in animals, by Mr. A. Sedgwick.

EDINBURGH

Royal Society, December 3.—The Right Hon. Lord Moncreiff, president, in the chair.—This being the opening meeting of the 101st session, it had been the intention of the President to give a Review of the Hundred Year's History of the Society; but, on account of his indisposition, the meeting permitted its postponement. Mr. Robert Gray, one of the vice-presidents, occupied the chair during the remainder of the evening.—Prof. Turner communicated a paper by Prof. Haycraft on the limitations in time of conscious sensation. The paper contained the result of experiments on the limitations in time of tactile and thermal sensations, and dealt also with the limitations in the case of the different senses.—Prof. Tait read a paper by Mr. W. F. Petrie on the old English mile. The old mile was longer than the present, and consisted of 5000 feet of 13 inches. It seemed to be identical with the old French mile. The furlong had no connection originally with the mile, which was modified to suit the former.—Mr. Patrick Geddes read a communication on the re-formation of the cell theory. In a second paper, in order to explain muscular contraction, he advanced an hypothesis based on the existence of surface tension in fluids.

DUBLIN

Royal Society, November 19.—Section of Physical and Experimental Science: G. Johnstone Stoney, F.R.S., vice-president, in the chair.—Prof. W. F. Barrett read a paper on hearing-trumpets and an attempt to determine their relative efficiency by physical means. With the view of obtaining a steady and comparable source of sound of a pitch and quality resembling the human voice, a reed pipe was inclosed in a padded box with an opening on one side, and blown by a steady current of air from a holder, a manometer showing the pressure, which was kept constant. The distance at which sound from this source ceased to be audible was noted, and in cases of slight deafness a sliding shutter was added. In other arrangements devised by the author, the principle of interference of sonorous waves was utilised, the degree of deafness being estimated by the departure from complete interference. An induction balance, in which the interrupter was a C tuning-fork, was also tried; as also a siren driven by a falling weight and blown by a current of air at constant pressure; but none of these arrangements were so simple and uniform as the reed. An attempt was made to test the value of ear-trumpets by means of a sensitive flame. The flame was, however, less sensitive than the ear to sounds of the pitch of the human voice. The author contended that the main object of a hearing-trumpet should be clearness, not loudness, and for this purpose the portable whispering tube was undoubtedly the best for conversation. For other purposes the principles laid down by Lord Rayleigh should be more generally adopted, the telescopic jointed instrument of gradual slope being the nearest approach to theory.—Prof. G. F. Fitzgerald, F.R.S., read a paper on the quantity of energy communicated to the ether by a variable current. The author shows that an alternating electric current, if it produces radiations of the nature of light, as it would do upon the most probable interpretations of Maxwell's electromagnetic theory of light, would radiate energy equal to $m^2 \times N^4 \times 10^{-20}$ ergs per second, where m is the magnetic moment of the current and N is the number of its alternations per second.—W. E. Wilson exhibited a simple form of reflecting spectroscope with a diffraction grating, which was described by Howard Grubb, F.R.S. By employing a pair of mirrors, by which the light is twice reflected, the necessity for having an instrument of inconvenient length is avoided.—R. J. Moss, F.C.S., exhibited a remarkable specimen of crystallised stibnite from Japan. The crystallographic characters of similar specimens have recently been described by E. S. Dana. Mr. Moss found that this stibnite may be regarded as practically pure antimony tersulphide; a very minute trace of iron is the only impurity present in appreciable quantity.

Section of Natural Science: Prof. V. Ball, F.R.S., in the chair.—H. St. John Brooks, M.B., read a paper on the osteology and arthrology of the haddock (*Gadus æglefinus*). The chief feature of this paper was a description of the articulations of all the bones and the attachments of the various ligaments. The author drew attention to the beautiful arrangement of the articulations of the upper jaw of fishes which is seen to great advantage in this form. Ligaments passing from the palate bones to the premaxillæ of the opposite side are crossed by others passing from the ethmoid to the maxillæ, the whole forming a lattice like arrangement. By these ligaments the component parts of the upper jaw are kept in contact with a nodule of cartilage, which lies between them and the ethmoid.—Prof. V. Ball, F.R.S., exhibited and drew attention to a conglomerate of quartz pebbles which is found at the base of the chalk in certain parts of the county of Antrim, and which appeared to him to be inconsistent with a deep-sea origin. He also exhibited bones of red deer, ox, pig, fragments of pottery and flint flakes, &c., from a kitchen midden at White Park, Bray, Co. Antrim. Among specimens recently contributed to the Geological Museum, samples of spherical phosphorite from Southern Russia were exhibited. One of them, which had been sliced, shows a beautifully radiated internal structure; this, it is hoped, will be figured and published with details shortly.—Dr. W. Frazer read a note on bones and shells obtained from drainage cuttings at Sandymount.—G. Johnstone Stoney, F.R.S., exhibited cores of limestone found in the drift overlying Cambrian slates near Greystones, Co. Wicklow. Water percolates through the drift, and, on reaching the Cambrian slates, makes its way horizontally through the lowest layer of the drift, corroding the limestone boulders, which form one of its constituents; cores of solid limestone are frequently found of some fantastic form in the heart of a friable mass which remains in the part of a boulder that has been acted on by water charged with carbonic acid. This shows that the corrosion is still actively progressing, and that the drift is here undergoing a change which is rapid from a geological point of view. The water also washes away the fine particles of clay, and the result of the change is to alter a clay drift containing a great number of limestones with some stones of other kinds into a gravel containing chiefly these other stones.—A. G. More, F.Z.S., exhibited as a specimen recently acquired by the Natural History Museum the mountain Goat (*Mazama americana*) from the Rocky Mountains. This animal is remarkable for the abundance of its soft white hair; it has the general appearance of the goat, and its horns somewhat resemble those of the chamois.

PARIS

Academy of Sciences, December 3.—M. Blanchard, president, in the chair.—Note on the universal hour proposed by the Conference in Rome, by M. Faye. The author urges several objections against the adoption of Greenwich astronomical time and meridian, calculating the longitudes from 0 to 24h. east, which might be convenient for navigation and astronomical purposes, but unsuitable for railways, telegraphs, government offices, and the public generally. For the formula, universal time = local time − (L + 12h.), where L indicates the longitude calculated east from Greenwich, he proposes to substitute, universal time = local time − L. The formula would thus be simplified by the suppression of the last term, and, instead of Greenwich astronomical time, the civil hour would be adopted as the universal hour. Thus would be avoided the inconvenience of disagreement between local and univeral time, which would otherwise be felt precisely in the most densely peopled regions of the globe.—Remarks on M. Piarron de Mondésir's so-called mechanical problem of the two chains, by M. H. Resal.—On preventive inoculation with artificially developed charbon germs attenuated by the method of rapid heating, by M. A. Chauveau. Of a large number of sheep inoculated with germs heated to + 80° C., not one succumbed, although further tests showed that the germs themselves had lost none of their prolific vitality.—Summary reports on the results of the French mission to Cape Horn: astronomial observations by M. H. Courcelle-Seneuil; terrestrial magnetism, magnetic registers, and photographic work, by Lieut. E. Payen; magnetic observations made at Orange Bay by M. Le Cannellier; *résumé* of the meteorological observations made at Orange Bay between September 26, 1882, and September 1, 1883, by Lieut. J. Lephay.—On the absorption line produced by diluted blood in the violet and ultra-violet region of the spectrum; photographic reproduction of this line in solar light, by M. J. L. Soret.—On the secular variation in the direction of terrestrial magnetic force at Paris (continued), by M. L. Descroix.—Description of an "aeroplane" constructed for the purpose of furthering aerial navigation, by M. de Sanderval.—Supplement to a previous note on M. Tisserand's formula connected with the celestial mechanism, by M. Radau.—Determination of the mutual distances of the three masses in the mechanical problem of the three bodies, by M. A. Lindstedt.—Theory of the ricocheting action of spherical projectiles on the surface of the water, by M. E. de Jonquières.—On the theory of Abelian integrals, by M. E. Goursat.—On a theorem of Riemann connected with the functions of independent n variables admitting $2n$ systems of periods, by MM. H. Poincaré and E. Picard.—On the geometrical curve of the fourth degree with two double points, by M. Humbert.—On the integration of a homogeneous rational function, by M. C. Stéphanos.—Measurement of the difference of potential of electric layers on the surface of two liquids in contact, one illustration (continued), by MM. E. Bichat and R. Blondlot.—On M. Desains' optical experiment: determination of the optical constants of a birefractive crystal of one axis, by M. Lucien Lévy.—Researches on the stability of solidified superfused sulphur, by M. D. Gernez.—On the artificial production of spessartine (manganesiferous garnet), by M. Alex. Gorgeu.—Experimental researches on the development and accumulation of saccharine (the phenomenon of "saccharogénie") in beetroot, by M. Aimé Girard.—On the acetate of biprimary bichloretted ethyl $\left(\begin{matrix} ClCH^2-CH^2 \\ ClCH^2-CO \end{matrix}\right>O\Big)$, obtained by the reaction of the monochloretted chloride of acetyl on monochlorhydric glycol, by M. Louis Henry.—On the conditions suitable for accelerating the oxidation of siccative oils, by M. Ach. Livache.—On copper as a preservative against infectious diseases, and on the absolutely harmless character of the powders of this metal employed by workers in copper, by M. V. Burq. From his further researches the author maintains, against recent statements to the contrary, that copper undoubtedly possesses certain prophylactic properties against several infectious maladies, and especially against cholera.—Construction of the scapulo clavicular cincture in the series of Vertebrates, by M. A. Lavocat.—On the sexual and larval polymorphism of the plumicole Sarcopidæ, by MM. E. L. Trouessart and P. Mégnin.—Researches on the physiological properties of maltose (continued), by M. Em. Bourquelot.—On the Adapisorex, a new genus of mammals occurring amongst the Lower Eocene formations of the neighbourhood of Reims, by M. V. Lemoine. — On the discovery of the genus Equisetum in the Kimmeridge clays of Bellême, department of Orne, by M. L. Crié.—On the quaternary lignites of Bois l'Abbé, near Épinal, by M. P. Fliche.—On the remarkable sunsets observed at Paris and elsewhere in France on November 26 and 27, by M. L. Renou. The author considers that this phenomenon may be connected with a condition of the atmosphere which recurs on the same day every year. Electric disturbances have been regularly observed between November 26 and 28 ever since the shower of meteors, which occurred on November 27, 1872.

BERLIN

Physical Society, November 16.—The experiments with a view to determining the neutral point in the spectrum in the case of the colour-blind, which Dr. König communicated to the Society in March last, have since been further prosecuted by him. With the help of the apparatus, formerly described, consisting of a prism, a movable collimator, and a telescope directed towards the prism's edge, Dr. König had now succeeded in determining in thirteen different cases of colour-blindness the place of the spectrum at which these colour-blind persons felt the impression of white—of the place, namely, which appeared to them exactly of the same hue as would a surface covered with magnesia and shone upon by the light of white clouds. Each measurement was carried out eight times, and then the average taken, by which it appeared that the error in the single measurement was confined probably between ± 0·09 and ± 0·5 millionths of a millimetre. Measurements carried out with an individual for the second time after an interval of fourteen days, showed likewise the same exactness. In the case of the thirteen colour-blind persons who were examined, among them being both red- and green-blind, the neutral point lay between 491·7 and 504·7 millionths of a millimetre, wave-length. If the persons so examined were ranged in accordance with the wave-lengths of their neutral point, it was found that within the limits above specified they formed a fairly continuous series in which red- and green-blind persons took their places indiscriminately, a result in perfect agreement with former conclusions. In his first investigations into the subject, Dr. König had further found that the intensity of light exercised an influence on the situation of the neutral point, and had now further prosecuted this question by experiments on three individuals. For the graduation of the intensity of light he made use of two Nicol prisms in front of the collimator tube, and found, in the case of all three individuals, that with increasing intensity of light the neutral point approached closer to the violet end of the spectrum. Let the wave-length be taken as abscissa, and the intensity of light as ordinate, then would the curve of the neutral points form no straight line, and would, under great increase of intensity, mount upwards almost perpendicularly.—Prof. Schwalbe had in the summer of this year, as in former years, visited several glacial cavities, a branch of inquiry in which he particularly interests himself. In these investigations he took special note of the cold winds issuing from fissures and clefts of the places in question. At Questenberg, for example, in the Southern Harz, he found a place where from a fissure in a steep gypsum wall of about 100 feet high, and having a southern situation, a wind issued with a temperature of 3° C., while the temperature of the air immediately surrounding it was 20° C. warmer. The temperature in the stone fissures was found by him to be still lower, the thermometer often showing zero there, while in the cavities themselves the temperature he had generally observed (in July) was 5° C. Prof. Schwalbe brought out the fact of the great diffusion of such glacial cavities. Besides two in the Harz, he had this summer counted as many as twenty to twenty-five glacial cavities, mostly quite unknown hitherto, in the Karst Mountains on the southern frontiers of Carniola. With regard to the explanation of this phenomenon he still held by the view formerly set forth by him, that the cold was caused by the water which had been cooled to 4° C. filtering through the porous stone, and he deemed a resumption of Herr Jungk's experiments on the cooling of the trickling water necessary to a definite decision on the cause of glacial cavities.

Physiological Society, November 23.—In the cortex of the vertical lobe of the brain, Prof. Munk had, as is known, demonstrated that the separate groups of voluntary muscles had each of them a definite central area whence their movements could be induced. One part of this cortical area was recognised as the central seat of the muscles of the nape and neck, and after these two groups had been topically distinguished, Prof. Munk conjectured that the voluntary muscles of the larynx and jaws would be found to have their centre in the section of the membrane appropriate to the jugular muscles. Dr. H. Krause had put this conjecture to experimental proof, and found it confirmed. On bending back a dog's epiglottis and drawing forward its tongue, the larynx could very readily be observed by daylight, and when the jugular part of the cerebral membrane was irritated by moderate electrical currents, he invariably noticed the rise of the larynx, the movement of the chordæ vocales to a place situated in the middle between expiration and phonation, the rise of the palate, the contraction of the constrictor pharyngis, and movements of the hindermost parts of the tongue. That the part of the membrane in question was the centre of the laryngeal movements was further confirmed by experiments of extirpation which were performed successfully on both sides with ten dogs. The part of the membrane was experimented on in this way first on one side and then on the other, and after all inflammatory symptoms had disappeared, and the cerebral wounds were cicatrised or in process of cicatrisation, it was found that eight dogs had entirely lost the capability of barking, and, on attempting to bark, uttered either no sound or only a hoarse whine, such as new-born puppies emitted. In the case of the two dogs which after the operation continued capable of barking, it appeared that the excision had been made too far on the outside, or not deep enough. Some dogs which after the operation were no longer capable of barking were, after several days, killed, when Dr. Krause searched for the nerve passages, which, in consequence of the removal of the cortical part, were degenerated. In the *ganglion mamillare* he found a part of the nerve fibres in a collapsed, discoloured, and degenerated state, and concluded that the fibres extending from the membranous centre of the larynx to its motory nerves passed through this ganglion. At the invitation of the President, Prof. Munk gave a brief plan of the topography of the membrane of the cerebrum, on which were projected the different sensible and motory nerves of the separate parts of the body. On a drawing of the cerebral surface he showed the particular sites which were the centres of seeing, hearing, feeling, and motion for the muscles of the eyes and the ear, for the face, tongue, nape, neck with larynx and throat, and for the thorax. A particular locality was also pointed out for the muscles of expiration and for those of inspiration. The centres for the extremities had not yet been experimentally demonstrated, but no doubt they were situated on the inside in the large fissure of the cerebrum, where, on account of the unavoidable profuse bleeding which occurred, operations were impracticable.

CONTENTS

THURSDAY, DECEMBER 20, 1883

MERRIFIELD'S "TREATISE ON NAVIGATION"

A Treatise on Navigation for the Use of Students. By John Merrifield, LL.D., F.R.A.S., F.M.S. (London: Longman and Co., 1883.)

THE author of this volume having been engaged for many years in preparing candidates for the different examinations into which navigation enters, has felt the want of a text-book embracing all that the different examining boards embody under that head, and has endeavoured, and we think successfully, to supply that want by the present treatise.

The work, although entitled "A Treatise on Navigation," deals only with one part, viz. that particularly relating to what is generally known under the name of dead reckoning, and does not touch on astronomical observation, which we presume Mr. Merrifield classes under the head of nautical astronomy, but which is really the most important part of navigation. The title therefore is somewhat misleading. Neither do we agree with the author's definition of theoretical and practical navigation; what Mr. Merrifield terms practical navigation, viz. the management of the ship, making and shortening sail, steering, &c., is usually known as seamanship. The theory of navigation is surely the proving that by the application of certain problems the particular position occupied by a vessel can be accurately ascertained; whilst the practice is the actually finding the ship's place by means of the instruments necessary to give the data required by the theory.

But although some small points in the work may be selected which may perhaps offend the practical navigator confident in his own ability, and consequently too much inclined to look down on the instructions of schoolmen, to whom he is far more indebted than he is generally disposed to admit, to the student this work will be found most useful: the chapters are well arranged, the exercises at the end of each chapter are pertinent to the preceding text, and require him to digest the text in order to answer them satisfactorily. We propose, however, to offer some remarks and suggest some additions which the author may perhaps consider should another edition of his work be required.

In the description of the compass one type only has been selected—that in use in the mercantile marine. No account is given of the instruments used in the navy or of Sir William Thomson's invention. This is certainly a defect in the work, as if one instrument can be considered as of more importance than another, in the navigation of a vessel, it is the compass. Without it, notwithstanding all the other improvements which have taken place in navigation, we should be in much the same position as the seamen of old, who were afraid to venture out of sight of land. In fact we have always thought that the education of naval men so far as regards the compass, and magnetism generally, has been very much neglected, and its vast importance has hitherto not received that attention, in treatises on navigation, it deserves. Mr. Merrifield has made a great stride in advance, as he treats, in his ninth chapter, of the coefficients and the means of correcting the compass for the local attraction of the ship. This is a subject of great importance in the present day; all navigators should be able to adjust their own compasses, and should have the means of doing so at their disposal, as a compass might be disabled in any vessel, and in war-ships, particularly, a general action might cause the loss of the correcting magnets of every vessel in the squadron, when, unless some officer on board could replace them, and correct the compasses, the fleet might be placed in a most critical position, more especially in thick weather or when entangled amongst shoals. We doubt if the latter contingency has yet excited any attention, yet its importance will be at once seen if we suppose that one ship only in a squadron has had her compass disabled in action and that subsequently thick weather prevails. Such a ship endeavouring to obey the signals of the admiral might either fall into the enemy's hands or by fouling vessels in her own squadron temporarily render them unfit to renew the engagement.

Whilst considering this contingency, it might perhaps be as well to draw attention to the fact that, in addition to our ironclads, many large steam-vessels are now fitted with sirens in place of the ordinary steam-whistle. It would therefore seem expedient that some definite means should be enforced to prevent their signals being mistaken for the sirens sounded in foggy weather from lighthouses and lightships.

In describing the mode of correcting the compass for the effect of local attraction no notice is taken of the method of doing so by a single magnet—often adopted in the navy. We are, however, glad to see that Mr. Merrifield refers the student to the works of Sir George Airy and Sir Frederick Evans, to both of whom sailors owe a debt of gratitude. That we are able to navigate our large iron ships and armour-plated vessels with the same facility as the old wooden ships of the past is due almost entirely to their labours, combined with those of the late Archibald Smith, F.R.S.

In the chapters on the various methods of finding the position of a ship by dead reckoning, known as the "sailings," we do not find much improvement on the works of the older writers except in one particular—Mercator's sailing. This, which is the most accurate method of dead reckoning, is treated of in a separate chapter, and the formula for calculating the meridional parts for the spheroid, as well as the sphere, is now for the first time published in "A Treatise on Navigation," the only work of the sort in which we remember to have seen it before being Galbraith's "Surveying." It is true that Riddle, in a note, refers the student to Gauss's paper, published in the *Philosophical Magazine* for 1828, and Mendoza y Rios, in his tables, gives the meridional parts for the spheroid as well as the sphere, but does not say what compression he used in the calculation: Mr. Merrifield, however, seems to be the first to give the subject that prominence in "A Treatise on Navigation" we think it deserves, more especially now when the steamers running from England to the United States are reaching the extraordinary rate of 450 miles a day, and it is no unusual thing to be two or three days without obtaining astronomical observations. It therefore becomes necessary to use the most rigorous means to calculate the position by dead reckoning, so that the errors of steering, &c., may not be augmented by errors in calculation. Such being the case, we regret that Mr. Merrifield has omitted from the chapter on traverse sailing the warning given in Raper that, especially in high latitudes, the differences of longitude should be found on each course, instead of the departures being lumped and the difference of longitude found from the result.

In the chapter on soundings and tides (No. 10), Mr. Merrifield has published the system of the late Sir Francis Beaufort for ascertaining the height of the tide at any moment provided we know the range and time of high water. This is the method generally adopted by surveyors when circumstances prevent their having a tide pole on shore, and is traditionally known amongst them, though not hitherto published. It is fairly accurate when the diurnal inequality is inconsiderable, and we can recommend it as being sufficient for all practical purposes in finding the depth of water to be added to the soundings on the chart in places like the Bristol and Irish Channels, where it is necessary, owing to the large ranges, to take the state of the tide into consideration in judging the position by soundings in foggy weather, or in calculating when a bank or flat can be safely crossed. The fact that in rivers or harbours certain winds affect the height and that atmospheric pressure also has an influence over tides may be safely ignored in the open sea, as their combined influence would probably never exceed half a fathom, but a range of from three to five fathoms can never be lightly considered by the careful navigator.

OUR BOOK SHELF

Farm Insects. Being the Natural History and Economy of Insects Injurious to Field Crops, and also those which Infest Barns and Granaries, with Suggestions for their Destruction. By John Curtis, F.L.S. Pp. 540, with 16 Coloured Plates, Royal 8vo. (London: John Van Voorst, 1883.)

This is simply a reissue of Curtis's classical work; it had long been "out of print" in booksellers' phraseology. It remains the best book on economic entomology that has appeared in this country, and has certainly served as a model for the Reports of various State entomologists on the other side of the Atlantic. No other author here has gone into the question of special injurious insects with the same care and minuteness, and it may be said that (with the exception of certain Reports issued in America) there is no similar collective work faithfully illustrated by the author's own pencil. The plates and woodcuts are in Curtis's best style, and if he had been an entomological *artist* only, his work would have remained unsurpassed.

Opinions may be divided as to the desirability of reissuing such a work "untouched," when so many years have elapsed since the publication of the chapters in the *Proceedings of the Royal Agricultural Society* that formed its basis. Much and valuable additional information has been obtained since the original articles were written, and very much alteration in nomenclature has resulted from the efforts of systematists to place this branch of entomological science on a sounder footing, but the facts remain practically unaltered, and there is the charm of a certain originality in the author's style that any radical reconstruction might have destroyed.

Nevertheless we do think it a pity that some one could not have been found with sufficient knowledge and courage to re-edit the book and bring it down to date. On the other hand, this process might have resulted in the work being no longer "Curtis's Farm Insects." Its value would be destroyed if rewritten, even by the most experienced, and we think the only practicable method of dealing with it in an absolutely new *edition* would be by means of copious annotations, not by recasting the whole.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Evolution of the Cetacea

I am glad to be able to assure Mr. Searles Wood that I have long been familiar with the specimen called *Palaeocetus sedgwicki*, preserved in the Woodwardian Museum at Cambridge, and have repeatedly examined it with much interest. It is undoubtedly Cetacean, and allied to the genus *Balaenoptera*, as Mr. Seeley demonstrated, though differing in smaller size and some other characters from any existing species. As, however, the light it throws upon the evolution of the Cetacea is very small compared to the time that would have been taken up in discussing its bearings, I did not think it worth while to allude to it in a lecture of which the length was necessarily limited. It is, after all, a most unsatisfactory fragment, as its geological age is, and probably always will remain, a matter of doubt. Allowing, however, the utmost antiquity assigned to it, my argument would rather be strengthened than weakened. Mr. Searles Wood seems to have missed the fact that my chief contention was against the prevalent view that the Cetacea have been derived from the Carnivora through the Seals. Any evidence which throws back their origin in time and derives them from some more generalised type of mammals would militate against this view. No one can suppose that the Ungulata originated at the commencement of the Tertiary period, as we know that they were then already differentiated into great and distinct sections. Their primitive ancestry must therefore be looked for far back in Mesozoic times. That I thought the Cetacea existed before the Tertiary period I distinctly intimated by suggesting, as an explanation of the absence of their remains in the chalk, that they might then have been inhabitants of great inland waters, but having had so many warnings of the fallacy of negative evidence in geology, I do not yet despair of the discovery of a veritable Cretaceous whale. W. H. Flower

The Java Eruption

I have been greatly interested in your note on M. Renard's researches as to the composition of the volcanic material ejected during the recent eruption of Krakatoa. The ashes, as stated, are those of a magma that would have produced an andesite with rhombic pyroxene. Now such an andesite occurs at so many points, and in such immense masses, round the great Pacific "circle of fire," that one is tempted to ask if it may not specially characterise this important volcanic region. I will, with your permission, briefly refer to some published, and one or two unpublished, facts with regard to the distribution of this andesite (called hypersthene-andesite by Whitman Cross and Iddings, and bronzite-andesite by F. Becke) round the Pacific circle.

In the *Neues Jahrbuch* for 1881 (*Beilage Band* 1881, 467) Dr. Oebbeke describes, under the term augite-andesite, a rock from the Sierra de Mariveles, Luzon. Owing to the kindness of the author, I have a section of this rock before me as I write, and I have little doubt that the strongly pleochroic mineral is mainly, if not entirely, a rhombic pyroxene. Augite, however, is also present.

Passing to the other side of the Atlantic, we have recent evidence to show that a rock of the same type occurs along the line of the Rocky Mountains and the Andes.

In *Bulletin No. 1 of the U.S. Geological Survey* (1883), Mr. Whitman Cross describes a hypersthene-andesite from Buffalo Peaks, Mosquito Range, Colorado.

In the *American Journal of Science* for September, 1883, Messrs. Hague and Iddings prove that the four great volcanic peaks of Mount Rainvier, Mount Hood, Mount Shasta, and Lassen's Peak, rising to heights of from 10,500 to 14,444 feet above sea-level in California, Washington Territory, and Oregon, are mainly composed of andesitic lavas and tuffs, in which hypersthene is the predominating bisilicate.

In the *Geological Magazine* for July, 1883, Mr. Waller describes a similar rock from Montserrat, and I have just analysed one for Prof. Bonney from Old Providence Island in the Caribbean Sea. Prof. Bonney also informs me that he has found the rhombic pyroxene in the andesites brought by Mr. Whymper from Pichincha and Antisina.

It must not, however, be supposed that the rock is limited either to the Pacific region or to the Tertiary and Recent periods.

M. Fouque has shown that hypersthene occurs in the Santorin lava of 1866.

Niedzwiedski described a hypersthene-andesite from Steiermark in 1872. Mr. Whitman Cross and myself have recognised the rhombic pyroxene in many well known Hungarian rocks, in which it had previously been regarded as augite. Lastly, thanks to kind assistance rendered by Prof. Rosenbusch, I have been enabled to show that some Palæozoic lavas and tuffs of the Cheviot region are of essentially the same type (*Geol. Mag.*, March, June, and August, 1883). J. J. HARRIS TEALL

12, Cumberland Road, Kew

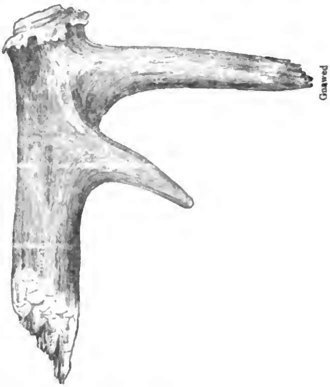
Diffusion of Scientific Memoirs

PROF. TAIT's admirable remarks on the moral obligation laid upon "every society whose memoirs are worthy of appearing in print" to disseminate its publications must have awakened a cordial response in the minds of many whose lot is cast in some provincial city or outlying local college. It is only too true that the volumes of the *Cambridge Philosophical Transactions* are "almost inaccessible" to many like myself, who often find themselves tantalised by the desire of consulting some of the classical masterpieces of research or analysis therein enshrined, which, therefore, are not to be consulted without a pilgrimage to Cambridge or to London. Yet I hardly understand why Prof. Tait should—save for the occasion of reviewing the happily exhumed memoirs of Prof. Stokes—have chosen the *Cambridge Transactions* as the one instance of "inaccessibility," since it is at least equally to be regretted that a memoir published in the *Transactions of the Royal Society of Edinburgh*—and there are masterpieces of research and analysis by the score irrevocably buried therein—equally necessitates a pilgrimage on the part of the provincial reader. I, for one, shall be extremely glad if Prof. Tait will act upon his own prescription—that simple, easy cure—and consider himself "bound to disseminate as widely as possible" the memoirs which he has himself consigned to those very inaccessible *Transactions*. I doubt, indeed, if even Prof. Tait has realised the difficulty besetting a would-be reader of original memoirs and researches, who is compelled to journey from one shore of England to the other in order to consult the *Edinburgh Transactions*, the *Cambridge Transactions*, the *Comptes Rendus*, the volumes of *Poggendorff's Annalen*, or those of the *Annales de Chémie et de Physique*, or the memoirs of any one of the five great Academies of the European Continent. SILVANUS P. THOMPSON

University College, Bristol, December 14

Deer and their Horns

THE question is often asked, What becomes of the horns shed every year in the deer forests? the number picked up or found hardly accounts for all those which have been shed. It is said that the deer themselves eat them. It is difficult to conceive how a deer, with its toothless upper jaw, can eat a hard bone—for such is a shed horn—but it seems probable, nevertheless, that they do so. I picked up a horn recently in the deer forest at Dunrobin which appears to show that it has been in great part eaten away; and this, I think, was the opinion of the members of the Zoological Society to whom I exhibited it last Monday. On inquiry from the head-keeper at Dunrobin, Mr. James Inglis, I find that it is the general belief that the deer do eat the shed horns, whilst the appearance of the specimen here referred to, confirms the popular belief. The marks on it are such as would be made by the broad incisors of the lower jaw, and the appearance generally suggests that the horn has been gnawed and mumbled by the cutting teeth of the lower and the toothless gums of the upper jaw. It would appear, therefore, I think, that deer do eat some at least of the shed horns, and this



Red deer's horn, eaten (by other deer?), picked up in deer forest, Sutherland, 1883. A young stag's horn.

is rendered the more probable by the fact, according to Mr. Inglis, that there are no foxes or other animals in this particular forest to account for the mischief. J. FAYRER

December 8

"I BEG leave to inform you that I am unable to say from personal knowledge whether it is the stags or hinds that eat the shed horns in the forest. I have never seen either eating horns, but I have no doubt they do so, probably both stags and hinds.

"I have never known dogs to eat deer-horns, and we have no foxes in our forest, and very rarely any dogs are to be seen in it; 'even although they should eat them,' the number of pieces we find all the year round, nearly all partially eaten, leaves no room to doubt that no other animal could have eaten them. I think they commonly eat them after they have been lying exposed to the weather for some time; the horns are then softer from exposure.

"In every case that I have seen, they commence at the top or point of the horn, and eat down towards the root or burr; the latter part is often left uneaten. As soon as I can collect a few specimens I will send them to you.

"We often find horns entire without any marks of teeth on them, but those are mostly not long shed. I have also got horns that had apparently lain for years without any marks on them. But of course no one would expect all the shed horns to be eaten.

"I am sorry that I cannot give you more information, and I am also sorry that as yet I have not been able to collect more information than I know myself, but when I have any fresh evidence I will let you know. "JAMES INGLIS

"November 18"

Sprengel on the Fertilisation of Flowers

IN NATURE, vol. xxix. p. 29, is a letter from Prof. Hagen of Cambridge, Mass., calling attention to the fact that Sprengel's treatise on the structure and fertilisation of flowers was not unappreciated in his own day. Now it so happened that only a week or two before reading this I took up by chance the "Introduction to Physiological and Systematical Botany," by Sir James Edward Smith, the American edition, dated 1814. On p. 208 the author says:—

"Sprengel has ingeniously demonstrated, in some hundreds of instances, how the corolla serves as an attraction to insects, indicating by various marks, sometimes perhaps by its scent, where they may find honey, and accommodating them with a convenient resting-place or shelter while they extract it. This elegant and ingenious theory receives confirmation from almost every flower we examine. Proud man is disposed to think that

'Full many a flower is born to blush unseen,'

because he has not deigned to explore it; but we find that even the beauties of the most sequestered wilderness are not made in vain. They have myriads of admirers, attracted by their charms and rewarded with their treasures, which very treasures would be useless as the gold of the miser to the plant itself, were they not thus the means of bringing insects about it."

It seems to me that this is a pretty decided indorsement of Sprengel's views. W. WHITMAN BAILEY

Brown University, Providence, Rhode Island, U.S.A., December 4

Salt Rain and Dew

I SENT Mr. H. N. Draper's letter (NATURE, vol. xxix. p. 77) to my father-in law, Dr. Petzholdt, of Dorpat University, who has made a special study of South Russia, Caucasus, Russian Turkestan, &c., and his reply is that it is a fact long known to chemists that the aqueous vapour in the atmosphere due to the evaporation of sea and salt-lake waters invariably contains chloride of sodium, which is precipitated to the ground by rain and dew. Dr. Petzholdt is not aware, however, that the phenomenon is more striking on the coasts of the Caspian and Aral than in other localities. In the *Annalen der Chemie und Physik*, vol. xxxv. p. 329, Liebig writes: "All the rain water which fell in Giessen (Hesse) during two years, in seventy-seven rainfalls, contained salt." F. GILLMAN

Quintana 26 (Barrio Arguelles), Madrid, December 6

Lunar Rainbow

ABOUT 6.20 this evening I was fortunate enough to observe a fine lunar rainbow. Previous to its appearance there was a halo caused by a band of cirro-strati, which gradually developed into a crescent-shaped rainbow, which, after disappearing for a minute or two, again was observed, only circular, finally fading away as the clouds dispersed about 6.40. C. H. ROMANES

Beckenham, Kent, December 11

AT 1.30 on the morning of the 12th inst., during the progress of the storm, I looked out of the window in a north-easterly direction and observed a beautiful lunar rainbow. The arc at first was complete, and faint traces of prismatic colours, especially on the outside, were noticeable. A portion in the middle having for a moment disappeared, the complete arc again again became visible, but with only a whitish colour. M. F. DUNLOP

Greenwich, December 15

PROFESSOR NILSSON

THE oldest naturalist in the world, as respects both age and the priority of his writings, has now left it. S. Nilsson of Lund, in Sweden, was born in 1787, and therefore was nearly a centenarian at the time of his death. His earliest publication was in 1812, being a paper on the various methods of classifying the Mammalia; and in every subsequent year he enriched the scientific literature of his own and other countries. The *Annals and Magazine of Natural History* and the Reports of the British Association for the Advancement of Science, for instance, contained several articles from his experienced pen. He especially devoted himself to the fauna of Scandinavia, and became the pioneer of that host of naturalists who have so ably distinguished themselves by similar researches and publications. He was a zoologist, palæontologist, anthropologist, ethnologist, and antiquary. *Nihil tetigit quod non ornavit.*

His works consisted chiefly of scattered papers; but in 1822 he published his "Historia Molluscorum Sueciæ Terrestrium et Fluviatilium," which has still a standard reputation. As it did not include the marine or Baltic Mollusca, the gap was twenty-four years afterwards more than filled up by the eminent Prof. Lovén; and that department of the Scandinavian fauna has now, through the continual labours of the late Prof. Sars and his no less eminent son, Dr. Danielssen, Mr. Herman Friele, the Fraulein Esmark, Dr. Westerlund, the late Mr. Malm and his son, Prof. Steenstrup, the late Dr. Mörch, Dr. Berg, Dr. Collin, and many other conchologists, received as great a degree of attention as has been bestowed on any region of the earth's surface and its circumjacent seas.

The subject of this memoir was, at the last-mentioned date (1822), Regius Professor in the Academy of Lund, and the Director of the Museum of Natural History there. One of his former pupils, Prof. Otto Torell, is well known to all naturalists by his exploration of Spitzbergen, and his present position as the Director of the Geological Survey of India.

We ought to be thankful in recollecting that other veterans of science are still among us, viz. Professors Owen and Milne-Edwards at the age of eighty-three, and Dr. Isaac Lea, in his ninety-third year. The study of natural history is evidently conducive to longevity.

J. GWYN JEFFREYS

SEMITICO-OCEANIC LINGUISTIC AFFINITIES

TO the *Transactions of the Royal Society of Victoria* for May, 1883, the Rev. D. Macdonald contributes a paper, in which he endeavours to establish the identity of the Oceanic and Semitic languages. This is announced as an important discovery both ethnologically and from the theological standpoint. It clears up, we are told, "the hitherto impenetrable mystery surrounding the origin of the Oceanians," because "the Semitic language could only have been carried into Oceania by Semites from the Semitic mainland." It also disposes of the new-fangled "evolution theory," which draws support "from the existence of savages and the supposition that they are descended from 'hairy quadrupeds,' . . . for it shows, as to one of the greatest bodies of savages, that they are descended from the most renowned and civilised people of antiquity." Certainly these are weighty conclusions, which, if established, would fully justify the further inference that "this discovery is more important on the whole than that of the Assyrian or Euphratean inscriptions deciphered of late with such marvellous ingenuity."

By "Oceanic" the writer understands all the languages except the Australian current in the Indo-Pacific insular world. These he evidently regards as constituting a single linguistic family, the Malayo-Polynesian, "comprising the Malagasy, Malayan, Polynesian, and Melanesian, better called the Papuan." His philology has thus not got beyond the days of Forster and Marsden, or the earlier writings of Prof. Whitney, all of whom are appealed to in support of this now exploded theory. The readers of NATURE need scarcely be reminded that from the Malayo-Polynesian must henceforth be detached all the strictly Papuan and Melanesian tongues, as constituting a fundamentally distinct order of speech, itself doubtless embracing many stock languages. Hence the same reasoning process that establishes the identity of Semitic and Oceanic would also establish the identity of Semitic with any other stock languages wherever spoken. The process thus proves too much, that is, proves nothing.

Although Semitic is here compared generally with the whole of the heterogeneous "Oceanic" group, it is remarkable that Efatese is taken as the chief point of comparison, not that this is claimed to be a typical member of the Oceanic group, but merely because it happens to be the dialect with which the writer is most familiar. Now in Efate, a small island about the centre of the New Hebrides, there is a good deal of linguistic confusion, strictly Polynesian (Sawaiori) dialects being spoken at the Polynesian settlements of Mel and Fil, while Melanesian idioms prevail elsewhere. But from the examples adduced, and especially from such agglutinating forms as *mitángu*, *mitáma*, *mitána* = my, your, his, eye (*máta* = eye), it is obvious that the Efatese in question is not an Oceanic (Malayo-Polynesian) dialect at all, but a strictly Melanesian tongue affected by Oceanic influences. The language on which the author mainly relies is consequently useless as a point of comparison between the Semitic and Malayo-Polynesian families.

The actual relation between these two families is again stated to be "that of an ancient to a modern language, as Latin to French, Saxon to English. This implies that we shall find the Oceanic, as compared with the Semitic, characterised by phonetic and grammatical decay, &c." Doubtless there is in Oceanic, as in all linguistic groups, abundant evidence of decay. But, as compared with the Semitic, it must be regarded not as a modern, but as an almost infantile, form of speech. Semitic stands in some respects on a level with, if not even on a higher footing than, Aryan itself, as regards its grammatical evolution, whereas in Malayo-Polynesian the verb is not yet clearly differentiated from the noun. Thus even in Samoan most of the so-called verbs are merely nouns modified by detached relational particles, and, like the adjectives, forming reduplicate plurals. Compare *nofo* = to sit, pl. *nonofo*, with *tele* = great, pl. *tetele*. This instance alone will satisfy the ordinary linguistic student of the prodigious gulf that separates the Oceanic from the Semitic with its highly complicated system of verbal conjugation.

And how does the writer propose to bridge over this gulf? Mainly by a string of words taken without method from any given Oceanic language, and compared with any member of the Semitic group to which it may happen to bear some faint resemblance in sound if not in sense. No attempt is of course made to establish some general preliminary system of "lautverschiebung," without which all such comparisons are absolutely destitute of any scientific value. They resolve themselves mainly into onomatopœic forms, the common property of all articulate speech, or into some of those numerous etymological curiosities which can always be found by the diligent seeker, but which are such terrible pitfalls for the unwary.

Most of the Hebrew terms themselves are moreover taken either in secondary and later forms, or else in secondary and later meanings, forms and meanings which are consequently useless for the purpose of comparison between the *organic* Semitic and Oceanic languages. Thus the Efate *mitaku* = to fear, is compared with the Hebrew *dag*. But this *dag*, or rather *dâag* (דָאַג, Jer. xvii. 8), is a comparatively modern form of an older *dâab* (דָאַב), which primarily means *to melt*, and which neither in sense nor sound shows any further resemblance with the Melanesian *mitaku*. This is only one instance from among many. The further back these supposed parallelisms are traced, the more divergent become the lines, until at last they fade away into parabolic curves, and leave the gulf between these linguistic systems more impassable than ever.

Mr. Macdonald does not expressly mention the "lost tribes." But it is on these flimsy grounds that, in a slightly incoherent concluding sentence, he claims to have rediscovered in the South Seas a lost Semitic people, "their language full-orbed and in all its living vigour"!

A. H. KEANE

AMERICAN WHEAT[1]

THIS is a pamphlet issued by the Chemical Division of the Department of Agriculture, U.S., and is further specified as *Bulletin* No. 1. It may be described as an elaborate monograph upon the composition of American wheat, and the subject is handled with great thoroughness, although the value of the result obtained falls considerably short of being startling. It is a specimen of painstaking analytical work which may form the basis for generalis tions of value in the hands of able agriculturists and statisticians.

The variation in the composition of the wheat grain itself as affected by climate is rendered evident, and a comparison is instituted between the composition of European, American, Egyptian, and Australian wheats. The author in the first place produces elaborate tables of analysis, showing the composition of numerous varieties of wheat. Secondly, he considers the composition of the typical or average wheat of each of the American States. Lastly, he compares American wheats with those produced in other quarters of the globe. Among this mass of analyses it is difficult to arrive at conclusions, and there is some danger of falling into error. Mr. Clifford Richardson finds that American wheats are drier than European wheats in the proportion of 10·27 to 14 per cent. of moisture. The percentage of dry matter is consequently much higher, and the grain is proportionately more valuable. The carbohydrates average 72 per cent. instead of 68 per cent. as in the case of English wheat for example. The amount of fibre is also less in American wheats. The ash constituents are most abundant in wheat from newly cultivated tracts, and on old worn out lands both the ash constituents and nitrogen are considered to have diminished.

American wheat is, however, deficient in albuminoids to a degree which appears to disconcert Mr. Richardson more than we think it need. In American wheat we evidently have a small grain, specially free from fibre (bran), peculiarly dry, very rich in carbohydrates and oil, but deficient in albuminoids. European wheats sometimes contain 19·5 per cent. of albuminoids, and ordinarily 13 per cent. American wheats contain upon an average 11·95 per cent. of albuminoids, but in Oregon and on the Pacific coasts only 8·6 per cent. Mr. Richardson seems to overrate the importance of this fact. He appears to be in doubt as to the true importance of the albuminoids when he says, "The albuminoids are regarded, *and probably rightly*, as the most valuable part of the grain." He might, however, have been led by his investigations to doubt how far a high percentage of albuminoids is the best indication of quality in wheat. First, Australian and Egyptian wheats are both somewhat deficient in albuminoids, and are yet known to be remarkably fine. He also notices that while Oregon and Californian wheats contain comparatively low amounts of albuminoids, the grains are large and handsome. He further points out that the proportion of albuminoids in spring wheats is higher than in winter wheats, although he fails to notice that all wheat-growers know that winter wheat is better than spring wheat. Having concluded that American wheat is at fault in this particular, he endeavours to explain why such is the case with a view to remedying the defect. So far from being a fault, the richness of American wheats in starch, and the comparatively smaller proportion of glutin, appears to us as indicative of its high quality. "Tail" corn contains more glutin than "head" corn, and badly matured grains are usually rich in this important constituent. A little consideration as to the constitution of a grain of wheat will show that the glutin is not the best criterion of value. The outside layers of the grain contain the glutin, and then honeycomb cells inclose the starchy interior. This outer portion of the kernel is the first to ripen while growth still continues along the axis and in the centre. The fully matured grain, in fact, becomes like a well-packed trunk, thoroughly stuffed out, and this with starch grains. If we are correct in this view of the maturing of the grain, the percentage of glutin must diminish in proportion as starch is

[1] "An Investigation of the Composition of American Wheat and Corn." By Clifford Richardson, Assistant Chemist. (Washington Printing Office, 1883.)

deposited, and increases in relative weight. We are disposed to think that the carbohydrates, and not the albuminoids, must be taken as the true criterion of quality in wheats, and that, judged by this test, the Americans have no need to fear that their wheats are inferior to those of Europe.

The author finds a difficulty (p. 33) in accounting for the small proportion of water in American wheats. Any agriculturist would have been able to tell him that well-developed, thoroughly matured, and well-harvested wheat always contains a less proportion of moisture than wheat in an opposite condition. It is due partly to simple drying, but also to the fact that good wheat is thoroughly filled up with starch cells (carbohydrates), and that there are no fissures left for moisture or air to lurk in. Well-fed meat contains less water than badly-fed meat for the same reason, viz. the thorough filling up of the internal spaces with fat cells. A little attention to the structure of the wheat grain would have enhanced the value of Mr. Richardson's monograph.

The fact that unripened and badly matured wheat is often rich in glutin is well known to chemists, and we are disposed to think that the richness of European wheat in this constituent is partly due to the fact that it is often defectively matured.

After treating exhaustively upon the composition of American wheat, the author proceeds to treat of flour and bread, and lastly of other cereals and maize. The pamphlet certainly repays the trouble of perusal, and indicates the vast pains which is now being taken by the United States Government in order to bring scientific knowledge to bear upon its most important industry. The wheat production of each State is watched with minute care, and the quality of the produce is subjected to analysis. It is gratifying to notice that Canadian wheat is in all respects equal to that grown in the United States.

JOHN WRIGHTSON

College of Agriculture, Downton, Salisbury

THE REMARKABLE SUNSETS

SINCE our last number appeared the view that the recent wonderful sunrise and sunset phenomena have really been due to the terrible eruption of Krakatoa in August last has been confirmed in the most definite manner. Material brought down by rain in Holland and snow in Spain has on microscopic examination proved to be identical with actual products of the eruption brought from Krakatoa in the ordinary manner.

The following letter to the *Times* from Mr. Joseph McPherson, an eminent geologist now in Madrid, must be read in connection with the letter from Holland given below:—"Desirous of obtaining positive proof of the brilliant theory put forth in your columns relative to the cause of the remarkable appearances at sunrise and sunset which have for many days excited public attention, I have this day analysed some fresh-fallen snow with the following results, namely, that I have found crystals of hypersthene, pyroxine, magnetic iron, and volcanic glass, all of which have been found in the analysis lately made at Paris of the volcanic ashes from the eruption of Java."

This being so, every fact connected with the displays instead of losing really gains an additional interest, and now that we know we are in presence of the work of the upper currents each date becomes of great importance.

The extraordinary fact now comes out that before even the lower currents had time to carry the volcanic products to a region so near the eruption as India an upper current from the east had taken them in a straight line *viâ* the Seychelles, Cape Coast Castle, Trinidad, and Panama to Honolulu, in fact very nearly back again to the Straits of Sunda! The 5th of September is now fixed from two sources as the date of the first appearance of the strange phenomena at Honolulu.

Mr. Bishop thus writes to the *Saturday Press* (published at Honolulu, September 22), which has been forwarded to us by the courtesy of the Hawaiian Consul at Glasgow:—

"I first noticed these peculiar appearances on Wednesday the 5th inst. at 7 p.m., so long after sunset that ordinarily no trace of colour remains on the western sky. The sky, from south-west to west, was then covered with a lurid red and dull yellow glow, much resembling that produced by a distant conflagration. This extended to an altitude of 15° or 20°. I continued to distinguish the light till 7.25."

He then proceeds:—

"I would note three peculiarities of the phenomenon, distinguishing it from ordinary sunset reflections, and unlike anything I remember to have observed before: (1) It appears to be a reflection from no cloud or stratum of vapour whatever. (2) The peculiar lurid glow as of a distant conflagration, totally unlike our common sunsets. (3) The very late hour to which the light was observable—long past the usual hour of total cessation of twilight. To this may be added (4) that the centre of brilliancy was more or less to the south of west."

Mr. Bishop at once ascribed the phenomena to Krakatoa dust, and suggested more vivid appearances along the line Honolulu, Ladrones, Manila, Sunda. Of course he knew nothing of the line Panama, Trinidad, Cape Coast Castle, Seychelles, Sunda.

In a subsequent communication Mr. Bishop tells us that the after-glow remained brilliant for some time, being very brilliant on September 30. The haze stratum was visible as a continuous sheet at a height far above that of the highest cirrus, a slight wavy ripple being noticeable in its structure, always perfectly transparent and invisible except under certain conditions. A conspicuous circle of 15° to 20° radius was observed during several days, "a misty, rippled surface of haze, with faint crimson hue, which at the edges of the circle gave a purplish tint against the blue sky."

He notes that Capt. Penhallow, of the *Hope*, observed these phenomena in lat. 24° N., 140° 29′ W., on September 18.

The following notes as to the eruption itself we take from the *Straits Times*, as dates and times are mentioned:—

"In the afternoon of Sunday, August 26, a rumbling sound was generally heard at Batavia, coming from the west, like that of far distant thunder varied by strong detonations, the concussion from which shook and rattled doors and windows on all sides . . . especially when on the night between August 26 and 27 these phenomena steadily became more violent until 1 a.m., when a detonation was experienced which brought about such a concussion that the gaslights here were all as it were extinguished at the same moment. Many persons, anxious for their wives and families and for life and limb, hence forbore to sleep and awaited the morning in great excitement. Morning broke, but the sun, instead of shining with that clear brightness which characterises the morning hours in the East, concealed itself, and the whole sky seemed overcast. At 7 a.m. on that day, August 27, the first shower of ashes was noticed here, from which it was inferred that whatever might be the volcano at work in the neighbourhood, the outburst must assuredly be appalling when ashes in showers could be noticed even in distant Batavia. The ash showers fell heavier, and before the hour of midday had struck the whole of Batavia was enveloped in thick darkness. From the lack of sunlight the temperature fell several degrees. People shivered with cold, their discomfort being heightened by anxiety, especially when lamplight had to be used at midday. Like a mountain a great sea wave came rushing on along the whole coast of West Java, forced its way into the rivers, thus causing them instantly to rise several yards and overflow their banks. Indescribable was the confusion into which prahus, steamboats, and tambangans were thrown in the lower city, and no pen can depict the confusion in old Batavia, resulting in especially the natives and Chinese seeking safety by a general flight. To give some idea of the tidal waves which agitated the sea and rivers, we need only say that at Tanjang Priok, in particular, the water rose ten feet within a few minutes, that it not only wholly overflowed a portion of Lower Batavia quite suddenly, but also bore fully laden prahus of twenty-five lasts and even more capacity ashore like straws. This phenomenon was repeated at 2 p.m., but not so violently. However great was the force exerted by this heavy flow, there came a moment, after it had raged its utmost, when the water in masses of immense height suddenly ebbing away vanished, and left the river beds and sea bottom a while dry. Meanwhile, the thick, heavy, and oppressive atmosphere, charged with sulphurous fumes, began to clear up somewhat in spite of the cold. It became lighter, and by the increasing light people beheld a sight seldom certainly witnessed here in the course of centuries. The streets, or rather the roads, the trees, and the houses, were covered with a wholly white layer of ashes, and presented in the land of the sun a genuine Dutch winter scene. In the meantime, when, later in the day the distant detonations had ceased and rumbles had become fainter, no one had yet the least idea of the havoc wrought by this strange natural phenomenon. By that time Anjer had been flooded and devastated by tidal waves; with few exceptions its inhabitants had been drowned in a moment of time, and on its site in the course of that disastrous Monday nothing but an extensive muddy morass could be seen."

EDITOR

We have received the following communications:—

EARLY in the morning, on December 13, between four and five o'clock, a violent tempest from the north-west arose. The temperature in the course of the morning was rather low, viz. 4° C., and, especially between six and seven, the wind was accompanied by showers of rain, intermingled with hail. This rain was of a peculiar nature, every drop, after having dried up, leaving behind a slight sediment of grayish coloured substance. This was most distinctly to be seen on the panes of windows turned towards the west or the north-west; the spots with which these panes were dotted did not leave the least doubt about their having been caused by the fallen rain.

The streamlets of rain, having evaporated, left on the whole surface of the windows the said grayish matter behind, so that there can be no doubt but the rain itself had conveyed from the upper air the above dust.

The magnificent "cloud-glow" which, on several previous evenings, had also been observed hereabouts, and which has been attributed by meteorologists—with good right, no doubt—to the volcanic ashes due to the catastrophe of Java, made us suppose that the substance observed by us on the windows could not but be of the same origin. We took it for granted that whirlwinds, when the storm set in, had brought the dust down to the lower regions of the atmosphere, where it mingled with the falling rain. Consequently we proceeded to examine microscopically the sediment, in order to compare it with original ash from Krakatoa, which had been sent to the Agricultural Laboratory at Wageningen to have its value as plant-food ascertained. The result of this examination was that both the sediment and the volcanic ash contained (1) small, transparent, glassy particles, (2) brownish, half transparent, somewhat filamentous, little staves, and (3) jet black, sharp edged, small grains resembling augite. The average size of the particles observed in the sediment was of course much smaller than that of the constituents of the ash. These observations fortify us in our supposition, expressed above, that the ashes of Krakatoa have come down in Holland.

Wageningen, December 14 M. W. BEYERINCK
J. VAN DAM

WITH every spare cranny in NATURE filled with volcanic dust, and the whole discussion in far abler hands than mine, I should be loth to trouble you, were there not one point in connection with the recent optical phenomena which has, as far as I know, escaped observation, and which may possibly be worthy of consideration. I allude to the connection between the sky-glows and the phenomenon commonly known as "*Rayons de Crépuscule.*"

To the latter phenomenon I have incidentally had my attention much drawn, having been for many years engaged in a set of cloud observations for a special purpose. This appearance has already been described, and to some extent discussed, in the pages of NATURE and elsewhere. Several other phenomena, some of them occurring while the sun is above the horizon, seem to have been confounded under the same name. That of which I now write consists of red rays converging to a point near the horizon opposite to the sun's position, usually at between fifteen and fifty minutes after the sun has set or before it has risen. On rare occasions I have seen these belts in the evening extending past the zenith so as to converge towards the position of the sun beneath the western horizon. The interspaces of these rays (which, as has long ago been explained by Mr. Lockyer, are the shadows of hills or clouds beyond the visible horizon) are often of a complementary blue-green. The colour of the rays is similar to that reflected at an earlier hour in the evening, or at a later in the morning, from the most elevated cirri. This phenomenon seems to be in itself almost entirely independent of any weather conditions, occurring under utterly diverse states of the atmosphere. It possesses one remarkable characteristic. It is far more common in Europe in the month of November than at any other period of the year, although the prevalent state of our November skies is scarcely such as to favour its visibility. To this characteristic I called the attention of some scientific friends several years ago, amongst whom I may mention the name of Robert H. Scott, F.R.S. I have thought that the "*Rayons de Crépuscule*" were somewhat more common in the years when the November meteors were most abundant. But if this prove to be the rule the exceptions are numerous. There are long periods during which there are no "*Rayons de Crépuscule*," or in which if they occur our view of them is entirely obstructed. I have always supposed that the fall of meteoric dust determines the condensation and congelation of the vapour which exists in those strata from which these red rays are reflected, just as London smoke determines the formation of spherules of fog. The solar rays are thus reflected from ice spiculæ suspended in the atmosphere, rather than, as I understand Prof. Brücke to imply, from the atmosphere itself. Are there any reasons for doubting the possibility of the existence of much water vapour at a far greater elevation than this stratum? This would ordinarily remain in the vapour state, being above the ordinary range of the *pulverised* meteorites.

Now the same orange-red glow in the east, from ten to twenty minutes after sunset, by which I have usually been able to predict the appearance of "*Rayons de Crépuscule*," has been almost constantly visible at that hour throughout the present period. Further, this has been followed slightly on one, and vividly on two, of those evenings when the succeeding glow was most remarkable, by the "*Rayons de Crépuscule*" themselves. And the rays of red light emerging on several occasions from the effulgent glow in the west appear to me closely to resemble western continuations of very elevated "*Rayons de Crépuscule.*"

Ecce iterum. Here we come back to Krakatoa. Granting the distance to which the vapour and dust were ejected from the bowels of Krakatoa to have been so great that the more rapidly rotating surface of the earth brought Panama under this vapour and dust in the space of less than a week, we have a gigantic pepper-box capable of condensing and congealing vapour which had long remained undisturbed in its serene heights. We do not need to call in the known currents of the atmosphere to explain the dispersion Poleward and therefore eastward of the volcanic matter, gravitation alone accounting for the transmission of the particles down the inclined isobaric planes.

To my theory of ice spiculæ it has been objected that these ought to produce halos. So, whenever the recent phenomena have been most strikingly developed, they have done. Yesterday was the third occasion during this period when, from 2.15 to 2.50 p.m. the sun was surrounded by a remarkable halo, the sky at the time being totally devoid (in the neighbourhood of the halo) of any visible upper clouds whatsoever. Cumuli passing the halo appeared green. The halo was followed by a splendid glow in the evening, and again this morning.

December 15 W. CLEMENT LEY

IF you are not yet suffering from a plethora of letters on this subject, I should like to add a few remarks to those which have been already made.

On Thursday, December 6, I witnessed one of these gorgeous sunsets in company with a friend, from the top of Rusthall Common, near Tunbridge Wells. Like Mr. Rollo Russell, I noticed that the peculiar *lasting* glow came from a lofty stratum of pale, fibrous, nearly transparent cirriform haze, which was almost invisible as the sun set, but afterwards came gradually into view, at first white in colour, and then gradually changing to orange, pink, and finally red, the change to pink occurring at 4.25 and to red at 4.45.

We also observed a strange reactionary effect produced by this glow, viz., that long after the red tints had faded from the ordinary cirrus in the western sky and from some snow-shower cumuli in the east, they were both relighted by the glow which had meanwhile increased in the west.

On Friday, this reflection *on to low clouds all over the sky* from the undoubtedly lofty stratum in the west was more noticeable, and it at once struck me that persons who had not observed the entire process of the extinction of the real reflection of the sun by these clouds, and their subsequent reillumination by reflection from the *upper* glow (as Miss Ley terms it), might erroneously be led to attribute this secondary illumination to their reflection of direct sunlight. On this ground alone, I should be rather inclined to accept with a little hesitation the observation on which Prof. Helmholtz bases his calculation, viz., that the clouds which were illuminated by the sun were 45° *above the horizon two hours after sunset.*

Nothing that I saw on either Thursday or Friday at all favoured such a fact. On the contrary, there was some positive evidence in favour of the reflecting medium being situated at a much more moderate altitude. In the first place, judging by an eye often engaged of late in taking vertical angles with a theodolite, I should say that on both days (when the sky was very clear and the stratum which emitted the glow was unusually well defined) the maximum height of the glow-stratum was not more than from 10° to 12° above the horizon.

Moreover the interval between when the ordinary cirrus ceased to glow and this upper stratum began to glow corresponded very much more with a height of from ten to thirteen miles than with such an enormous height as forty miles.

Miss Ley has, I believe, already calculated the height of the stratum to be thirteen miles, and I think this height is far more probable than one of forty miles. Besides, can we imagine either vapour, or volcanic dust, or a mixture of both, to be capable of remaining in suspension in air of such tenuity as must exist at such an altitude? Moreover, I think it must be admitted that whatever be the cause, whether meteoric dust, or impalpable pumice carried over by the upper anti-trade currents from the Java eruption, the reflection arises from a definite stratum and not merely from an atmosphere filled throughout with such dust. Possibly, as Mr. Edmund Clark suggests, the dust may act as a nucleus for the condensation of any vapour that may exist at such a high level, and it is possible that just as we find certain definite positions at which condensation occurs, and therefore clouds float, at lower altitudes, so there may be some particular height at which condensation is determined in these upper regions, thus accounting for the definiteness of the reflection and the presence of the cirrus haze to which it apparently belongs.

Thus, Dr. Vettin of Berlin has recently shown that the clouds have a marked tendency to float at certain defined levels, which can only be supposed to result from the action of certain physical causes regarding whose nature we are at present entirely ignorant.

The name of the cloud and the corresponding elevation in feet are as follows :—

Name of stratum	Height in feet
Lower cloud	1,600
Cloud	3,800
Cloudlets	7,200
Under cirrus	12,800
Upper cirrus	23,000

Now we see that these heights increase very nearly in a geometrical ratio, with 2 as the common factor, so that we might anticipate a tendency for cloud to be formed (assuming that the empirical relation held good) at an elevation of about 46,000 feet, or a height of nearly nine miles. It would be at least interesting to find that the average height of the reflecting layer in these recent sunsets lay at about this elevation.

Another circumstance which favours the notion that the dust would be carried from the tropics, and float above, and not below, this level is that, while at all lower elevations the polar currents predominate, it is just about this same level that the equatorial or southerly air-currents begin to exceed those which have a northerly component in strength and frequency. Thus, according to Vettin, the following figures represent the relative volumes (?)[1] of air carried by the equatorial and polar currents at different altitudes over Berlin :—

Equatorial	Polar	Height in feet
305	226	From 41,000 feet up to the extreme limits of the atmosphere.
253	228	41,000
206	222	23,000
164	212	12,800
108	131	7,200
92	118	3,800
83	158	1,600

This table, I think, makes it easier to understand how the dust should have been transported over to extra-tropical regions from the neighbourhood of Java, and why it should appear only in the *very high strata.*

E. DOUGLAS ARCHIBALD

GILBERT WHITE of Selborne, in one of his letters (lxv., to the Hon. Daines Barrington), describes the "amazing and portentous phenomena" observed in the summer of 1783. "The sun at noon looked as blank as a clouded moon, and shed a rust-coloured ferruginous light on the ground, particularly lurid and blood-coloured at rising and setting. The country people began to look

[1] I have not the copy of the *Zeitschrift* by me just now, and am only quoting from memory. I cannot therefore be sure whether it is volumes or frequencies. For the purpose in hand either would do equally well.

with a superstitious awe at the red lowering aspect of the sun; and indeed there was reason for the most enlightened person to be apprehensive, for all the while Calabria and part of Sicily were torn and convulsed with earthquakes, and about that juncture a volcano sprang out of the sea off the coast of Norway."

Those who are familiar with the letters and poems of Cowper will remember his references to the same phenomena in that year, as in "The Task," Book ii.—

"Fires from beneath, and meteors from above
Portentous, unexampled, unexplained,
Have kindled beacons in the skies; and th' old
And crazy earth has had her shaking fits
More frequent, and foregone her usual rest."

Mrs. Somerville, in her "Physical Geography," traced the origin of these atmospheric phenomena to the great eruption of Skaptar, one of the volcanoes in Iceland, which broke out May 8, and continued till August, sending forth clouds of mingled dust and vapour, which spread over the whole of northern Europe. Mr. Henderson, in his work on Iceland, and Dr. Daubeny in his work on volcanoes, also describe this eruption, and the enormous quantities of volcanic dust sent by it into the atmosphere.

Mr. Norman Lockyer ascribes the recent abnormal sunrise and sunset phenomena to the clouds of volcanic dust from the great eruption of Krakatoa on September 2. The different effect caused by a tropical eruption and one in northern regions would be such as Gilbert White observed, and what we have lately witnessed. In the eruption of 1783 the stratum of dust and vapour must have been at a low level compared with that of 1883. We know in a general way the course of the circulation of the atmosphere, as we do that of the ocean: the flow of currents from the Poles to replace the ascending volume of air in the equatorial zone, which gradually diffuses itself in the upper regions of the atmosphere. But of the direction and velocity of these lofty strata we know little in detail; just as we have variations and unexplained diversions even of oceanic currents, but in the atmosphere to far greater extent. From Humboldt and Arago we have been taught to believe that the pumice and vapour clouds from volcanoes are raised to enormous altitudes, and the dispersion of these may be too irregular to admit of calculating the exact time after a tropical eruption when atmospherical phenomena would appear in particular localities. The fact remains that abnormal atmospheric effects have resulted from the presence in upper regions of the air of pumice dust in unusual quantity.

In some regions of the earth these phenomena have been frequently observed, as on the coasts of Peru, where we would expect a large amount of volcanic dust to be present. In Ellis's "Voyage to the Sandwich Islands," he describes just such appearances as we have been recently seeing. "Towards evening and in early morning I have seen clouds of every hue in different parts of the heavens, and such as I had never seen before: for instance, rich and perfect green, amber, carmine; while the hemisphere round the rising and setting sun has been one blaze of glory." Similar sunlight effects are described by Bishop Heber in his narrative. "Besides tints of crimson, flame-colour, &c., there were large tracts of translucent green in the immediate neighbourhood of the sinking sun, and for some time after sunset; with hues such I have never seen before, except in a prism, and surpassing every effect of paint or glass or gem." These effects were such as aqueous vapour alone could not have produced, and were doubtless due to foreign matter in the upper regions of the atmosphere.

In the meteorological observations of Luke Howard there are several records of similar abnormal sunlight effects when the sky was "deep blood-red after sunset, with hues passing through crimson and a gradation of lighter reds and orange and flame colour." Whether these appearances can be connected with particular volcanic disturbances or not, they seem to have been due to the presence of foreign matter in the upper strata of the air; and there are rarely periods when some volcanic region is not in active eruption.

On more than one evening in December the metallic-green colour of the moon attracted general notice. This was not due to the laws of complementary colour, for it remained when not a vestige of red or crimson could affect the vision. Mr. Edward Whymper states that the peculiar hue recalled to him the same appearance as witnessed by him in South America when the atmosphere was charged with volcanic dust.

JAMES MACAULAY

In 1880, when travelling in Southern Algeria, I was talking with some colonists about a simoom, when a Frenchman present exclaimed "C'est la première fois que j'ai vu le soleil bleu." Upon interrogation I was assured by the whole company that the sun, seen through the fine dust of a Sahara wind, had a decidedly blue colour. I do not know whether this is always the case when a storm is blowing from the desert; but the fact, even if not a regular one, throws some light upon the East-Indian green sun. It confirms evidently the opinion that the green colour and the remarkable weakness of the sun's light, as observed in India, were due to volcanic dust from Krakatoa. An eruption like that of August must throw up into the highest layers of the atmosphere dust not only in enormous quantities but also of extraordinary fineness. And I see no difficulty in assuming that this dust, transported by air currents over Africa and Europe, was the cause of the "remarkable sunsets," the more so, as the latter phenomenon is evidently a wandering one. At Constantinople the first remarkable sunset was observed on November 20 (splendid), and subsequently we saw the same glow of the heavens in the morning and evening of the first five days of December, though partially masked by clouds. Afterwards the observation was rendered impossible by bad weather.

Constantinople, December 12 DR. BUDDE

I HAVE read with great interest the accounts of the extraordinary sunsets we have had lately. I have watched all the effects most carefully for the last fortnight, and it may be of some interest to you to hear my account. The first time I noticed anything very odd was on the evening of the 24th. I was then calling on a friend who lives on this lake, and it was dark enough to have candles, when on looking up at his studio window I saw three or four masses of cumuli piled up against each other, and all of unusual, or rather I should say unnatural, colour. I said to my friend, "Well, I never saw such a sky or clouds, it is exactly like an old master picture, like a rich Titian sky." . . . I said this because what *ought* to have been blue sky was quite a rich green, and some of the clouds rich amber, others red brick colour, and others a yellow green. There was a high wind; these clouds were in the north, or nearly opposite the sunset, and very near. I was startled, because I knew some of the colours to be unnatural, especially at that time of day (4.30); it was not a green or an amber I had ever seen, and I have watched the sky very carefully for many years. Then, about a week ago, I saw the same effect again, and on looking round towards the sunset my eye caught the crescent moon; it was of a *pale blue green*. Two evenings before this, I was startled on looking up from my book (and some time after candles had been brought in) to see quite a red glare behind the "Old Man"; as it was almost night, I thought it was some large fire, but on going out I saw that it was merely a glare from the sunset; and more to the east near the horizon there were lurid masses of red cloud very far off showing through bars of nearer gray cloud. I thought of running into Ruskin's study and telling him to look, and went as far as his door, but then deemed it better not, as the effect was of so lurid and awful a nature, I thought it might put him off his work! My next scene was one morning; finding the room very dark, I suddenly discovered the maid had shut the shutters; I got up to open them, and to my astonishment saw Coniston *Old Man all red*, but with no shadows! I was all the more astonished because it was still much too dark for any light on the "Old Man" at all! and I can assure you it really looked *alarming*. I have of course often seen the mountain red and orange, but never before sunrise. I concluded that this glare was caused by some very bright reflection from the rising sun on the sky above, and bright enough to make the mountains all red. I watched this more or less until nine o'clock, when at last the usual shadows appeared, the mountain getting I suppose some real sunlight. Then my last effects have been two extraordinary after-glows a few evenings ago. It seemed to me that about half an hour before sunset the sun began to shine through some extraordinary vapour capable of being illuminated *very much* more than the ordinary atmosphere, so much so that we had faint *cast* shadows from it on our lawn; there was no sign of the sun or even where he was, as this vapour was so *equally* illuminated. It lasted long; and when candles had been in some time, there was still a band of *intense rose* colour on the western horizon.

ARTHUR SEVERN

Brantwood, Coniston, Lancashire, December 9

THIS atmospheric phenomenon still continues morning and evening to excite admiration. Its effects, however, on the colour of the sky disappear at an earlier hour than has hitherto been the case; on the morning of Wednesday, the 5th inst., the southern heavens were resplendent with richest and most brilliant colours, to attempt the description of which would be somewhat puzzling. It seems as if of late the grandest displays occur before sunrise. The afternoon effects were remarkable less for richness of coloration than for the lustre of the light which arose in the west after sunset and for the predominance over the whole sky of opalescent white colours. The reflection of the light on church towers and buildings brought out the architecture in strong and startling relief. There was, however, at 4.15 p.m. a colour display, and on this occasion the moon for a short time was again changed to a hue of emerald green. On the 6th, before sunrise, the phenomenon reappeared in a mantle of lurid red colour. The display passed through the usual changes of colour and disappeared when the sun rose. In the afternoon the glow at 4 p.m. reappeared, followed by the usual brilliant radiance; the colours were, however, sea-greens, opaline whites, and bright grays till 4.30 p.m., when a blood-red colour overspread the western sky. The glow faded sooner than usual. The morning of the 7th though splendid was less grand in character than the display of the previous morning. At 4 p.m. a rosy hue suffused a few light clouds that rested on the sky. At 4.15 pearly whites and mauves and grays prevailed. Just at this time an irregularly shaped vaporous mass of an exquisite tint of lake formed in the west 45° above the horizon, and gradually spread to a point near the horizon. At 4.30 the usual orange-coloured arc appeared in the west, and for a few moments the light emitted was almost dazzling. The display was somewhat evanescent. On the 8th, before sunrise, the sky was enriched with various hues of red, carmine, green, and yellow. At 3 p.m. there was a detached cloud canopy coloured with a deep rose, but changing to an orange hue; 5 p.m. dense cloud canopy with red radiance visible through the clouds. On the 9th a dense cloud canopy shut out observation. At 4 p.m. a bright yellow glare coloured the horizon of the western sky. This was followed by the orange-coloured radiance, but the display was fugitive. The morning and afternoon of the 10th were unfavourable for observation owing to a dense cloud canopy, but a yellow-coloured light in the sky was perceptible. On the 11th the sky before sunrise was brilliant with colours pink, blood-red, yellow, and green. At 8 a.m. for a few moments the sun appeared of a green colour. This afternoon's effects were very beautiful. At 3 p.m. a yellow glow prevailed: this gave way to a remarkable streak of a vivid green colour extending along the horizon from north-west to south-west; above this was a vaporous mass reaching to within a few degrees of the zenith. Beyond this mass and overspreading the zenith the colour was mauve. In the eastern sky the colours were reds, mauves, and blues. This evening the moon again shone with a green light. The glowing arc of orange-coloured radiance which evening after evening shone in the western horizon seems to have ceased to be apparent here. The effects of the splendid sky coloration in causing the flame of gas lamps to appear white, or rather in fact to resemble the electric light—noticed by Mr. Sydney Hodges at Ealing—was at this place a striking feature of the displays. A destructive hurricane from the north-west set in at 11 p.m. on the 11th inst., and was of greater violence than any that has occurred here from that point for these forty years. The night was moonlight, with flying scud. In the night, between one and two o'clock a.m., during the height of the hurricane, the phenomenon of paraselene or mock moon was visible. The false disk was well defined, equalled the moon in size, but was less brilliant, and was some 4° or 5° from the true moon; prismatic halos were visible during the night. The wind blew in terrific gusts, striking houses and buildings almost with the force of a battering ram. Before sunrise on the 12th a red glare suffused the sky, and at half-past eight a.m. the sun appeared of a dark green colour, and remained of this colour for several minutes. The violence of the hurricane subsided towards four a.m. During the lulls of the storm there were on one or two occasions tremors that I could not connect with the vibration of the house from the effect of the wind, and which seemed to me to be earth tremors. In the afternoon the glow appeared in the west in the shape of a mass of a luminous yellow body some 25° above the horizon, which sank gradually below the horizon, and left a clear sky. On the morning of the 13th the only colour visible was a deep yellow, and that colour prevailed in the vicinity of the sun throughout the day. Thermometer again rose to 50°, barometer falling. In the afternoon of that day, cloud obscuration shut out observation.

December 14.—At sunrise, owing to the denseness of the prevailing cloud canopy, observation was not possible. At 10 a.m. the canopy broke up and dispersed, and, except along the eastern horizon, the sky became blue and clear. At 11 a.m. a broad, colourless stream of remarkable moving vapour or cloud haze, and rayed, nebulous cirri of a very filmy structure, issued from a point occupied by a few clouds of the stratus type on the western horizon, and travelled across the zenith eastwards. The motion of the vapour and cirri was rather fast as it swept across the sky. The quick-changing forms were most astonishing, some being of a leaf structure, some pointed rays, some curled, others horizontal bars. The forms of both haze and cirri were most fantastic. The stream continued to flow till after 2 p.m. I have never before observed anything like it. At 3.15 p.m. there was a wide-spreading green sky space about 20° in altitude on the western horizon. Above it gradually in the clear sky, a rich russet glow, with no definite outline, became developed, and continued to prevail. A 4 p.m. a pink glow coloured some clouds resting on the western sky and flushed the entire horizon. Towards 5 p.m. the russet colour gave way to a smoky yellow tint, and soon afterwards the light disappeared. Cloud-forms during the day took the most weird and fantastic forms. Imagining that the phenomenon was on the wane, I was surprised to witness a display so brilliant and imposing. On this day the thermometer rose to 54°. At 8 p.m. there was a rather broad band of green light round the disk of the moon. It seemed to me that neither the sun nor the moon during the days and nights of the 12th, 13th, 14th, and 15th gave the usual light.

December 15.—The sunrise this morning was of a most impressive character. From just before sunrise till 8 a.m. the eastern sky was flushed with blood-red colour. At 8 a.m. the sun again shone with a most beautiful green light for a few minutes. The room in which the observations were made has two windows, one facing east, the other south, and the marvellous spectacle was witnessed of a flood of crimson glare filling the east window, while through the south window poured a volume of dazzling green light. This afternoon there was a thick cloud canopy, and rain fell, but a yellow glare penetrated the clouds on the south and west. At 4 p.m. through a cloud rent could be seen the bright pink, russet green, and yellow colours of the glow. The thermometer registered 44°.

December 16.—The glare was visible this morning, but no colour other than smoky yellow was visible. Afternoon the glare very powerful, but at 3.45 pale yellow was the only colour. This, however, prevailed in the west, but extended round the whole horizon. The spoked ray feature, however, was greatly developed.

The steel coloured radiance which glowed in the western sky at 3.30 p.m. at the time of closing my letter was followed from 4 till shortly after 5 p.m. by the fiery glare which has been a marked feature of the red sky displays during their prevalence. The sky effects were much the same as on the previous afternoon, except that the nebulous matter was traversed by fan-shaped pointed rays, and its structure presented a billowy appearance.

December 17.—Glare at sunrise as on other mornings of late, the coloration less grand and brilliant. During the morning a stream of filmy cirri issuing from the point in the heavens occupied by the sun and travelling across the zenith till after midday. 3.30 p.m.—Steel coloured glare, followed at 4 p.m. by the development of the usual fiery glow in the western sky, traces of which remained till 6 p.m.

In the "Notes" in NATURE for the 6th inst. (p. 135) is a record of a fall, on the night of Nov. 17, at Storelvdal, Norway, of layers of gray and black dust. This was the day of the date of a fall of discoloured rain near Worcester. Recent accounts announce the visibility of the phenomenon in America, where its cause is ascribed to meteoric dust. Reports of falls of ashes on land and shipboard tend rather to strengthen the volcanic dust theory. According to the "Annals of Philosophy," vol. ii., the sun appeared of a blue colour in April of the year 1821 in England. It seems from other sources that there were in February of that year a violent volcanic eruption in the island of Bourbon, and in June of the previous year a destructive outbreak in Gunung Api.

Worcester, December 17 J. LL. BOZWARD

THE following observations of the remarkable "glow" that has lately been attracting such universal attention at sunrise and sunset may be of use for comparison with similar phenomena observed in other parts of the world. They relate to the phenomenon as observed at sunrise on those occasions when the atmospheric conditions and other circumstances have been favourable for obtaining good observations, though I may state that, even when cloudy, and no clear blue sky visible, the red glow has frequently made itself apparent through the clouds.

December 4.—6.40 a.m. The whole eastern sky between the east-north-east and south-west, for an altitude of 15°, was of a pale pink; at 7.15 it had increased in altitude to 45°, and near the horizon was of a deep crimson. At 7.30 it began to fade away, changing to a yellowish pink, and at 7.45 it had disappeared, excepting a slight crimson haze having an altitude of about 10°, and confined to that portion of the horizon at which the sun was about to make his appearance.

December 12.—6.30 a.m. A narrow belt of brilliant crimson clouds about 5° wide skirted the horizon between the north-east and south-south-east; at 7 it had considerably decreased in brilliancy, and reached an altitude of 15°, and at 7.30 it had become of one uniform pink colour, and now reached the great altitude of 60°. It now began gradually to fade away, changing to a yellowish pink, and rapidly decreasing in altitude until by 7.45 it had entirely disappeared, leaving a clear blue sky, which at 7.50 became tinged with the ordinary sunrise tints.

December 13.—6.50 a.m. A bright yellow glow having an altitude of 15°, appeared on the horizon, extending from the east-north-east to the south-east; at 7.20 it had increased in altitude to 60°, the upper portion being of a pink colour, giving to the blue sky immediately adjoining a sickly green tint. At 7.50 the pink glow near the zenith had disappeared, and the yellow glow near the horizon had changed to pink; it had now decreased in altitude to 10°, and extended no further than between the east and south-east points of the horizon. As the sun rose above the horizon it again changed to yellow.

December 17.—7.15 a.m. The clouds which up to this time had overcast the sky cleared away, although a very brilliant display of the "glow" was to be seen. The entire eastern sky between the east-north-east and south-south-east for an altitude of 75° was of a beautiful pink, excepting immediately on the horizon, where it was yellow. At 7.45 the glow disappeared, leaving a clear blue sky until 7.55, when the usual sunrise tints made their appearance.

From the foregoing remarks it will be seen that the "glow" in this locality has generally made its appearance 1h. 20m. before sunrise, and excepting in one instance (December 4) it has disappeared ten minutes before the sun has made his appearance above the horizon.

Dalston, E., December 18 B. J. HOPKINS

I HAVE observed the "after-glow" here (Madrid) since November 30, when it first came under my notice. The effect was particularly fine on the 2nd inst., the atmosphere being perfectly clear, and the moon (new, two and a half hours behind the sun) quite brilliant, as also the stars. At 4.24 (Madrid time) the sun went down, and we had a fine, but not unusual, golden sunset effect which lasted about fifteen minutes. At 5 the sky was gradually lit up again, say 100 miles north and south of sun point on the horizon, and some 45° of arc above, the colour varying from pink-red to crimson, less intense on high, but with a defined semicircular boundary against blue sky, which at this period assumed a *greenish* tint, as did also the moon without losing her brilliancy. But I did not observe any "streaks of Polar auroral light," mentioned in Mr. Bozward's letter; the crimson fan (shall I say?) was uniform, and maintained its intensity till six o'clock, though it gradually receded; the moon at the same time recovering her silvery appearance; and at 6.15, that is one hour and forty minutes after sunset, all was over. At 6 p.m. the barometer (4-inch height aneroid by Ladd) marked 705·50 mm. (say 27·80 inches; Madrid is 655 metres above the sea), and the thermometer (Casella, K.O., No. 9538), sheltered, 4 metres above ground, stood at 10° Cent.

On the 3rd inst. the effect was somewhat different, owing to slight haziness, coupled with delicate ripples of cirrus above, a few streaks of heavy cloud down on horizon, and slight breeze from south-west; but the whole phenomenon on the 4th inst. was the most instructive. These are my notes:—

4.34 p.m. sundown; usual sunset effect, golden; massive horizontal streaks of neutral tint cloud, from 5° to 20° above horizon, with intervals, coloured Indian red; cirrus above light crimson. 4.50, all over, clouds no longer illuminated, sky on horizon dull yellow. 5 p.m., yellow band turned *pale green; low clouds remaining quite dark* (not illuminated), upper transparent cirrus pink or light purple, *gradually* fading off into blue atmosphere, which remained *decidedly blue* although the moon and haze circle round her (= four moon diameters) were decidedly *greenish*. 5.15, purple fan receded or contracted somewhat, and more crimson in colour; green tint on horizon fainter. 5.25, upper purple tint quite gone; light down on horizon bright red like conflagration (or iron heated to redness); moon greenish; *heavy cloud streaks quite dark;* and here I will say that although I noticed in Madrid a very slight breeze from north-west, *all* clouds remained to all appearance perfectly stationary from beginning to end. 5.35, at this moment the lower clouds (say to 20° above horizon) were *reilluminated as at sunset* from beneath (Indian red), after remaining forty-five minutes in total shade. At 5 45 this new illumination began to fade, and the red glow on the horizon had risen somewhat, and was dusky. 5.50, only a few red streaks under the clouds; glow as before, apparently more intense, owing to increasing darkness. 6.0, glow dull, and low down on horizon, nearly all on the north side of the sun's setting point. 6.15, all over. Barometer 702 mm. (say 27·65 in.); thermometer 12° C.

Since December 1 the whole phenomenon, without losing intensity, has become reduced in extent, *i.e.* the fan of light (so to speak) is getting smaller, especially in the direction of its length on the horizon. Yesterday (5th) I noticed the same *reillumination* of cloud; to-day we had heavy clouds and rain at the time, and barometer 699 mm. and thermometer 6°5 at six. F. GILLMAN

Quintana 26 (Barrio Arguelles), Madrid, Dec. 6

THERE has been a very fine "glow" this evening, with the delicate rose tint which is so unusual. I observed the bands at C and D very strongly marked, and also a faint band at about *a*, and another about half way between C and D. This is the best marked evening glow that we have had here since about the end of last week.

Dublin, December 14 J. P. O'REILLY

SIGNOR DENZA, Director of the Central Observatory at Moncalieri, writes that these sunsets were seen from November 25 to December 1, and again from December 4 to December 7, throughout the whole of Italy from the Alps to the extremity of Calabria, and everywhere with great intensity. A vast number of reports have been received at the Central Observatory, generally to the same effect. So vivid was the glow, that by many observers it was taken for an aurora borealis, the prevailing colours oscillating between red and deep orange, and afterwards passing through all the tints to the most delicate pink. During the evenings of November 28 and 29 nearly the whole sky was lit up, and the phenomenon was followed first by storms, fogs, and rain, and later on by snow. Observed with the spectroscope, the light presented nothing but the usual absorption lines of the vapour of water, but very intense. Before dawn and after sunset the zodiacal light was seen very distinctly.

Numerous letters have appeared in the *Times* on the sunsets during the past week:—

MR. G. J. SYMONS sends the following extract from the Meteorological Report from Adelaide Observatory, South Australia, for October, 1883:—"On every clear evening during this month, and the last fortnight of September, a peculiar phenomenon has been apparent in the western sky. Shortly after sunset a red glow will make its appearance, at an altitude of about 50°, being very faint at first, but as the brightness of the sky near the horizon dies away with the receding sun, the red glow will expand downwards, becoming at the same time more brilliant, until at last the whole western sky will be lit up with a beautiful light, varying in colour from a delicate pink to a most intense scarlet, and the spectacle presents a most brilliant appearance. The upper part will then gradually fade away until the colour is noticeable only 7° or 8° above the horizon, at which time the light is at about its brightest. Afterwards, a secondary glow will sometimes make its appearance at an altitude of about 50°, and gradually spread downwards until the sky is again lit up. In the secondary phenomenon the colours are generally more delicate. The whole thing will fade away about 8 p.m. This phenomenon has been noticed all over the south eastern portion of this continent, from Port Augusta (lat. 32° S.) to Melbourne; and in India the sun has at times presented a most peculiar appearance, being green at rising, then gradually changing to a blue at noon, and inversely from noon to sunset. Various theories have been started to account for the phenomena."

COL. STUART-WORTLEY states that in 1862 he spent a year in South Italy on purpose to study the formation of clouds by the aid of photography. "During that time I spent some time at Naples while the great eruption of that year was going on, and was struck with the unusual colours of the sunsets during and after the eruptions. I still have photographs of both sunrises and sunsets indorsed with memoranda as to unusual and exceptional colours." Four years ago, while sailing in the Pacific, Col. Stuart-Wortley was much struck with the fact that very frequently the whole vault of heaven was overspread with magnificent and glorious colouring, and that in the higher regions of the air colours were found that were never seen at the horizon or below a certain height. "Now, this exceptional magnificence and peculiarity of colouring only occurs in certain latitudes and in well-defined belts, and I venture to suggest that, seen in the light now thrown on the subject by Mr. Norman Lockyer and others, the constant stream of volcanic matter thrown out by the great volcanoes in the mountain ranges of South America, and possibly from elsewhere, form an almost permanent stratum of floating matter, carried in certain directions and kept in certain positions by alternating currents in the higher regions of the air, and that to this stratum of volcanic matter much of the exceptional colouring found to be associated with sunrises and sunsets in portions of the Southern Pacific Ocean is due."

MR. W. H. PREECE writes:—"I think I can add one link to Mr. Lockyer's chain of reasoning. If we assume that the mass of volcanic matter projected with such force into the atmosphere in the Straits of Sunda was highly electrified, then it must have been electrified with the same sign as that of the earth—viz. negative. Therefore, when the force of projection had exhausted itself, the cloud of matter would be subject to two other forces besides gravity—the repulsion of the electrified earth, and the self-repulsion of each particle of electrified dust. The first would determine the tenuity of the cloud, for the lighter the particles the further they would be repelled, and the heavier the particles the quicker they would descend. It is quite possible to conceive that they might be so minute and so highly electrified as to reach the utmost confines of our atmosphere, where they would remain as long as they remained electrified. The second repulsive force would cause the particles to spread out continuously in a horizontal plane until they would cover an area determined only by their quantity. When we take into consideration the movements of the atmosphere and the rotation of the earth, I see no reason to doubt that an immense cloud of highly electrified matter, projected into the atmosphere in Java, could spread itself in the higher regions of the atmosphere over an area equal to that of Europe. That this is not fanciful is proved by the behaviour of smoke. I have often watched when at sea, on a still, calm day, the black smoke of some passing steamer rise to some determined height, and then gradually spread itself at an equal and constant distance from the sea like a great flat pall. I have also seen on land the smoke from some manufacturing shaft blown gently by the wind follow the curves of the land, remaining always at the same distance from the ground, but gradually spreading outwards in every direction. I have also seen two lines of smoke refuse to coalesce, but repelling each other exactly as they ought if they were similarly electrified. That smoke is, therefore, negatively electrified I firmly believe, though I have never tested it. Now, that this wonderful atmospheric disturbance was accompanied by extraordinary electrical disturbance was shown, not only by Capt. Watson's observations near the spot, but by Prof. Smith's records at Madras, and hence it requires no great stretch of the imagination to conceive electricity playing a great part in the recent gorgeous display of atmospheric effects."

IN reference to Mr. Preece's letter, Mr. Crookes writes:—"In a paper read before the Royal Society in 1879 I showed that at a rarefaction of the millionth of an atmosphere two pieces of electrified gold leaf repelled one another at a considerable angle for thirteen months without loss of charge. Therefore at a rarefaction of a millionth (corresponding to a height above the earth's surface of about sixty-two miles) air is a perfect non-conductor of statical electricity, without interfering with the mutual repulsion of similarly electrified particles. When we bear in mind that the specific gravity of gold is five or six times that of the rock whose disruption formed the dust in question, and that the size of the individual particles of dust is certainly many thousand times smaller than my gold leaves, there is every reason to believe that electrified dust, once projected fifty or sixty miles above the earth's surface, might remain there for many years."

BISHOP BROMBY, writing to the *Times*, says that in a letter from a member of his family at Hobart, Tasmania, the writer speaks admiringly of "the loveliest after-glow which was spread over the sky on the other side of the water where the sun had set." This was written on October 12 by one who was ignorant that similar phenomena had been observed in other parts of the world.

ANOTHER correspondent of the *Times* states that in a letter dated "Duem, September 24, 1883," Hicks Pasha wrote:—"By the way, have you in England noticed a large black spot on the sun? To-day, when it rose, it was of a pale green colour, and we saw through our glasses an immense black spot on the lower half of it. What does this portend? I feel sure there must be some notice of it in the papers in England."

SHERIFF RAMPINI of Lerwick, Shetland, writes that the sunsets have been observed in these northern islands.

MR. G. F. BURDER of Clifton sends the following extract from a letter from a passenger travelling from San Francisco to Sydney, three days after leaving Honolulu. The writer says:—"On Wednesday, September 5, we witnessed a most curious phenomenon. The sun set perfectly blue, and next morning it rose a flaming ball of blue The blue light was reflected in our cabins."

ON November 30, at 4 p.m., another remarkable sunset was observed in Stockholm. A correspondent states that the western sky became covered with an intense purple after-glow, having the appearance of an enormous distant conflagration, which nearly reached the zenith, and lasted for an hour, even after it was dark, and the stars were visible. On the morning of December 1 a similar intense light was observed at sunrise. The colour was, however, then more yellow. The phenomena have also been observed in the north of Sweden, in Gothenburg, in Christiania, and in Copenhagen.

THE KRAKATOA AIR-WAVE

ON Thursday last Mr. R. H. Scott communicated a paper to the Royal Society giving a map and tabular statements concerning certain barometric disturbances observed towards the end of August last.

The obvious correspondence of the forms and times of occurrence of the barometric disturbances, described in Mr. Scott's paper, at once suggested to General Strachey that they were due to a common origin, and the great volcanic eruption at Krakatoa in the Straits of Sunda appeared to supply a probable efficient cause. General Strachey therefore took up the question from this point of view, and at the same meeting communicated a paper, of which the following is an abstract:—

"Any shock of sufficient violence might be expected to produce an atmospheric wave, advancing from the place where it was caused in a circular form round the globe, at first expanding until it had got half round the earth, and then again contracting till it was again concentrated at the antipodes, from which again it would be thrown back, and so pass backwards and forwards till it was obliterated. It might have been expected that such a wave would travel with the velocity of sound, being probably of the same nature as that which causes sound, though the vibrations had not the peculiar character that affects our organs of hearing. It has, however, been suggested to me that the wave may rather have had the character of a solitary wave produced in a liquid, the velocity of which in the air would not materially differ from that of sound.[1]

"A rough examination of the facts at first made known by the observations recorded in Great Britain indicated that there was *primâ facie* strong evidence in support of this view, and that the phenomena would be approximately explained by the passage round the earth of a series of waves travelling at the rate of about 700 miles an hour in opposite directions from the place where the volcanic eruption occurred. The records since procured from other places, and the more careful examination of the facts, have quite confirmed this conclusion.

"Although we may expect to obtain additional data from other parts of the globe, which will make the investigation of this somewhat remarkable phenomenon more complete, yet those we now have are sufficient to justify an attempt being made to bring the more important facts before the Royal Society without further delay.

"The following table shows the stations from which the records have been received of which use has been made in this discussion, with certain particulars of their geographical position, and of their distances measured on great circles, from Krakatoa, the place of eruption:—

Place	Longitude	Latitude	Distance from Krakatoa, measured on a great circle	
			From west to east.	From east to west.
	° ′	° ′	° ′	° ′
Toronto	W. 79 15	N. 43 40	142 15	217 45
Valencia	„ 10 18	„ 51 55	249 31	110 29
Coimbra	„ 8 24	„ 40 13	247 58	112 2
Armagh	„ 6 39	„ 54 21	252 17	107 43
Falmouth	„ 5 4	„ 50 9	252 15	107 45
Glasgow	„ 4 18	„ 55 53	253 57	106 3
Stonyhurst	„ 2 28	„ 53 51	254 34	105 26
Aberdeen	„ 2 6	„ 57 10	255 25	104 35
Kew	„ 0 19	„ 51 28	255 27	104 33
Greenwich	„ 0 0	„ 51 29	255 39	104 21
Paris	E. 2 20	„ 48 50	256 49	103 11
Brussels	„ 4 20	„ 50 51	258 17	101 43
St. Petersburg	„ 30 20	„ 59 56	272 3	87 57
Krakatoa	„ 105 22	S. 6 9		

[1] The log of a surveying ship at the north of Borneo, since received, shows that the explosions were heard there on the morning of August 27, at a distance of 1200 miles from the volcano; and it has been also stated that these sounds were heard in Ceylon, at a distance of about 2000 miles.—R.S.

"As the earlier disturbances, on August 27 and 28, extend over several hours, it became necessary to fix on certain sufficiently well defined points in the curves representing the barometric pressure, from which to measure the epochs of the passage of successive disturbances. The *first* and *second* of the series are, in almost all the curves, well defined and generally similar in form, commencing with a distinct rise, which is again followed by a distinct fall, the fall being shorter than the rise. These features are followed by a less definite rise succeeded by a shallow fall, after which there is again a rise, which gradually passes into the more regular trace.

"The *third* and *fourth* of the disturbances can be traced in all the curves, but they no longer exhibit the same characters, and are usually nothing more than a sudden sharply defined rise, though in front of some of these there is a more or less distinct trace of a hollow.

"The *fifth* and *sixth* of the series become less distinct and are lost at several stations, being usually rises; while a *seventh* faint disturbance, as a shallow hollow, can be traced in a few of the curves, after which nothing can be distinguished.

"By a comparison of the time intervals between the first and third, the third and fifth, and the fifth and seventh disturbances, and assuming (which the facts seem to justify) that the velocity of the wave has remained unchanged in its passage from east to west, it would appear that the first well-defined rise in the first of the series corresponds to the rises which are prominent in those succeeding it. And the same conclusion has been drawn from an examination of the second and fourth compared with the fourth and sixth of the series.

"Adopting these conclusions, the times of the successive passages of the initial rise have been measured from the curves, suitable allowance having been made where the rise was difficult to trace, or, as sometimes happened, a hollow appeared corresponding in position with the hollows in the earlier form of the disturbances. There is, of course, some doubt attaching to these measurements, but their general consistency seems to indicate that they may be accepted as fairly representing the facts under discussion.

"The following table gives the results of these estimates of the times at which the successive waves passed the several stations, reckoned from midnight of Aug. 26, in Greenwich mean time:—

Place	Times of passage of wave.													
	I.		II.		III.		IV.		V.		VI.		VII.	
	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.
Toronto	16	55	25	10	55	10	61	30						
Valencia	13	55	26	30	50	50	62	5	87	55	96	10	124	25
Coimbra	13	50	26	55	50	30	62	40						
Armagh	13	30	26	45	50	40	62	15	87	45	96	20	124	30
Falmouth	13	25	27	0	50	25	62	15	...		97	45	124	30
Glasgow	13	30	27	0	50	35	62	20	87	35	97	30		
Stonyhurst	13	20	26	50	50	25	62	25	87	40	97	30	124	5
Aberdeen	13	20	27	5	50	30	62	30	87	20	98	30		
Kew	13	15	27	15	50	15	62	30	...		98	0	124	5
Greenwich	13	15	27	15										
Paris	13	15	27	30	50	0	62	50						
Brussels	12	35	27	45	50	0	62	55	86	45	98	40		
St. Petersburg	11	15	28	40	48	30	63	50	84	40				

"From these figures are deduced the intervals between the successive passages of the waves from east to west, and from west to east, respectively, or of the times of travelling round the earth, which are shown in the next table, for all stations excepting Toronto.

"From the results thus obtained it would follow that the wave travelled round the earth from east to west in 36h. 57m., being at the rate of ·1026 hour for one degree of a great circle of the earth, and from west to east in 35h. 17m., being at the rate of ·098 hour for one degree. From the velocities thus determined the probable time of the origin of the wave has been calculated from the known distance of each place from Krakatoa, the time occupied in the passage of the wave from Krakatoa to the place of observation, and the observed time of the passage of the waves.

"The mean value thus obtained from the waves moving from east to west for the time of the origin of the disturbance at

Intervals occupied in travelling round the earth.

Place.	From east to west.								From west to east.					
	I. to III.		III. to V.		V. to VII.		Mean.		II. to IV.		IV. to VI.		Mean.	
	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.	h.	m.
Valencia	36	55	37	5	36	50	36	57	35	35	34	5	34	50
Coimbra	36	40	...		...		36	40	35	45	...		33	45
Armagh	37	10	37	5	36	45	37	0	35	30	34	5	34	48
Falmouth	37	0	37	3*	37	3*	37	2	35	15	35	30	35	22
Glasgow	37	5	37	0	...		37	3	35	20	35	10	35	15
Stonyhurst	37	5	37	15	36	25	36	55	35	35	35	5	35	20
Aberdeen	37	10	36	50	...		37	0	35	25	36	0	35	43
Kew	37	0	36	55*	36	55*	36	57	35	15	35	30	35	23
Greenwich	36	45												
Paris	36	45	...		...		36	45	35	20	...		35	20
Brussels	37	25	36	45	...		37	5	35	10	35	45	35	28
St. Petersbrg.	37	15	36	10	...		36	43	35	10	...		35	10
Mean excluding Toronto	37	4	36	51	36	48	36	57	35	24	35	9	35	17

Krakatoa is 2·52h. Greenwich mean time, or 9·53h. local time, that is 9h. 32m. a.m. of August 27.[1]

"In like manner the waves travelling from west to east gave results which were exhibited in another table.

"The mean value of the time of the origin of the disturbance obtained from the waves moving from west to east is therefore 2·20h. Greenwich mean time, or 9·21h. local time, that is, 9h. 13m. local time.

"The mean between the two values obtained from the waves travelling against the earth's motion of revolution, and those travelling with it is 2h. 24m. Greenwich mean time, or 9h. 24m. local time, August 27.

"The velocity of the waves in miles will be for those which travel from east to west 674 miles per hour, and for those passing from west to east 706 miles per hour. The velocity of sound is for a temperature of 50° F. 757 miles an hour, and for 80° F. 781 miles an hour. With a temperature as low as zero F. the velocity will only be reduced to 723 miles an hour, which is still considerably in excess of the greater of the observed velocities. The excess of the velocity of the waves which travelled in the same direction as the earth's motion of revolution, that is, from west to east, over that of those which passed in the opposite direction, is about 32 miles an hour, which might be accounted for by the circumstance that the winds along the paths of the waves would, on the whole, be from the west, which would cause an increase in the velocity of the one set, and a diminution in that of the other, so that the observed difference of 32 miles would correspond to an average westerly wind of 16 miles an hour, which is not improbable.

"It should be observed that the path of the wave which passed Toronto approached very near to the North and South Poles, and that the velocity in both directions appeared to be somewhat less than in the waves which passed over Central Europe. The wave which passed northwards over Asia travelled at the rate of about 660 miles an hour, or about 15 miles an hour slower than the wave which passed over Great Britain from east to west. This reduction of velocity seems to be within the limits of what might be due to the low temperature of the regions.

"The wave travelling from east to west having been perceptible on the barometer traces at several of the stations until about 122 hours after its origin, and its velocity having been 674 miles an hour, it had travelled before its extinction more than 82,200 miles, and had passed 3¼ times round the entire circuit of the earth.

"It is further worthy of notice that during August 30 and 31 and September 1, a very severe cyclonic storm was crossing the North Atlantic, and that the wave coming from the westward early on the 31st, No. VI. of the series, must have passed on in front of the cyclone, and that its next transit would have carried it into the very centre of the cyclone near the British Isles on the afternoon of September 1. This perhaps ac-

* At these stations the fifth transit cannot be traced.

[1] It has not been thought necessary to give *in extenso* the table showing the separate values deduced from the several observations, but they differ from the mean by in no case more than a few minutes.

counts for no trace of it being found, though the wave coming from the eastward on the morning of that day, just before the cyclone had arrived, No. VII., was discernible.

"There is no definite statement, so far as I am informed at present, of the true time of any particularly severe shock or explosion at Krakatoa excepting that which is contained in the letter of Mr. Watson (published in NATURE, December 6, 1883), whose ship was within a few miles of the volcano on the morning of August 27. He refers to an unusually severe explosion as having occurred at 11h. 15m. a.m. local time, which is nearly 45 minutes later than the time, 9h. 32m., arrived at in the foregoing discussion. The point of the disturbance (as indicated by the barograms) which has been taken as the front of the wave is the highest point of the first abrupt rise of the trace, and is perhaps, on an average, not far from one hour after the first signs of disturbance, the increase of pressure having been very rapid during the interval, but broken into two or three steps or oscillations. During the following half hour there is usually a large decrease of pressure, succeeded by another abrupt rise lasting about half an hour. Then follow a fall of about an hour, then a rise of an hour and a half, and then a fall of an hour and a quarter. The whole length of the disturbance on the time scale is between five and six hours, corresponding to an actual distance of between 3500 miles and 4000 miles. The length of the first main wave of the disturbance is about one hour on the time scale, or about 700 miles in length over the earth's surface.

"In the present position of our knowledge of the facts, it can only be surmised that the shock of 11h. 15m. a.m. of August 27, observed by Mr. Watson, corresponds to the second main feature of the disturbance. That the wave which forms the first feature would have originated at 11h. 15m. a.m. is apparently inconsistent with the observed velocities, which it has been shown are remarkably consistent, and indicate without much doubt an origin at 9h. 32m. a.m.

"The barometric disturbance at Mauritius noted by Dr. Meldrum is said to have begun soon after 11 a.m. local time. The distance from the volcano to Mauritius being about 3450 miles, the wave at the rate of 674 miles per hour would have reached the island in 5h. 7m. Taking the great shock at 2h. 32m. Greenwich mean time, as before reckoned, the wave would reach Mauritius at 7h. 39m. Greenwich mean time, or adding the allowance for difference of longitude, 3h. 50m., the local time would be 11h. 29m., which agrees satisfactorily with the facts as recorded.

"In conclusion, it may be noticed that the sea-waves produced by this volcanic disturbance, assuming the time of its occurrence to have been 2h. 32m. Greenwich mean time on August 27, were propagated with an approximate velocity of 480 miles an hour to Mauritius, of 430 miles an hour to Port Elizabeth near the Cape of Good Hope, and 420 miles to Galle, and a somewhat slower rate to Aden. The details of the occurrence of these waves on the coasts of India will shortly be laid before the Society by Major Baird, who has informed me that the velocity of the wave between Galle and Aden was 378 miles an hour, and the lengths of the great waves from 287 to 630 miles."

"P.S.—December 15. Since the above was read before the Royal Society a copy of the barometric trace from New York has been received, which shows disturbances very similar to those recorded at Toronto, and at times which are quite in accordance with the general conclusions stated in the paper."

NOTES

IN connection with the resignation of Prof. Sylvester of his Chair in the Johns Hopkins University, we find that it was resolved at a meeting of the trustees held October 1, "That as this resignation is doubtless the result of mature reflection on the part of Prof. Sylvester, it is hereby accepted, but that in doing so the Board of Trustees cordially extend to him its hearty thanks for the invaluable services which he has rendered to the University, and also its profound sense of the great ability, the conscientious fidelity, and untiring energy with which he has discharged the arduous duties of his Chair, thereby elevating the science of mathematics to its proper plane, not only in this institution but in this country." It was also resolved "That Prof. Sylvester be appointed Professor Emeritus in the Johns Hopkins University."

IT may be remembered that at the recent Geodetic Congress the French delegates opposed the adoption of Greenwich as the universal meridian, though M. Faye was in favour of the adoption of Greenwich time. At the meeting of the Paris Academy on December 3, M. Faye, whilst supporting the proposal that the universal time should be that of Greenwich, stipulates for the civil hour instead of the astronomical hour, and for the counting of longitudes from 0h. to 12h. positive towards the east and negative towards the west, instead of from 0h. to 24h. reckoned towards the east, but leaving it to astronomers and navigators to employ at discretion for the universal time that according to civil or astronomical reckoning, as may seem best.

A MEETING was held in Sheffield last week for the purpose of carrying out, in connection with Firth College, a proposed technical department having reference to the trade of the district. Among those who spoke were Mr. Mundella and Dr. Sorby, and we need not say that all agreed as to the desirability of establishing such a department, and the necessity of educating our captains, as well as our privates, of industry, in the principles of their crafts. For that, Mr. Mundella insisted, is the true technical education. He gave the experience of a friend who has just been visiting the United States, and inspected the means for technical education existing there; the distinct conclusion was "that there is more skill and intelligence in American industrial pursuits than there is in our English industrial pursuits." It is much that we know our weakness and are taking means to remedy it. No doubt the Firth College will soon have a well equipped technical department.

THE Lecture Arrangements at the Royal Institution before Easter, 1884, are as follows:—Prof. Dewar, six lectures (adapted to a juvenile auditory) on Alchemy (in relation to modern science), commencing on Thursday next (December 27); Mr. R. S. Poole, two lectures on the Interest and Usefulness of the Study of Coins and Medals; Mr. A. Geikie, five lectures on the Origin of the Scenery of the British Isles; Prof. J. G. McKendrick, five lectures on Animal Heat: its Origin, Distribution, and Regulation; Prof. Ernst Pauer, six lectures on the History and Development of the Music for the Pianoforte, and its Predecessors the Clavecin, Harpsichord, &c.; Prof. Tyndall, six lectures on the Older Electricity, its Phenomena and Investigators; Prof. Henry Morley, six lectures on Life and Literature under Charles I.; and Capt. Abney, six lectures on Photographic Action, considered as the Work of Radiation. The Friday Evening Meetings begin on January 18, Prof. Tyndall on Rainbows. The discourses on the other evenings will probably be as follows:—Rev. T. G. Bonney, the Building of the Alps; Prof. Max Müller, Râjah Râmmohun Roy; Mr. G. J. Romanes, the Darwinian Theory of Instinct; Prof. Thorpe, the Chemical Work of Wöhler; Sir Frederick Bramwell, London (below bridge) North and South Communication; Prof. Hughes, Theory of Magnetism (illustrated by experiments); Mr. C. V. Boys, Bicycles and Tricycles in Theory and Practice; Mr. J. N. Langley, the Physiological Aspect of Mesmerism; Mr. Walter Besant, the Art of Fiction; Prof. O. Reynolds, the Two Manners of Motion of Water (shown by experiments).

EVERY one must wish well to the scheme for an Institute for East London, to the meeting in connection with which last Friday at the Mansion House the President of the Royal Society gave the benefit of his experience as an East End doctor forty years ago. The demand for such commodities as the Institute would furnish is strong enough; eminent men of science who have lectured in Whitechapel on their special subjects tell us that the largest obtainable place of meeting in the district is invariably crowded.

A MEETING and *conversazione* will be held under the auspices of the National Association of Science and Art Teachers, in the Manchester Technical School and Mechanics' Institution on Saturday, December 22. Prof. Roscoe, F.R.S., will take the chair. It is expected that a large number of science and art teachers will be present, including visitors and delegates from the Liverpool, Birmingham, and Newcastle-upon-Tyne branches of the Association. It has been arranged on this occasion to bring together for exhibition a collection of apparatus, models, text-books, diagrams, and appliances of a new and interesting nature bearing upon the study of science and art. We have no doubt the meeting will be a successful one. The Association is calculated to be of great service to science teachers, and deserves encouragement. Prof. Huxley is president, and the secretary is Mr. W. E. Crowther, Technical School, Manchester.

AT the last meeting of Superintendents of National Education at Washington, Prof. Bickmore described the lectures on natural history which he now gives every Saturday to school teachers, and the first history of these lectures. The authorities of the Natural History Museum wrote to the Board of Education in New York suggesting that a select few of their teachers should come to hear an informal address upon the objects there exhibited. Sets of these lectures were attended first by those few, then by fifty, then by over one hundred teachers. They are now given to a full hall every Saturday. No continued systematic series of illustrations could be met with, so a photographer was employed to take transparencies of specimens and copies of various illustrations bearing upon the subject to be exhibited by the oxy-hydrogen light. Another lantern is also used to throw light upon the written lists and diagrams or upon objects which are arranged in pigeon-holes, upon each one of which exactly the lecturer can throw the light as it is wanted.

AFTER some interesting reflections upon the wonderful strides in population revealed by the last United States census, Dr. Harris pointed out to the same meeting how partial would be the value of any special technical education that might be given to a whole school. He urged that mechanical inventions were every day throwing out of work "hands" that had acquired manual dexterity. Education of the brain to directive intelligence is the great want. The large development of invention is set down to the study of natural science and of the phenomena of physical processes. On the other hand, the relish, by many students at least, for manual instruction leads the authorities at Boston to report that "manual training is so great a relief to the iteration of school work that it is a positive benefit rather than a detriment to the course in the other studies."

WE learn from Trondhjem that the starling has been seen for the last two winters in the north of the Trondhjem Amt, sitting on the roofs of houses at Christmas time, notwithstanding the cold, which was considerable for the season. In the present year some of the birds are again to be seen after their usual period of migration.

Naturen reports that Prof. Heiberg of Christiania has demonstrated the presence in the air passages and pulmonary substance of hares of a form of strongylus, both barren and charged with ova, which would appear to be the cause of an otherwise unexplained mortality among these animals in the autumn of last year in the district of Eidsvold in Norway.

SEVERAL Russian writers have of late been drawing attention to the fact that the Japanese seas harbour various species of fish which are poisonous. Dr. Sawtscherks even suggests that ships going to these waters ought to be provided with descriptions and representations of these suspected fish, of which twelve varieties would appear to belong to Tetrodon, *T. inermis*, the Japanese "Kanatuka," being reported as especially venomous. According to Dr. Guldrew, one Japanese fish, known as Fuku, is so poisonous that death follows almost instantaneously after eating only a moderate-sized bit of the flesh. The Japanese are forbidden by law to eat this fish, but it is nevertheless not unfrequently the cause of death among the lower classes, who believe it to be possessed of certain marvellous properties, on account of which they risk the danger of being poisoned.

IT is evident that we have much yet to learn respecting insects which habitually go through their early stages in *sea water*. In the current number of the *American Naturalist* (December, 1883) is a account by A. W. Pearson of the larva of the Dipterous family *Stratiomyiidæ* that was found by him beneath *Zostera* on the beach near the mouth of the Merrimac River. With a few exceptions all marine insects are either Coleopterous or Dipterous, and it is the latter order especially that shows itself the most diversified in point of larval adaptation to extraordinary conditions.

M. TILLO publishes in the last number of the *Isvestia* of the Russian Geographical Society the results of very accurate measurements he has made of the lengths of the rivers of Russia in Europe. The measurements have been made on the ten-versts-to-an-inch map of Russia, and present great differences with those which were published by General Strelbitsky in his work, "Superficie de l'Europe;" these last have been made on a map of a much smaller scale (sixty versts to an inch), and contain several errors. The figures of M. Tillo are, on the average, by 26 per cent. greater than those of M. Strelbitsky, showing thus the error which may ensue from measurements made on smaller maps; several rivers, as the Kama, Dnieper, Dniester, and Oka, are, in M. Strelbitsky's measurements, respectively by 200, 285, 300, and 315 versts too short; whilst the ten versts' map has given to M. Tillo a length of the Dnieper only by one-twentieth shorter than the three-versts-to-an-inch map. The chief rivers of Russia appear now with the following lengths: Volga, 2108 miles (the verst being taken equal to 0·663 miles), Ural, 1480 miles; Dnieper, 1329; Don, 1124; Kama, 1117; Petchora, 1024; and Oka, 915 miles.

IN the same periodical, M. Woeikof points out that the tea tree and the bamboo could be advantageously cultivated in Russian Transcaucasia. The most northern point where he has seen the tea tree in Japan is Akita, close by the western shore of Niphon, under 39° 45′ N. lat.; and he has been told that it is grown even at the frontier of Amovori, under the fortieth degree of latitude. The average temperature at Akita would be, according to meteorological observations at Niigata and Hakodade, about 11°·5 Cels. for the year, zero in January, 23°·5 in July, and 24°·5 in August. The tea tree grows very well also in the valleys at Ponevara, under 38° N. lat., 900 feet above the sea-level, where the average yearly temperature is no more than 12°, and that of January no more than 0°, whilst every year there falls a deep snow. As to the bamboo tree, it is cultivated under 39° 10′, 500 feet above the sea-level, on the western slope; and under 38° 35′, 400 to 450 feet above the sea level, on the eastern slope. In the western parts of Transcaucasia, between Batoum and Tuapse, the average yearly temperature varies from 13° to 15°, and that of January is between 4°·5 to 6°·5. Both are thus higher than those of Japan. The summer is, perhaps, a little colder, but this difference would hardly exercise any influence. Even in the interior of the country, up to the Great Caucasus ridge, and east to that of Meakhi, the average temperatures at places up to 1000 feet above the sea-level would allow the culture of the tea tree. As to the rains, they are quite sufficient in Western Transcausia, whilst in the eastern parts of the country irrigation would be necessary.

L'Astronomie states in its last number, in reference to a recent note in NATURE, that Admiral Mouchez has drawn up a memorial praying for the removal of the Paris Observatory from its present position, but that he has not yet presented it to the Council of the Observatory, but will do so at an early period. It is not the first time that the idea has been started. The proposal was made in 1868, and a Commission appointed to report on the matter. The scheme was objected to strongly by Leverrier, and finally rejected after a very sharp discussion.

THE Swedish frigate *Vanadis* has just started on a cruise round the world. King Oscar's second son participates in the cruise, as well as Dr. Hjalman Stolpe, who has been commissioned by the Government to collect materials for the nucleus of a National Ethnographical Museum in Stockholm. The frigate, whose mission is chiefly scientific, will call at many places of interest, as, for instance, the Straits of Magellan, the Marquesas and Sandwich Islands, the remarkable Malden Island, &c. A Swedish merchant, M. Fürstenberg of Gothenburg, has contributed 600*l*. for the purchase of objects of scientific value.

M. BOURDALOU, having published in 1864, in his work, "Nivellement Général de la France," that the average level of the Mediterranean is by 0·72 metres lower than that of the Atlantic, this result was received with some distrust by geodesists. General Tillo points out now, in the last issue of the Russian *Izvestia*, that this conclusion is fully supported by the results of the most accurate levellings made in Germany, Austria, Switzerland, and Spain, which have been published this year. It appears from a careful comparison of the mareographs at Santander and Alicante by General Ibanez, that the difference of levels at these two places reaches 0·66 metre, and the differences of level at Marseilles and Amsterdam appear to be 0·80 metre when compared through Alsace and Switzerland; the *Comptes Rendus de la Commission Permanente de l'Association Géodésique Internationale* arrive at 0·757 metre from the comparison with the Prussian levellings, whilst the fifth volume of the "Nivellements der Trigonometrischen Abtheilung der Landesaufnahme" gives 0·809 *viâ* Alsace, and 0·832 *viâ* Switzerland. The difference of levels at Trieste and Amsterdam, measured *viâ* Silesia and Bavaria, appears to be 0·59 metre. Each of these four results (0·72, 0·66, 0·80, and 0·59), having a probable error of 0·1 metre, their accordance is quite satisfactory, and we may admit thus that the average level of the Mediterranean is in fact lower by 0·7 metre than that of the Atlantic.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. J. L. Waldon; a Night Heron (*Nycticorax griseus*), European, presented by Mr. N. H. Fenner; two Barbary Turtle Doves (*Turtur risorius*) from North Africa, presented by Miss Stewart; four Ring-hals Snakes (*Sepedon hæmachetes*), a Hoary Snake (*Coronella cana*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Black-faced Kangaroo (*Macropus melanops* ♂) from Australia, a Broad-nosed Lemur (*Hapalemur simus* ♂) from Madagascar, an Exanthematic Monitor (*Varanus exanthematicus*) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN

THE MASS OF SATURN.—Prof. Asaph Hall has communicated to the Royal Astronomical Society a note upon the mass of Saturn deduced from observations of the outer satellite *Japetus*, made with the 26-inch refractor at the Naval Observatory, Washington, in 1875, 1876, and 1877. The mean distance of the satellite from its primary, reduced to the mean distance of the latter (9·53885), was found to be 515''·522 from 128 observations. For the periodic time of *Japetus* Prof. Hall compared his own observations with one by Sir W. Herschel on Sept. 20, 1789, and with Sir John Herschel's observations made at the Cape of Good Hope in 1837. The resulting sidereal revolution is 79·3310152 days. Hence the mass of Saturn in units of the sun's mass is $\frac{1}{3482·2}$. Bessel, from heliometric measures of the great satellite *Titan* obtained a value of $\frac{1}{3501·6}$, which has been since used in nearly all calculations where the mass of this planet enters; Jacob, from observations of *Titan* made at Madras in 1856–58, inferred a mass of $\frac{1}{3487·2}$, which it will be seen closely approaches that given by Prof. Hall. The value deduced by Leverrier from the theory of Uranus is $\frac{1}{3529·56}$, and therefore is the smallest of all.

CLOSE DOUBLE-STARS.—M. Perrotin has published in the *Astronomische Nachrichten* further measures of double-stars made at the Observatory of Montgros, Nice, amongst which are some of the close binaries. In July last he thought 72 Ophiuchi (rather a problematical object) might be elongated in the direction 110°, but in the following month it appeared single under good conditions of atmosphere. Of the closer stars we find—

		Position	Distance
η Coronæ Borealis ...	1883·564 ...	156·00 ...	0·610
Σ 1938	——·595 ...	112·95 ...	0·750
ε Equulei	——·640 ...	285·57 ...	0·973
O.Σ. 395	——·667 ...	95·30 ...	0·690

PONS' COMET.—The following approximate places of Pons' comet are deduced from the provisionally corrected elements of MM. Schulhof and Bossert:—

At Greenwich Midnight

1883–4	R.A. h. m. s.	Decl. ° '	Log. distance from Earth	Log. distance from Sun
Dec. 31 ...	21 39 4 ...	+23 54·9 ...	9·8263 ...	9·9585
Jan. 2 ...	21 53 26 ...	20 45·2		
4 ...	22 7 37 ...	17 22·8 ...	9·8098 ...	9·9409
6 ...	22 21 31 ...	13 49·5		
8 ..	22 35 3 ...	10 7·5 ...	9·8029 ...	9·9249
10 ...	22 48 9 ...	6 21·0		
12 ...	23 0 44 ...	+ 2 33·2 ...	9·8065 ...	9·9111
14 ...	23 12 45 ...	− 1 12·2		
16 ...	23 24 10 ...	4 52·7 ...	9·8201 ...	9·9002
18 ...	23 34 58 ...	8 24·9		
20 ...	23 45 8 ...	11 47·7 ...	9·8414 ...	9·8928
22 ...	23 54 41 ...	14 59·5		
24 ...	0 3 37 ...	17 59·9 ...	9·8678 ...	9·8894
26 ...	0 11 57 ...	20 48·2		
28 ...	0 19 44 ...	−23 25·1 ...	9·8966 ...	9·8901

The intensity of light is at a maximum in the middle of January. The comet will be nearest to the earth on January 9, distance 0·634, or rather less than two-thirds of the earth's mean distance from the sun. At its last appearance in 1812 it did not approach the earth within about 1·35.

TEMPEL'S COMET, 1867 II.—M. Raoul Gautier of Geneva is engaged upon a revision of the orbit of this comet, which, it may be remembered, experienced great perturbations from a near approach to the planet Jupiter during the revolution 1867–73. It may probably arrive at perihelion again about May, 1885. If there should still be unpublished observations of this comet, it would be desirable to communicate them at once to M. Gautier, that they may be brought to bear upon his investigation.

DE MORGAN'S FIVE FIGURE LOGARITHMS.—There is a report that the five-figure tables of logarithms of numbers and trigonometrical functions published "under the superintendence of the Society for the Diffusion of Useful Knowledge," but which are usually known as De Morgan's Tables, are out of print, and that there is no present intention of a further issue. If this be the fact, it is much to be regretted: they are by far the most convenient five-figure tables that we possess, on the score of size and legibility, and have been widely utilised in astronomical calculations. Lalande's Tables, the stereotype edition of Firmin Didot, are good, and the same may be said of Gauss's, where it is of advantage to have two degrees on one opening; but we nevertheless unhesitatingly give the preference to "De Morgan."

PROBABLE NATURE OF THE INTERNAL SYMMETRY OF CRYSTALS

SOME studies pursued by the writer as to the nature of molecules have led him to believe that in the atom-groupings which modern chemistry reveals to us the several atoms occupy distinct portions of space and do not lose their individuality. The object of the present paper is to show how far this conclusion is in harmony with, and indeed to some extent explains, the symmetrical forms of crystals, and the argument may therefore in some sort be considered an extension of the argument for a condition of internal symmetry derived from the phenomena of cleavage.

If we are to suppose that crystals are built up of minute masses of different elements symmetrically disposed, it is natural to inquire in the first place what very symmetrical arrangements of points or particles in space are possible.

It would appear that there are but *five*, which will now be described.

If a number of equal cubes are built into a continuous mass (Fig. 1), a system of points occupying the centres and angles of these cubes will furnish an example of one of these symmetrical arrangements. In this system each point is equidistant from the eight nearest points, and if a number of equal-sized spheres be stacked on a base layer arranged so that the sphere centres when joined form a system of equal squares, a side of which bears to the diameter of the spheres the ratio $2 : \sqrt{3}$ (see plan *a*), the sphere centres in such a stack will also furnish an example of this first kind of symmetry (Fig. 2).

A second kind of symmetry will be presented if one-half the points in the first kind be removed so that we have only those at the cube centres, or only those at the cube angles. In this system each point is equidistant from the six nearest points, and if equal-sized spheres be stacked upon a base layer, arranged so that the sphere centres when joined form a system of equilateral triangles, a side of which bears to the diameter of the spheres the ratio $\sqrt{2} : 1$ (see plan *b*); and if the layers be so placed that the sphere centres of the fourth layer are over those of the first, those of the fifth over those of the second, and so on, the sphere centres in such a stack will also furnish an example of this second kind of symmetry (Fig. 3).

A third kind of symmetry will be presented if again one-half the points be removed, *i.e.* so that when cubes of two colours arranged in such a way that each cube is surrounded by cubes of the other colour are used (see Fig. 1), we have only the points at the centres of the cubes *of one colour*. In this system each point is equidistant from the twelve nearest points, and if equal-sized spheres be stacked upon a base layer in which the spheres are in contact, and whether they form a square pattern (see plan *c*), or a triangular one (see plan *d*)—provided that, if triangular-pattern layers be employed, the sphere centres in the fourth layer must be over those in the first, those in the fifth over those in the second, and so on—the sphere centres (the arrangement being the same in either case) will furnish a second example of the third kind of symmetry (Figs. 4 and 4*a*, the latter showing a stack with the angle removed to display the triangular arrangement).

A fourth kind of symmetry, which resembles the third in that each point is equidistant from the twelve nearest points, but which is of a widely different character from the three former kinds, is depicted if layers of spheres in contact arranged in the triangular pattern (plan *d*) are so placed that the sphere centres of the third layer are over those of the first, those of the fourth over those of the second, and so on. The symmetry produced is hexagonal in structure and uniaxal (Figs. 5 and 5*a*).

A fifth kind of symmetry, and this completes the number of very symmetrical arrangements possible, resembles the second kind of symmetry in that each point is equidistant from the six nearest points, and bears the same relation to the fourth kind (Fig. 5) as the second (Fig. 3) bears to the third (Fig. 4); that is to say, it may be regarded as produced by the insertion of additional points in positions midway between points arranged in the fourth kind of symmetry. It is depicted if triangularly constituted layers identical with those depicting the second kind of symmetry (plan *b*) are deposited in the following way (Fig 6):—First place three layers as though to produce the second kind of symmetry; then place the fourth with its sphere centres over those of the second layer; then the fifth so that the third, fourth, and fifth, like the first, second, and third, are in the second kind of symmetry; then the sixth with its sphere centres over those of the fourth and second; and then the seventh, so that the fifth, sixth, and seventh layers are also in the second kind of symmetry; and so on. The symmetry produced is, like the last, hexagonal in structure and uniaxal.

The writer believes that every one of the various symmetrical forms presented by crystals can be shown to be consistent with the subsistence of an arrangement of the atoms of the crystallising compound in one or other of these five kinds of symmetry *at the time when crystallisation begins*; and proposes to show that a relation subsists between the atomic composition of very many bodies and their crystal forms in harmony with this conclusion.

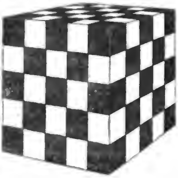


Fig. 1.

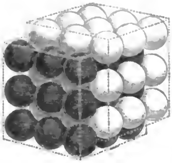
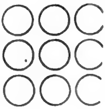


Fig. 2.



Plan *a*.

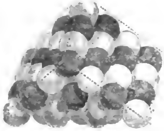
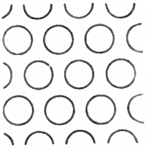


Fig. 3.



Plan *b*.

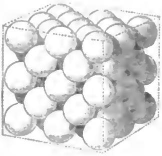
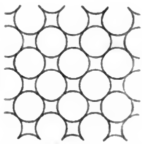


Fig. 4.



Plan *c*.

To proceed then to facts, we notice first that, as a rule, compounds consisting of an equal number of atoms of two kinds crystallise in cubes.

The following may be mentioned:—

Potassic chloride, KCl.

Potassic bromide, KBr (sometimes elongated into prisms, or extended into planes).

Potassic iodide, KI.
Sodic chloride, $NaCl$.
Sodic bromide, $NaBr$.
Sodic iodide, NaI (anhydrous above 40° C.).
Cæsi chloride, $CS.Cl$.
Plumbic sulphide, PbS.
Argentic chloride, $AgCl$.

When we have named lithic chloride, crystallising above 15°

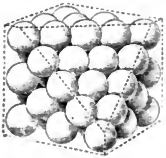
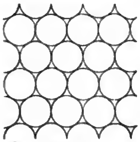


FIG. 4a.



Plan *d*.

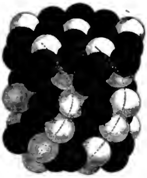
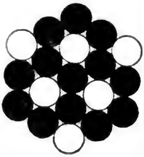


FIG. 5.



Plan *e*.

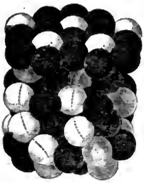


FIG. 5a.

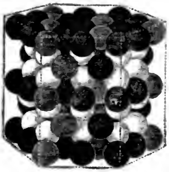
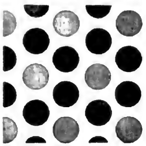


FIG. 6.



Plan *f*.

in octahedra, we have mentioned most of the compounds consisting of two elements in equal proportions known to us in a crystalline state.

Mercuric sulphide, $Hg.S$, which crystallises in six-sided prisms, is an apparent exception, but if we were guided by the gaseous volume of mercury in determining its atomic weight, we should have to write the compound Hg_2S.

Other apparent exceptions are:—
Zincic oxide, ZnO, crystallising in six-sided prisms.
Cadmium sulphide, CdS; and
Glucina, GO, crystallising in minute six-sided prismatic crystals.

Now three out of our five possible kinds of internal symmetry have three axes or directions at right angles to each other, in reference to which they are disposed in the same symmetrical manner, and two kinds, the first and second, admit of a very symmetrical arrangement of two kinds of particles *in equal numbers* (see Figs. 2 and 3). Surely this coincidence is very significant, and at lea t suggests the probability that when a compound consists of two kinds of chemical atoms in equal numbers, these atoms are symmetrically placed according to either the first or the second kind of internal symmetry.

We observe next that the third and fourth kinds of symmetry (Figs. 4 and 5) readily lend themselves to the symmetrical arrangement of particles of two kinds present in the proportion 1 : 2. For, as already pointed out, these two kinds of symmetry may either of them be produced by piling up layers of spheres placed triangularly in contact (see plan *d*), and spheres of two colours present in the proportion of 2 : 1 can be arranged in a most symmetrical manner in layers of this kind (see plan *e*).

As to what varieties of position of bi-coloured layers of this kind with respect to one another are possible, consistent with great symmetry, we have concluded that, apart from the question of arrangement of colour, there are but two, viz. the third and fourth kinds of symmetry (Figs. 4 and 5); but taking colour into account a greater variety is possible. Thus a little consideration shows us that, while all the possible ways of depositing the second layer produce a practically identical result, a choice of six different equally symmetrical results is presented in depositing the third layer, in all of which the spheres of the less numerous colour form files of spheres in contact running through the layers, and three of which belong to the third kind of symmetry and three to the fourth.

To specify these: We may have the less numerous spheres of the third layer placed with respect to those in the second and first:—

(1) So that the three spheres of each of the files just above alluded to range in line, the lines joining their centres forming a series of parallel straight lines crossing the planes of the layers obliquely. This arrangement belongs to the third kind of symmetry.

(2 and 3) So that the centres of these three spheres, when joined, form a slightly obtuse angle; a different result being produced as the angle is made to the right or to the left. This pair of arrangements belongs also to the third kind of symmetry.

(4) So that the less numerous spheres in the third layer are vertically over those in the first. This arrangement belongs to the fourth kind of symmetry.

(5 and 6) So that, as in (2) and (3), the triplets of spheres form a system of equal obtuse angles, but the angles now being very obtuse. There are here, as in (2) and (3), a right-handed and a left-handed arrangement. These belong to the fourth kind of symmetry.

The deposition of the third layer, by the necessities of symmetry, determines the deposition of succeeding layers, and it follows therefore from the above that six different equally symmetrical arrangements of spheres of two colours present in the proportion 2 : 1 are possible in the third and fourth kinds of symmetry.

As to (1) the parallel files of the less numerous spheres crossing the first three layers will extend through subsequent layers.

As to (2) and (3) every three continuous layers will display the less numerous sphere centres placed to form the same angles as are presented by the triplets in the first three layers, and consequently these sphere centres lie on spirals which are right-handed or left-handed as the case may be; the less numerous spheres in the fourth layer being vertically over those in the first, those in the fifth over those in the second, and so on.

As to (4) the less numerous spheres in the fourth layer must lie vertically over those in the second, those in the fifth over those in the third, and so on; and thus the files of spheres in contact running through successive layers form a series of similar zigzags.

As to (5) and (6) the sphere centres, as in (2) and (3), lie either on right-handed or on left-handed spirals; in this case the less numerous spheres in the seventh layer being vertically over those in the first, those in the eighth over those in the second, and so on (Figs. 5 and 5*a*).

When we inquire whether the symmetrical arrangements just traced are in harmony with the facts respecting compounds of two kinds of atoms in the proportions 1 : 2, we find some very important evidence.

Thus water, H_2O, crystallises in six-sided prisms or in rhombohedra; forms both of which are compatible with one or other of the above symmetrical arrangements.

And the following most interesting concurrence of facts indicates that the symmetrical arrangements in the fourth kind of symmetry above described (see Figs. 5 and 5*a*) are those of the atoms of quartz.

(*a*) Quartz consists of oxygen two atoms, silicon one atom; just the proportions in these arrangements.

(*b*) It has the property of circular polarisation, from which it has been proved that its molecules must have a *spiral* arrangement, and, since some crystals have the property of rotating in one direction, some in the opposite, that this spiral arrangement is right-handed in some crystals, left-handed in others.

(*c*) It crystallises in six-sided prisms terminated by six-sided pyramids, a form derivable, as we have seen, from the arrangements before us.

As to this last point, just a word of explanation why we must not look for the angles exhibited by our model arrangements to be identical with the angles made by the pyramid faces in quartz.

It is a matter of common observation that the process of crystallisation is generally associated with change of bulk, and if we suppose this change to arise from expansion, or contraction, generally expansion of the different kinds of atoms, and that these different kinds have *different degrees of expansion*, we see that a mass symmetrically arranged in the manner supposed will in crystallising expand or contract more in some directions than in others, and while we should look for a similar change in the direction of each of the three transverse subordinate axes of the crystal, we should look for a different change in the direction of the principal axis. And thus, supposing the mass when liquid immediately before it began to crystallise to have had the internal symmetry which has been depicted, it is evident that the unequal change of dimension in different directions might suffice to bring about such an inclination of the faces of the terminal pyramids to the sides of the prism as is actually found to exist.

In support of this explanation we have the fact that crystals not of the regular system have been found to expand unequally in different directions when subjected to heat.

Further evidence in support of the theories here submitted is found in the fact that, with scarcely any exception, the compounds we are now considering do not crystallise in the regular or cubic system.[1] WILLIAM BARLOW

(*To be continued.*)

THE HELVETIC SOCIETY OF NATURAL SCIENCES

THE sixty-sixth session of this Society was held early in the month of August of the present year in the city of Zurich. The proceedings of the various Mathematical, Physical, Chemical, Zoological, Botanical, and Medical Departments are somewhat fully reported in the *Archives des Sciences Physiques et Naturelles*, Geneva, October 15. On August 6 a preliminary meeting was held of the delegates of the Cantonal Sections and Special Committees, and next day the session was formally opened in the Town Hall under the presidency of Prof. Cramer. The two ensuing days were devoted to the work of the several Sections, all of which were well attended by numerous Swiss and foreign savants, brought together by the double attraction of the Helvetic Society and the National Exhibition, which was also held this year in Zurich.

In the Mathematical Section, over which Prof. W. Fiedler presided, the chief papers were those of Prof. Geiser (Zurich), on surfaces of the third degree; of Dr. Rudio (Zurich), on the geodetic lines traced on surfaces of the second degree; of Prof. Fiedler (Zurich), on the intersection of equilateral hyperboloids revolving on parallel axes.

In the Physical Section, presided over by Prof. R. Clausius, M. F. A. Forel (Morges) communicated the result of his researches made to determine the limits of variation of temperature in the waters of Lake Geneva. According to his thermometrical soundings, the diurnal variation is perceptible down to a depth of from 10 to 15 metres; the summer variation from 60 to 100 metres. Exceptional winters like that of 1879-80 are felt as low as 334 metres. Since that year the temperature of the water at these great depths has been raised on an average about half a degree Centigrade.

Some preliminary results of his researches on the refraction and dispersion of crystallised alums were communicated by M. Charles Soret of Geneva. By means of his completely reflecting refractometer, described in the *Archives* for January, 1883, the author has determined the indices of refraction for the principal lines of the solar spectrum from *a* to G inclusively for six sulphuric alums with alumina base.

Prof. Clausius read a paper of practical importance on the theory and proper method of construction of dynamo-electric machines. Some curious experiments were made by M. C. de Candolle of Geneva, showing how ripples are formed on sandy surfaces at the bottom of the sea. From these experiments it results that the phenomenon is produced by the friction of a liquid mass against any substance more viscous than itself. Hence the sand may be regarded as forming with the water a viscous mixture, on the surface of which the friction of the pure liquid develops ripples in the same way that the friction of the air develops ripples on the surface of the water itself.

Amongst the other memoirs in the Physical Section the most noteworthy were those of Prof. H. F. Weber (Zurich) on liquids and gases as heat conductors; an experimental demonstration of the second principle of the mechanical theory of heat, by M. Raoul Pictet; on the determination of the ohm, by Prof. H. F. Weber; on the results of the observations and researches made in the laboratory of the Lausanne Academy on atmospheric electricity, by M. Henri Dufour of Lausanne. The author described several successful attempts made by him to reproduce artificially the electric phenomena observed in the terrestrial atmosphere.

The Chemical Section was opened, under the presidency of Prof. Wislicenus, by Prof. V. Meyer's memoir on the nature of the chemical elements according to recent research. The author leans to the views of Mendeleeff and Lothar Meyer, who regard the properties of simple bodies as the periodical functions of their atomic weights. The fact that Mendeléeff was able to predict the existence of gallium and scandium, and correctly determine their atomic weights, was adduced in support of the theory that all the elements are merely different compound forms of one primitive substance. Hence, although hitherto baffled, the attempts now being made to decompose them may result in the experimental determination of one absolute primordial substance.

Prof. F. Krafft (Basle) presented some higher alcohols of the series $C_nH_{2n}+2O$, accompanying them with some remarks on the synthesis of alcohols in general. A *résumé* was given by Prof. Louis Soret (Geneva) of his researches on the absorption of the ultra-violet rays by various substances of animal origin. The author dwelt on the great importance of this branch of spectral analysis to chemistry, and concluded with a brief description of the method and appliances used by him in his original researches.

Other valuable chemical papers were those of Dr. M. Cérésole (Lausanne), on acetacetic acids; of Prof. V. Meyer on the apparatus used in determining the densities of gases at very high temperatures; of Prof. Schulze, describing the researches made by him jointly with M. J. Barbieri on phenylamidopropionic acid, which is obtained by heating albuminoid substances with chlorhydric acid and chloride of tin; of Prof. Wislicenus (Wurzburg), on the relation of the optical rotatory power of carburets of hydrogen, on the existence of an atom of asymmetric carbon, and on the products of the reaction of dichloride of phtalyle on the sodic combination of malonic ether; Prof. G. Lunge (Zurich), on the formation of sulphuric acid in lead chambers; Dr. Urech (Stuttgart), on a lamp fed by ether of petroleum. This lamp, constructed by C. C. Lilienfein, of Stuttgart, consists of a metallic receiver containing the ether of petroleum, and connected with a Bunsen burner slightly modified in consequence of the liquid nature of the combustible.

In the Zoological Section Prof. C. Vogt, president, the proceedings were opened by a communication from Prof. H. Fol (Geneva), on the physiological origin of the individual in the

[1] With regard to calcic fluoride (fluor-spar), which appears as an exception, it may be remarked that a different atomic weight for calcium which would enable us to write the compound CaF would enable us to get over a difficulty with regard to another compound of calcium, as we shall see presently.

higher animals. M. H. Goll of Lausanne, presented a contribution to the natural history of the sedentary and migratory coregones of Lake Neuchâtel. Memoirs were received on the Arachnidæ of Switzerland by Prof. Pavesi of Pavia; on the fauna of Guatemala, by Dr. Otto Stoll of Zurich; on some new species of Medusæ from the Red Sea, by Dr. Keller of Zurich; on the Pelagic fauna of the Swiss lakes, by Dr. Othmar-Emile Imhof of Zurich; and on the influence of the physico-chemical environments on the development of the tadpole of the edible frog, by M. E. Yung of Geneva. From experiments made by mixing marine salt in various proportions with the natural freshwater element, M. Yung arrived at the conclusion that, the more saline the water, the slower is the development of the tadpole, all transformations ceasing in solutions of 9/1000, and death following in a few hours in solutions of 10/1000.

In the Botanical Section, Prof. Cremer, president, valuable memoirs were received from Prof. O. Heer of Zurich, on the Glacial flora of Switzerland, and on the fossil flora of Greenland. These were the last pages contributed to science by the distinguished savant, who had scarcely finished the revisal of the proofs when he died suddenly at Lausanne, on September 27. A series of hybrids between the *Primula auricula* and *Primula viscosa*, showing an uninterrupted series of forms intermediate between these two species, was exhibited by Prof. Favart of Lausanne. He also showed that the *Cardamine fossicola*, Godet, hitherto classed with the *C. pratensis*, Lin., should be grouped with the *C. matthioli*, Moretti. Some remarks were made by Prof. Schnetzler of Lausanne on a monstrosity of the Chinese primrose, and on the relation between an aërial alga (*Chroolepus umbrinus*) and a lichen (*Pyrenula* sp.) M. C. de Candolle described the results of his attempts to determine how far any light may be thrown on the disputed origin of the *Cytisus adami* by the anatomical structure of its leaves. This plant, which suddenly made its appearance in the nursery of Adam at Vitry, near Paris, early in the present century, and which is remarkable for producing red and yellow blossoms mostly on separate branches, is usually regarded as a cross obtained by grafting the *Cytisus purpureus* on the *C. laburnum*. But M. de Candolle concludes that it is not a hybrid, but simply a degenerate variety of the *C. laburnum*.

In the Medical Section, Prof. von Kölliker, president, Prof. Klebs of Zurich read a remarkable paper on the transformations of the human species, which he regards as mainly the result of pathological influences.

Valuable communications were also made on the centres of origin of the optic nerves and on their relation to the cerebral cortex, by Dr. C. von Monakow of St. Petersburg; on the relations existing between the excitability and vulnerability of certain muscular groups, by Prof. Luchsinger of Berne; and on the mechanism of the ruminating process, by the same author.

The report on the Geological Section was unavoidably postponed to the November issue of the *Archives*.

NOTES FROM THE OTAGO UNIVERSITY MUSEUM

IV.—*On the Structure of the Head in "Palinurus," with special reference to the Classification of the Genus*[1]

THE genus *Palinurus* was divided by Milne-Edwards into two groups or sub-genera—one, the "Langoustes ordinaires," containing species in which the antennulary flagella are short, the bases of the antennæ approximated, and the rostrum present; while the other, or "Langoustes longicornes" (*Panulirus*, Gray; *Senex*, Pfeiffer), contains species in which the antennulary flagella are short, the antennæ widely separated at their proximal ends, and the rostrum absent.

In this classification, which is still in the main adopted by systematists, no notice is taken of the stridulating organ, first mentioned, I believe, by Leach, in *P. vulgaris*, and described at length by Möbius, and later by myself, in the same species.[2] This unique sound-producing apparatus is present in all the "Langoustes longicornes" which I have yet examined, as well as in *P. vulgaris* and *P. trigonus* among the "Langoustes ordinaires"; while in all the remaining members of the latter group which have come under my notice (*e.g.* the common New Zealand species, *P. lalandii* and *P. edwardsii*) there is no trace of it.

There is also great diversity among the "Langoustes ordinaires" in the development of the rostrum, the true size of which can only be seen in a longitudinal vertical section of the head (see Fig. 1). In *P. lalandii* and other non-stridulating species, the rostrum (A, *r*) is well developed, and bears comparison with that of *Homarus*, while in *P. vulgaris* (B, *r*) it is a mere spiniform tubercle meriting special description only from its position. *P. vulgaris*, moreover, has no trace of procephalic processes, which are present, though small, in *P. lalandii* (A, *pc.p*).

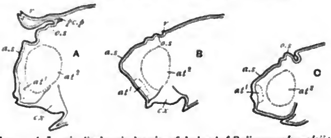


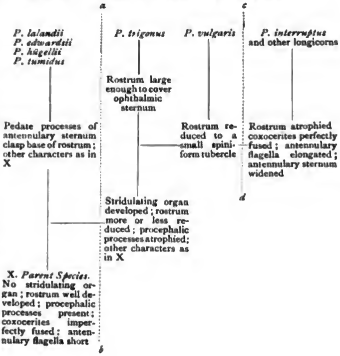
FIG. 1.—A, Longitudinal vertical section of the head of *Palinurus edwardsii*; B, of *P. vulgaris*; C, of *P. interruptus*. *a.s*, antennulary sternum; *at¹*, articular cavity for antennule; *at²*, for antenna; *c.x*, unanchylosed part of inner wall of coxocerite; *o.s*, ophthalmic sternum; *r*, rostrum; *pc.p*, procephalic process.

The woodcut shows that as regards both the rostrum and the antennulary sternum (the fixed part of the stridulating organ), *P. vulgaris* (B) approaches far more nearly to the "Langoustes longicornes," as represented by *P. interruptus* (C), than to the non-stridulating "Langoustes ordinaires," as represented by *P. edwardsii* (A).

On the other hand, all the brevicorn species examined agree in the imperfect fusion of the coxocerites or proximal segments of the antennæ. A transverse section taken immediately in front of the renal apertures shows that a small portion of the adjacent or inner walls of the coxocerites in *P. lalandii*, *P. vulgaris*, &c., are merely in apposition, whereas in the longicorn species concrescence is complete.

Assuming that the *Palinuridæ* are derived from an Astacoid or Homaroid ancestor through some such intermediate form as *Palinurellus*, one cannot but conclude that the species which have no stridulating organ, a well-developed rostrum, procephalic processes, and imperfectly fused coxocerites, come nearest to the parent stock, and that those in which the stridulating organ is developed, the rostrum and procephalic processes absent, and the coxocerites completely united with one another, have diverged most from that stock, and present us with the extreme of modification of the Palinuroid type.

This view is expressed in the following phylogenetic table:—



[1] Abstract of a paper taken as read at a meeting of the Otago Institute, September 12, 1883, and to be published in the next (16th) volume of the *Transactions of the New Zealand Institute*.

[2] Leach, "Malacostraca podophthalmata Britanniæ"; Möbius, *Archiv für Naturgeschichte*, 1867; T. J. Parker, *Proc. Zool. Soc.*, 1878, p. 442.

In a natural classification of the genus the most fundamental separation appears to me that along the dotted line *a b* dividing the non-stridulating from the stridulating species. This division once made, the stridulating species fall into two natural subdivisions, expressed in the table by the line *c d*, which divides the brevicorn from the longicorn forms.

I think the most convenient classification is obtained by dividing the species along the two lines *a b*, *c d* into three subgenera, one identical with the "Langoustes longicornes" of Milne-Edwards, the others formed by splitting up the "Langoustes ordinaires" into species with and species without a stridulating organ.

The following table embodies the proposed arrangement:—

Genus PALINURUS, Fabr.

A. Stridulating organ absent; rostrum well developed, clasped by paired pedate processes of the antennulary sternum; procephalic processes present; coxocerites imperfectly fused; antennulary flagella short (sub-genus *Jasus*, T.J.P.).
P. lalandii, P. edwardsii, P. hügelii, P. tumidus.

B. Stridulating organ present; rostrum variable, but rarely (? never) as well developed as in (A); pedate clasping processes absent; procephalic processes absent.
a. Antennulary sternum narrow below, bases of antennules being hidden, in a view from above, by bases of antennæ; coxocerites imperfectly fused; antennulary flagella short (sub-genus *Palinurus*).
α. Rostrum well developed, covering ophthalmic sternum. *P. trigonus.*
β. Rostrum reduced to a small spiniform tubercle; ophthalmic sternum uncovered.
P. vulgaris.
b. Antennulary sternum broad below, bases of antennules being visible from the dorsal aspect; coxocerites perfectly fused; antennulary flagella long (sub-genus *Panulirus*, Gray; *Senex*, Pfeiffer).
P. interruptus, P. fasciatus, &c., &c.

Dunedin, N.Z., October 2 T. JEFFERY PARKER

SCIENTIFIC SERIALS

Bulletin of the Belgian Royal Academy of Sciences and Belles Lettres, October 4.—Obituary notices of the late M. Joseph Plateau, by MM. Duprez, Valerius, and Liagre.—Second communication on the discovery of the fossil iguanodon at Bernissart, by P. J. Van Beneden.—Researches on the absolute force of the muscles of the Invertebrates; Part I. Absolute force of the adductor muscles in the lamellibranch molluscs (four illustrations), by M. Félix Plateau.—Note on a new optical illusion, by H. Valerius.—Remarks on the action of lightning conductors constructed on the Melsens system, by H. Valerius.—Arithmetical and algebraic theorems, by E. Catalan.—Note on the pelvisternum in the Edentates (ten illustrations), by Prof. Paul Albrecht.—Funeral oration of M. Henri Conscience in Flemish and French, by M. Pierre Willems.—Memoir on the bibliography of international law before the publication of Grotius's "Jus belli et pacis" (1625), by Alphonse Rivier.—Confession de Poëte, a poem, by Charles Potvin.—Some traits of the social life of the Celestial Empire. How history is manufactured in China; civil and military decrees, by Ch. de Harlez.—Reports on the competitive papers sent in on the subject of Grétry, a critical study of his life and works. The prize, a gold medal of the intrinsic value of 32*l.*, was awarded to M. Michel Breuet of Paris.—Reports on the competitive papers received on the subject of realism, its definition and influence on contemporary painting. The essay by M. Henry Hymans, a member of the Academy, was pronounced the best. But the prize, also a gold medal worth 32*l.*, was not awarded to him, owing to his failure to comply with the conditions of the competition.—Discourse on the annual exhibition of paintings, by M. Fetis The prize of a thousand francs for the best cartoon on the subject of help for the wounded on the battle-field, as a decorative piece for a military hospital, was awarded to M. Henri Evrard, of Saint Gilles-lez-Bruxelles.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 6.—"The Wave-lengths of A, *a*, and of some Prominent Lines in the Infra-Red of the Visible Spectrum." By Capt. Abney, R.E., F.R.S.

M. Fievez has recently sent the author a map of the solar spectrum from C to A ("Annales de l'Observatoire Royal de Bruxelles," nouvelle série, tome v.) inclusive, and as part of this region is one which he is measuring, he examined the new publication with great interest. Photography and eye measurements do not coincide in the detail of the grouping of the little *a* group, or from there as far as A, and A itself is shown by M. Fievez's map as wanting in some details which appear in the photographs. The wave-lengths of the different lines from above "*a*" to A are not those given by Fievez, when comparison photographs of the 1st order of the red with the 2nd of the ultra-violet were taken on the same photographic plate, or when the 2nd order of the red is compared with the 3rd order of the green taken in a similar manner. Prof. Rowland's concave gratings were employed for this comparison. Cornu's map was used as a reference for the ultra-violet wave lengths, and Ångström's map for those in the blue and green.

Description of line	λ from comparison of 1st and 2nd orders	λ from comparison of 2nd and 3rd orders	λ according to Fievez	Remarks
"*a*"	{7184·4 7185·4	7184·5 7185·4	7197·7 7198·7 }	This is shown in Ångström's map as a single line λ 7184·9.
Most refrangible edge of A.	7593·6	7593·7	7600·0	Ångström gives 7604 for the centre of this line; which of the bands he took as A is not clear. Langley gave 7600·9 for this edge.
Centre of 6th pair of lines in the flutings following A.	7644·2	7644·33	7652·2	

The determination of A has been made by Mascart, Smythe, and others, besides Ångström and Langley, with discordant results. The above may be taken as accurate, as are Cornu's and Ångström's maps.

The following are wave-lengths of some of the principal lines in the infra-red. The scale numbers refer to the author's map of the infra-red, which is published in the *Phil. Trans.*, Part II., 1880:—

Scale number	Description	Wave-lengths
1046	This line is a double, of which the components have the accompanying wave-lengths......	8226·4 8229·9
1441	....	8496·8
1509	....	8540·6
1685	....	8661·0
2175	A double line, the components of which have the accompanying wave-lengths	8986·2 8989·5
2638	,, ,, ,,	9494·5 9500·1
3161	....	9633·8

Mathematical Society, December 13.—S. Roberts, F.R.S., vice-president, in the chair.—The following were elected members:—Messrs. A. B. Basset, H. Fortey, R. T. Glazebrook, F.R.S., G. Heppel, J. J. Thomson, H. H. Turner, and Prof. W. Thomson, Cape Colony.—The following papers were communicated:—The form of standing waves on the surface of running water, by Lord Rayleigh, F.R.S.—A method of finding the plane sections of a surface and some considerations as to its extension to space of more than three dimensions, by Mr. W. J.

C. Sharp.—On a deduction from the elliptic-integral formula $y = \sin (A + B + C \ldots)$, by Mr. J. Griffiths.

Linnean Society, December 6.—Sir John Lubbock, Bart., president, in the chair.—H.H. Maharajah of Travancore, and Messrs. C. A. Barber, E. Bostock, H. Friend, J. Hannington, J. S. Hicks, J. Richardson, R. Tate, and H. Tisdall were elected Fellows of the Society.—Mr. B. Daydon Jackson exhibited a specimen of "Mexican whisks," known also in the London market as "chien-dent," which are now imported in considerable quantity from the vicinity of La Puebla in Mexico. It is believed to be derived from a species of *Andropogon*, but is in bulk coarser than the similar material from Southern Europe from *Andropogon gryllus*, and finer than the species of *Panicum* used in India for brushes.—Mr. Arthur Bennett exhibited a specimen of *Carex ligerica* gathered by Mr. Cunnack on the Scilly Isles (Cornwall), and believed by him to be a sterile form of *C. arenaria*, but identified as *C. ligerica* by Prof. Babington, and therefore new to science. Mr. Bennett also drew attention to locally so-called "vegetable hedgehogs," these being agglomerated larch leaves (having some resemblance to a rolled hedgehog) found in the Shropshire meres.—A large number of Lepidoptera from the district of Georgetown, Colorado, and a few from Missouri were exhibited by Mr. Ernest Jacob, who had collected them while engaged in the U.S.A. Geological Survey in the above districts, 1880-81.—A series of dried plants from Australia were shown on behalf of Mr. James Robertson.—Mr. Charles Darwin's paper on instinct (noticed in our last week's issue) was then read by the Zoological Secretary, and an important discussion followed, in which Mr. Wallace, Profs. Huxley, Allman, Mivart, Foster, Lankester, Mr. McLachlan, Mr. Seebohm, and others took part.

Zoological Society, December 4.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Philip Crowley, F.Z.S., exhibited and made remarks on an egg of a Bower-bird from Southern New Guinea, supposed to be that of *Chlamydodera cerviniventris*.—Sir Joseph Fayrer, F.Z.S., exhibited a shed deer-horn, apparently gnawed by other deer, and made remarks on this subject.—Mr. Sclater exhibited, on the part of Dr. George Bennett, F.Z.S., four skins of a species of Paradise-bird of the genus *Drepanornis*, obtained in the vicinity of Port Moresby in Southern New Guinea. Mr. Sclater considered this form to be only subspecifically different from *D. albertisi* of North-eastern New Guinea.—Mr. W. Burton, F.Z.S., exhibited a supposed hybrid between a male blackcock and a hen pheasant.—Mr. R. Bowdler Sharpe gave descriptions of some new species of Flower-peckers, viz.:—*Dicæum sulaense*, from the Sula Islands; *D. pulchrius*, from South-eastern New Guinea; and *D. tristrami*, from the Solomon Islands. The author added some critical notes on other species of *Dicæum* and *Prionochilus*.—Mr. J. B. Sutton read a paper on the diseases of monkeys dying in the Society's Gardens, on which he gave many interesting details. Mr. Sutton called special attention to the prevalence of the belief that monkeys in confinement generally die of tuberculosis, and showed that such is not really the case.—Mr. H. O. Forbes, F.Z.S., read a paper describing the peculiar habits of a spider (*Thomisus decipiens*) as observed by him in Sumatra.—A second paper by Mr. Forbes gave an account of some rare birds from the Moluccas and from Timor Laut. To this the author added the description of a new species of Ground-Thrush from Timor Laut, which he proposed to call *Geocichla machiki*, in acknowledgment of services rendered to him by Dr. Julius Machik in Sumatra.—A communication was read from Prof. J. von Haast, F.R.S., containing notes on *Ziphius* (*Epiodon*) *novæ-zealandiæ*, in continuation of a former paper read before the Society on the same subject.—A second communication from Prof. Haast gave a description of a large Southern Rorqual (*Physalus* (*Balænoptera*) *australis*) which had been washed ashore dead on the New Brighton beach about five miles from Christchurch, New Zealand. Prof. Haast was doubtful as to the distinctness of this animal from *Balænoptera musculus* of the Northern Atlantic.—Mr. G. French Angas, C.M.Z.S., read some notes on the terrestrial Mollusca of Dominica collected during a recent visit to that island.

Mineralogical Society, December 11.—The Rev. Prof. Bonney, president, in the chair.—The following papers were read:—On some specimens of lava from Old Providence Island, by the President.—On the evidence of the occurrence of nickel iron with Widmanstatten's figures in the basalt of North Greenland, by Prof. K. T. V. Steenstrup.—Note on a new mode of occurrence of garnet, by H. Louis.—A chemical examination of the Greenland telluric iron (translated from "Medelelser fra Grönland," Heft 4, 1883), by Joh. Lerenzon.—At 9 p.m. (pursuant to notice) the meeting was made special, and the members of the Crystallographical Society were elected members of the Society, a portion of the rules relating to election being for the time suspended.

DUBLIN

University Experimental Science Association, Nov. 13.—Prof. V. Ball in the chair.—On the magnetophone, by Prof. Fitzgerald. A new form of the instrument was exhibited by W. V. Dixon. In this a diaphragm removed from a telephone is placed in close proximity with one extremity of a bar magnet, at the other extremity of which small masses of soft iron fixed radially on an axle are rotated. A note is produced at the diaphragm.—On the phenomena attending pressure on sensitive plates, by W. Hogg. Experiments confirmatory of those described by Capt. Abney were made, and enlarged photos of the developed marks shown. Similar experiments on sensitive albuminised paper were described by P. M. Crosthwaite; the use of paper allowed of considerable pressure being applied.—On compound locomotives, by F. Trouton.—On the identification of minerals by means of their specific heats, by J. Joly.—On the deposition of metallic copper in cracks, by N. M'J. Falkiner.—Experiments gave results similar to those obtained by Becquerel.

MANCHESTER

Literary and Philosophical Society, November 27.—H. E. Roscoe, F.R.S., president, in the chair.—On the fungus of the salmon disease—*Saprolegnia ferax*, by H. Marshall Ward, M.A., Fellow of Christ College, Cambridge.

PARIS

Academy of Sciences, December 10.—M. Blanchard, president, in the chair.—Note on a new compound of rhodium, by M. H. Debray.—On the quantities forming a group of nonions analogous to the quaternions of Hamilton, by M. J. Sylvester.—Summary report on the geological, botanical, zoological, and anthropological work accomplished by the French mission to Cape Horn, by Dr. Hyades. In the southern islands of the Fuegian Archipelago the prevailing rocks were found to be schists and granites greatly weathered wherever unprotected by vegetation. The dwarf Antarctic beech is limited to an altitude of 400 metres, the *Fagus betuloides* to 300, forming with the Drimys and Berberis a forest zone with a humid soil poor in vegetable humus, and covered with mosses, heaths, and a considerable variety of small plants. The marine flora abounds in all kinds of algæ (the most common being the *Macrocystis pyrifera*), affording a shelter to numerous zoophytes, Annelidæ, mollusks, Crustaceæ, and migratory fishes of eight or ten species. Of the shell-fish, which abound on most of the seaboard, all the large species are edible. Although poorer than the marine, the land fauna includes several species of Coleoptera, Lepidoptera, Arachnidæ, some forty species of birds, but no reptiles or frogs. The mammals are represented only by one species of fox, two rodents, and an otter, besides the domestic dog. The natives all belong to the Tekeenika stock of Fitzroy, called Yahgans by the present English missionaries. They speak an agglutinating language current from the middle of Beagle Passage to the southernmost islands about Cape Horn. About 1000 words of this language were collected, including some abstract terms, such as *tree*, *flower*, *fish*, *shell*. The numerals get no further than *three*, although the natives count also on the fingers. Over a hundred anthropometric observations were taken on individuals of all ages and both sexes. Good photographs were also obtained of a large number of Fuegians, besides numerous castings of all parts of the body, some skeletons, and a great variety of ethnological materials.—Note on the *Phylloxera gallicola*, by M. F. Henneguy.—Observations on the new planet 235 made at the Observatory of Paris (equatorial of the west tower), by M. G. Bigourdan.—Observation of the spectrum of the comet Pons-Brooks, 1812, at the 14 inch equatorial (0·378 m.) of the Bordeaux Observatory, by M. G. Rayet.—On the form of the expressions of the mutual distances in the problem of the three bodies, by M. A. Lindstedt.—On the number of the permutations of n elements presenting s sequences, by M. D. André.—Note on a theorem of Liouville, by M. Stieltjes.—New demonstration of two theorems of M. Bertrand, by M. Georges Ossian Bonnet.—Formulas giving the electric resistance of the circuit employed in the Edison system of electrical lighting, by M. G. Guéroult.—Observations relative to a method of studying earth currents, in connection with a communication recently made by M. Blavier, by M. F. Larroque.—Researches on the solidification of superfused sulphur (second part), by M. D. Gernez.—Determination of the equivalent of aluminium by means of its sulphate, by M. H. Baubigny.—On the formation of acetylene at the expense of the iodoform, by M. P. Cazeneuve.—New researches on the susceptibility of the eye to differences of luminous intensity, by M. Aug. Charpentier.—Cholera, small-pox, typhoid fever, and charbon amongst the coppersmiths of Villedieu, by M. Bochefontaine. Although the whole atmosphere of the place is, so to say, saturated with copper, nine of the inhabitants of Villedieu, all engaged in the copper industry, fell victims to cholera in 1849. Considering the difference of population, this would represent a mortality of 5700 in Paris. Nearly half of the population was attacked by small-pox in 1870, and a fatal case of charbon occurred in 1865.—On the existence and distribution of eleidine in the bucco-œsophagian mucous membrane of mammals, by M. L. Ranvier.—On the genus Vesquia, a fossil yew found in the Aachen formations of Tournai, by M. C. Eg. Bertrand.—On a luminous phenomenon observed after sunset at Amiens on several evenings about the end of November and beginning of December last, by M. Decharme. The author feels inclined to attribute these effects to the aurora borealis. Details of similar manifestations observed in other places were quoted from a recent number of NATURE.

BERLIN

Physical Society, November 30.—Dr. Kayser placed before the meeting a concave grating sent by Prof. Rowland to the Physical Institute, explained the principle of this apparatus, and exhibited a photograph of the normal spectrum produced by help of the grating, as also a negative prepared by Prof. Rowland, on which Dr. Kayser was able with the naked eye to count between the two H lines over seventy fine lines, among which some appeared to form groups, so that by means of a microscope many more lines still would be distinguishable.—Prof. von Helmholtz next gave a minute report of the continuation of the experiments he had instituted with a view to explaining galvanic polarisation according to thermodynamic principles. Suppose that an electric current passed through a liquid completely free of gas, then would the gases generated by decomposition of the electrolyte be first absorbed by the liquid, and only after the latter was saturated to a degree corresponding with the pressure of gas resting on it would the development of gas begin. The previous solution of gas in the liquid was the expression of an attraction or of a molecular energy between the water and the gas, which acted in the same direction as did the electromotive energy which decomposed the electrolyte at the electrode. The absorption of the gas, therefore, agreeably with the teaching of the mathematical theory, increased the electromotive energy, and all the more so the less gas the liquid contained. This accorded with the experience derived from experiments that the convective current was so much the stronger by how much the less gas the fluid had absorbed. If the liquid already contained gas in solution, a part of it would escape at the surface by a kind of dissociation, and form above the liquid an atmosphere the pressure of which corresponded with that of the momentary saturation of the liquid. This dissociation of the solution represented a work which could reciprocally be applied to the conversion of gas to a liquid state; that is to say, supposing the conditions were such that the temperature of the system was maintained throughout unaltered, the whole process was a reversible one. With this consideration let one start from any normal condition whatsoever, from atmospheric pressure for example, then it was the teaching of the theory that the work was all the greater the less was the quantity of gas in solution, and in the case of very small gas volumes the work would be endless, that is to say, in every fluid were dissolved minute quantities of gas which could no longer be discharged. If the electrolytic fluid contained oxygen in solution, as in fact was regularly the case, the oxygen would be drawn by convection towards the oxygenous electrode, and there augmented by the oxygen which had been electrolytically separated, and after loss of its electricity become neutral. The gas would now begin to diffuse itself towards the other, the hydrogenous electrode, and this diffusion would produce the polarisation current which, just as much as the diffusion stream, was opposed to the electrolytic current and convection. The quantity of oxygen in the fluid and its diffusion might be illustrated by a curve which ascended from the hydrogenous electrode as its zero point rectilinearly to the oxygenous electrode, and so long as the electromotive force remained the same at the electrodes a state of equilibrium was maintained between electromotive force, convection, polarisation current, and diffusion; a state of equilibrium which was disturbed when the current was interrupted for however short a time. The theory of these processes taught, what experience confirmed, that a much greater electromotive force was required after the interruption to re-establish electrolysis than was before needed to continue the process. If the fluid were saturated with gas to a degree corresponding with the pressure of gas resting on it, the gases generated by electrolysis escaped. Seeing, however, that the degree of saturation was dependent on the pressure of gas, therefore, with the increase of gas pressure, the electromotive force which caused the development of gas would likewise have to be increased. It was now sought to ascertain the least electromotive force that was sufficient under a definite pressure to cause a development of gas, and the experiments made with this object in view showed that the development of the first bubbles had to overcome a considerable resistance, and therefore demanded intenser currents than were needed for later gas bubbles. When, by a definite current through an extended metallic wire, gas was developed in an electrolyte, by lessening the electromotive force it was possible to produce only single gas bubbles at one point of the wire. The same amount of electromotive force which was sufficient to produce this effect was not, however, equal to the generation of bubbles from the outset. To effect this latter result, a much stronger current would have to be employed. All these processes and relations here briefly indicated were mathematically calculated, and the results of the experiments invariably coincided with the teachings of the theory.

CONTENTS

THURSDAY, DECEMBER 27, 1883

VORTEX RINGS

The Motion of Vortex Rings. By J. J. Thomson. (London: Macmillan and Co., 1883)

BOTH as regards the interest of the subject and the treatment it has received at the hands of the author we do not doubt that the essay before us is destined to take a foremost place amongst the essays which have been called forth, or at all events distinguished, by the Adams Prize.

The fact that these essays are upon set subjects precludes the possibility of the prize being awarded for a distinctly original conception. It is almost a necessity that the subjects chosen should involve the extension of some mathematical investigation which has already been carried a certain length.

The subject of the present essay is distinctly of this class; it involves an extension of the investigation of the theory of vortex motion in an ideal fluid, founded by Helmholtz and continued chiefly by Sir William Thomson.

At the time Helmholtz conceived the fundamental principle, ideal hydrodynamics had no other interest, besides its mathematical interest, than it derived from the somewhat casual explanations it affords of the phenomena met with in the motion of actual fluids. Helmholtz's investigation had some relation to the observed phenomena of actual vortices, particularly to the phenomena of smoke rings, of which it afforded a general explanation. But between the fundamental equations which Helmholtz gave and their application to an actual vortex ring certain integrations were necessary, and these integrations presented mathematical difficulties. If we consider the line of smoke which forms the ring as indicating the portion of air in which vortex motion exists, we may say that the difficulties of integration at which Helmholtz stopped arise from the thickness of this line of smoke, or, calling this the circular core of the ring, from the finite area of the section of this core. Helmholtz contented himself with applying his theory to an indefinitely thin core; and the fact that the results of a theory based on a frictionless fluid would only have an imperfect relation to the motions of viscous fluids, together with the fact that such rings, although they may be produced by artificial apparatus, are short-lived, and have no existence in the general motion of fluids, offered but little inducement for farther prosecution of the subject. The case however was altered when it was conceived by Sir William Thomson that the atoms of matter may be such rings moving in a perfect universal fluid. Smoke rings, although their behaviour seems to have suggested the idea, could not, owing to the viscosity of the air, by any means be made to afford an experimental verification of the capabilities of such an hypothesis. The only way was to integrate Helmholtz's equations, and thus arrive at the theoretical behaviour of such rings. Unfortunately the mathematical difficulties are such that there is little hope of obtaining a complete theory of vortex rings having cores of any finite area. Sir William Thomson, however, started an approximate theory as a step towards this; he succeeded in approximately integrating the equations for rings the cores of which had sections finite but small compared with the openings of the rings, and with such rings it appears that his theory can be tested as regards matter in the gaseous state.

To do this, however, it is necessary to do more than work out the theory of a single circular ring having a core of circular section. The phenomena of gases depend on the internal vibration of the atoms and on the influence which they exert on each other by collisions or otherwise. It was necessary therefore to obtain the theory of the vibrations of these rings, also of the effect of what may be called collisions.

Sir William Thomson took many steps towards the theory of vibrations. But the theory of collisions was left for Mr. J. J. Thomson.

Mr. Thomson has not, however, confined his attention to the point set for the prize, but, starting from the foundation laid by Helmholtz, has recast the theory to his own method.

Having deduced general expressions for the momentum, moment of momentum, and energy in a mass of fluid in which there is vortex motion, which expressions are better adapted for his purpose than any previously obtained, he proceeds to the theory of a solitary vortex ring subject to the same limitation as that treated by Sir William Thomson, *i.e.* the diameter of the core small compared with the opening of the ring, but of more general shape, in that it may have any small deviation from the circular form. He obtains results which, where they correspond, agree very approximately with those previously obtained by Sir William Thomson.

The author then proceeds to the immediate subject of the essay—the action upon each other of two rings.

In dealing with this subject he introduces another important limitation, *i.e.* that the rings shall not approach each other by a distance which is large compared with the openings of the rings.

With this limitation, by means of a very powerful piece of mathematical work, the theory of the mutual action of such rings is deduced, both as regards mean motion and vibration; and he has thus carried the theory of vortex atoms to such a stage that in certain general respects it can be applied to the theory of gases.

The essay, however, does not end here, for, although outside the set subject, the author proceeds to consider the theory of "linked rings." This term does not seem well chosen, for it conveys the idea of rings linked as in a chain, whereas what it is used to express is a ring of which the core is compounded of several separate cores wrapped in a spiral manner round each other like a ring composed of twisted wire.

In the treatment of this branch of his subject he has been no less successful than in the earlier parts.

From the general scheme of his essay it is clear that the author has had in his mind as a general object the verification of the vortex atom theory; and although he avowedly refrains from going at length into such a vortex atom theory of gases as might be built upon his work, he adds a chapter at the end in which he discusses certain results of his work, which may be applied without further calculation to the vortex atom theory of gases.

It is this chapter which will excite the most general interest, for although the fact of this still very incomplete theory being found consistent with observed gaseous phenomena would not afford a crucial test of its fitness to explain the phenomena of solids and liquids, still its failure to explain the phenomena of gases would appear to be crucial as regards its unfitness as an atomic theory.

The fair and cautious spirit in which Mr. Thomson discusses his results cannot be too much admired, although we may not be quite able to realise the truth of his reasoning.

The most general and important phenomenon of gases is that sometimes called Boyle's law—that the product of the volume and pressure of any fixed weight of gas varies directly as the amount of heat, *i.e.* kinetic energy, in a gas.

Accordingly Mr. Thomson calculates the product of the pressure and volume which would result in the case of a vortex atom gas. This he finds equal to two terms, one being the kinetic energy multiplied by a constant, the other a certain quantity which involves the squares of the velocity of the medium at the boundary surface. To fit Boyle's law this second term must vanish or nearly so. Mr. Thomson argues that it does so vanish, because the surface being at rest the velocity of the fluid at it must be small. This argument we entirely fail to follow, possibly owing to some misapprehension on our part; but it seems to us that a vortex being near a solid surface is no reason for supposing the tangential velocity of the fluid small, while if the gas consists of vortex atoms so must the solid surface, and there is nothing to show that the mean square of the velocity within the solid and at its surface will be less than in the gas.

Passing on from Boyle's law, with the explanation of which he is satisfied, the author next turns to the phenomena depending on the velocity of the gaseous molecules. As this seems to us the most interesting part of the discussion, we quote the passage in full:—

"According to the vortex atom theory, as the temperature rises and the energy increases the mean radius of the vortex rings will increase, but when the radius of a vortex ring is increased its velocity is diminished, and thus the mean velocity of the molecules decreases as the temperature increases; thus it differs from the ordinary kinetic theory, where the mean velocity and the temperature increase together. It ought to be remarked, however, that though in the vortex atom theory the mean velocity decreases as the temperature increases, yet the mean momentum increases with the temperature.

"The difference between the effects produced by a rise in temperature on the mean velocity of the molecules will probably furnish a crucial experiment between the vortex atom theory and the ordinary kinetic theory of gases, since all the laws connecting the phenomena of diffusion with the temperature can hardly be the same for the two theories. In fact, if we accept Maxwell's reasoning about the phenomenon called 'thermal effusion' we can see at once an experiment which would decide between the two theories.

"The phenomenon is this, if we have a porous diaphragm immersed in a gas, and the gas at the two sides of the diaphragm at different temperatures, then when things have got into a steady state the pressures on the two sides of the diaphragm will be different, and Maxwell, in his paper 'On Stresses in Rarefied Gases' (*Phil. Trans.* 1879, part i. p. 255), gives the following reasoning to prove that, according to the ordinary theory of gases, the pressures on the two sides are proportional to the square root of the absolute temperatures of the sides. He says:—

"'When the diameter of the hole and the thickness of the plate are both small compared with the length of the free path of the molecule, then, as Sir W. Thomson has shown, any molecule which comes up to the hole on either side will be in very little danger of encountering another molecule before it has got fairly through to the other side.

"'Hence the flow of gas in either direction through the hole will take place very nearly in the same manner as if there had been a vacuum on the other side of the hole, and this whether the gas on the other side of the hole is of the same or of a different kind.

"'If the gas on the two sides of the plate is of the same kind but at different temperatures, a phenomenon will take place which we may call *thermal effusion*. The velocity of the molecules is proportional to the square root of the absolute temperature, and the quantity which passes out through the hole is proportional to this velocity and to the density. Hence, on whichever side the product of the density into the square root of the temperature is greatest, more molecules will pass from that side than from the other through the hole, and this will go on till this product is equal on both sides of the hole. Hence the condition of equilibrium is that the density must be inversely as the square root of the temperature, and since the pressure is as the product of the density into the temperature, the pressure will be directly proportional to the square root of the absolute temperature.'

"If we were to apply the same reasoning to the vortex atom theory, we should no longer have the velocity proportional to the square root of the absolute temperature, but to some inverse power of it, and the above reasoning would show that if p and p' be the pressures, t and t' the temperatures on the two sides of the plate, $p/p' = (t/t')^m$, where m is a quantity greater than unity. Thus accurate investigations of the phenomenon of thermal effusion would enable us to decide between the vortex atom and the ordinary kinetic theory of gases. These experiments would, however, be difficult to make accurately, as we should have to work with such low pressures to get the mean path of the molecules long enough that the pressure of the mercury vapour in the air-pump used to rarefy the gas might be supposed sensibly to affect the results. In the theoretical investigation, too, the effects of the bounding surface in modifying the motion of the gas seem to have scarcely been taken sufficiently into account to make the experiment of the crucial test of a theory; and it is probable that the theory of the diffusion and viscosity of the gases worked out from the laws of action of two vortex rings on each other, given in Part II. of this essay, would lead to results which would decide more easily and more clearly between the two theories.

"The preceding reasoning holds only for a monatomic gas which can only increase its energy by increasing the mean radius of its vortex atoms; if, however, the gas be diatomic, the energy will be increased if the shortest distance between the central lines of the vortex cores of the two atoms be diminished, and if the radius of the vortex atom is unaltered the velocity of translation of the molecule will be increased as well as the energy; thus for a diatomic molecule we cannot say that an increase in the energy or a rise in the temperature of the gas would necessarily be accompanied by a diminution in the mean velocity of its molecules."

With the argument here used we have no fault to find, but it does seem to us that the author has fallen into some confusion between the experimental phenomenon of thermal transpiration through porous plugs and the theoretical idea of "thermal effusion." It has probably escaped Mr. Thomson, but the experiment he suggests was included in the general investigation, made by the writer of the present review,[1] by which the phenomenon of thermal transpiration was discovered, and although it still appears that these are the only experiments on this subject, yet they conclusively prove that the difference of the pressure on the two sides of the plate is proportional to the square roots of the absolute temperatures. So far then it would seem that the crucial experiment has been made and that the verdict is against the vortex atom theory; but this is not so, for, although the experiment Mr. Thomson suggests has been made, it is definitely and experimentally shown in the same investigation that the action of the porous plug is entirely different from that which Maxwell calls thermal effusion, being due entirely to the tangential action of the walls of the passages, and further this tangential action is in strict accordance with the present dynamical theory of gases. This experiment with the porous plug, then, affords no test whatever in the way suggested by Mr. Thomson. Mr. Thomson has, we think, been unfortunate in his choice of tests; and we would suggest *the velocity of sound* as affording a crucial test for which the experimental work is already done. It appears to be an almost obvious deduction from the vortex atom theory that the velocity of sound must be limited by the mean velocity of the vortex atoms; and since Mr. Thomson has shown that this mean velocity diminishes with the temperature, while experimentally it is found that the velocity of sound increases as the square root of the temperature, it appears that the verdict must be against the vortex atom theory. However the vortex atoms are very slippery things, and we should like to hear Mr. Thomson's opinion before adopting one of our own.

Besides discussing the theory of gases, Mr. Thomson goes somewhat fully into a vortex atom theory of chemical combinations; in this he raises many points which will doubtless be of great interest should the hypothesis survive the crucial test by the theory of gases which this essay now for the first time renders possible.

Of the mathematical interest of the essay we can only say that to those who can appreciate it this will be found to be very great. OSBORNE REYNOLDS

OUR BOOK SHELF

Krystallographische Untersuchungen an homologen und isomeren Reihen. Von Dr. A. Brezina. I. Theil. Methoden. (Wien, 1884.)

THIS very useful volume forms an introduction to the author's crystallographic investigations which earned the prize of the Vienna Academy. It deals exclusively with the principles and the methods employed in those investigations, and constitutes a complete storehouse of the formulæ required in the study of crystals, and of the best means of applying those formulæ. The following subjects are successively treated: the optical principles involved in the goniometer; the practical use of the instrument, and the errors to which it is liable; the criticism of probable errors of observation; stereographic projection; all possible cases of trigonometrical calculation, including the method of least squares; and a slight sketch of the use of the polarising apparatus.

An important feature of the book is the illustration of methods by the actual measurement of seven crystals of a triclinic substance. The readings of the goniometer scale are first given, and from these the reader is led through the entire series of processes: stereographic projection, assignment of indices, calculation of elements, and recalculation of angles, each given in its place as an example of the principles and formulæ employed. This practical illustration is a far more effectual means of recommending the methods to the reader than mere verbal description.

It will probably be found that these methods of calculation are the most valuable part of the book; they are so systematically arranged and tabulated that the various steps may be distinguished at a glance, and any numerical error must be detected at once, while much labour is saved by the methodical order in which the operations are conducted.

It is to be presumed that the laborious process of calculating the angle between each pair of faces from the elements by means of the general formula is given as an exercise in the method of least squares rather than as an example of the course to be actually adopted in any but rare cases.

One subject, however, of some importance is barely touched upon; namely, the criticism of images obtained from crystal faces on the goniometer, and their interpretation. Both in the descriptive paragraphs and in the above-mentioned illustration, all measurements of the same angle upon different crystals are assumed to be equally good, so that their arithmetic mean is adopted as the observed value, whereas the difficulties presented by multiple images seem to deserve treatment in a book which deals so exhaustively with the practical side of the subject. It is to be regretted also that the discussion of optical properties and measurement has been almost crowded out of the work. H. A. M.

[1] "Certain Dimensional Properties of Matter in the Gaseous State," *Phil. Trans.* 1879, Part II.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Remarkable Sunsets

SPEAKING of Virginia City, the great silver mining centre of Nevada State, I said, in "An Engineer's Holiday," that it "lies among the foothills of the Sierra, at an elevation of 6200 feet, on the eastern face of Mount Davidson . . . surrounded by innumerable interlocked mountains, conical in outline, red-brown in colour, and perfectly bare of all vegetation. These stretch, as far as the eye can reach, to where the snowy tops of the Humboldt peaks stand against the sky, and the terrible sterility of the scene is enhanced rather than relieved by the thin meanderings of the Carson River, whose course is marked by a narrow green line. This is the only sign of water visible in the arid panorama, whose bare, red cones are steeped all day in dust-haze, and lighted for a few minutes at sunset by an 'Alpenglow' which dyes the countless peaks in as countless gradations of rosy light."

It certainly did not occur to me, when I wrote the above three years ago, that the finer and higher particles of the dust-haze which obscures the dry air of the American desert may have been concerned in producing the splendid sunset effects which I witnessed at Virginia City; but this, after our recent experiences, seems very probable. D. PIDGEON

Holmwood, Putney Hill, December 22

I HAVE received a letter, dated December 5, from Mr. Joseph Moore, of New Garden, North Carolina, U.S.A., in which he informs me that "the phenomena at both sunset and sunrise have been unusual in more than a dozen instances here during the autumn. Only the night before last we had an extraordinary sunset. The sky bore all the tints of which you speak, but I do not remember to have noticed the cirrus cloud in more than one instance. The sunsets have been subject for remark in quite a number of the papers." I inclose also a newspaper, the *Olive Branch*, of Hancock, Minnesota, U.S.A., which has been forwarded to me by another correspondent, containing a notice of the sunset of November 10.

Richmond, Surrey, December 22 F. A. R. RUSSELL

IN a letter dated Tokio, October 3, describing a tour in the interior of Japan, Prof. James Main Dixon writes:—"During the two or three days at the end of August we enjoyed fine dry weather, but the sun was copper-coloured and had no brightness. It was capital weather for travelling, but rather inexplicable. When we got to Nikko, the people came to us to inquire if some catastrophe were impending, for the appearance of the sun foreboded evil. We laughed at their fears, and assured them all was right. However it seems that if the appearance of the sun foreboded no evil, it was a wonderful sign of the greatest earthquake and volcanic catastrophe on record. The fearful explosion of Krakatoa, in the Straits of Sunda, took place on August 26, and there seems little reason to doubt that the monsoon had carried the volcanic dust along with it, the dust obscuring the sun. The distance is nearly 3000 miles."

LEWIS CAMPBELL

St. Andrews, December 22

Peripatus

DR. VON KENNEL, in a note on the "Development of Peripatus," which appeared in a recent number of the *Zoologischer Anzeiger*, and has been translated and printed in your columns, has thrown some doubt on the accuracy of the observations recorded in the late Prof. Balfour's memoir on the "Anatomy and Development of *Peripatus capensis* (*Quart. Journ. Micro. Sci.*, April, 1883). We trust that you will give us, as the editors of that memoir, this opportunity of making a few brief statements in reply to the somewhat unusually outspoken criticisms contained in his preliminary note.

Dr. von Kennel entirely omits to mention in his paper that Prof. Balfour's researches refer to a Cape species of Peripatus (*P. capensis*), whilst the species which he has worked at are West Indian, and differ considerably from *Peripatus capensis*.

Considering the fact, well known to embryologists, that there are numerous instances of great discrepancies in the embryonic history of closely-allied forms, it seems to us strange that the only explanation, suggested by Dr. von Kennel, of the differences between his results and those recorded in Prof. Balfour's memoir should be that the latter are absurdly erroneous.

The remarkable attitude which Dr. von Kennel has assumed in this matter must have been obvious to all competent zoologists. We offer these remarks mainly because his statements have appeared in a journal which has a wide circulation amongst readers who are not so well able to judge of the merits of the case.

We are able to state in conclusion that the results enumerated on pp. 256, 257 of Prof. Balfour's memoir have been confirmed by Mr. Sedgwick on a large number of fresh and well-preserved embryos of Peripatus from the Cape, obtained since the publication of the memoir.

H. N. MOSELEY
A. SEDGWICK

[THE translator of Dr. von Kennel's "Note on the Development of Peripatus," to whom we submitted the above letter, writes to us that, "though with a large experience in such matters, he is quite unable to see anything 'unusually outspoken' in Dr. von Kennel's criticisms; had any such occurred, he would have passed them over; nor does he find any foundation for the statement that Dr. von Kennel explains the results of Prof. Balfour's memoir as 'absurdly erroneous.' Dr. von Kennel, at the beginning of his note, only asserts that his observations *cast some doubt* on those of Balfour, apologetically adding that his material was immensely richer than Balfour's, and at the conclusion of his Note he simply calls attention to the discrepancies between his observations and Balfour's illustrations." At the translator's request we quote the original of the two critical paragraphs with the translations, so that the many competent zoologists who are amongst our readers can judge whether the latter adds to or takes from the spirit of the former.—ED. NATURE.

"Ich thue dieses hauptsächlich deswegen, weil die durch Moseley und Sedgwick publicirte Abhandlung aus dem Nachlass Balfour's einige Abbildungen von Embryonen und Schnitten durch solche enthält, deren Genauigkeit ich nach meinem reichlichen und ausgezeichnet conservirten Material und nach den Beobachtungen am frischen Objecte etwas anzweifeln muss, deren Deutung vollends die Probe nicht hält."

"I do this chiefly because the treatise published by Moseley and Sedgwick from the posthumous notes of Balfour contains some representations of embryos and cross-sections of the same, upon whose accuracy in details I, with my rich and well-preserved collection of specimens, and observations on fresh objects, must cast some doubt, and the interpretation of which does not bear investigation."

"Ich enthalte mich hier, um nicht weitläufig zu werden, jeder Discussion, muss jedoch noch einmal darauf hinweisen, wie wenig Balfour's Abbildungen und die Schilderungen der Herausgeber mit den hier mitgetheilten Thatsachen stimmen."

"I here abstain for the sake of brevity from all discussion, but must, however, call attention to the fact how little Balfour's illustrations and the descriptions of the Editors agree with the facts as they are here given."]

A New Rock

DURING my visit last summer to Lake Sagvand, in the Balsfjord, near the city of Tromso, I discovered a new enstatite-bearing rock, which forms entire little hills. It is composed of light yellow-green enstatite, mixed with magnesite. The magnesite, which is entirely free from lime, is partly white, partly dirty grey in colour, in which latter state it contains a little oxidulated iron, and appears then distinctly crystalline, with rhomboidal planes of cleavage. The rock is greatly interspersed with little grains of chromite, which are found in the enstatite as well as the magnesite. Here and there small grains of pyrite also appear. The substance is perfectly free from olivine, at all events neither olivine nor serpentine has been discovered under microscopical analysis.

The rock must be considered a new petrographical species. I have named it "Sagvandite," from the place where it was first discovered. It appears with a strong reddish-brown colour on its uneven surface, where the magnesite is completely washed out, so that the enstatite alone remains. The rock is not slaty, and must so far be said to be of massive structure.

When I have had an opportunity of thoroughly analysing the new substance, I propose to give a complete description of it in NATURE.

KARL PETTERSEN

Tromso Museum, Finmarken, Norway, December

Diffusion of Scientific Memoirs

IN his notice of the Reprint of Prof. Stokes' papers in NATURE for Dec. 13 (p. 145), Prof. Tait, with characteristic incisiveness, speaks of the "almost inaccessible" volumes of the *Cambridge Philosophical Transactions*, and proceeds to offer an "easy cure" for that simple though grave malady. I think if Prof. Tait had taken the trouble to make the inquiry he would have found that very few societies are so liberal in the free dissemination of their publications, and that the number of universities, prominent societies, or libraries which do not receive them gratis, or merely in exchange, is very small.

December 14 W. M. HICKS

THE question so pointedly at issue between Mr. Hicks and myself is one which can be settled by statistics only. NATURE would do a real service to science by collecting statistics as to the *numbers* of different centres (home, and foreign, separately) at which the *Transactions* of various scientific Societies were freely accessible in 1883 (say); and also the corresponding numbers in 1853. The Royal Society regularly publishes such information in its *Transactions*, so does the Royal Society of Edinburgh.

I have been a Fellow of the Cambridge Philosophical Society for about 30 years; and, during that time, I have received from the Society some fasciculi (of *Proceedings* only) certainly not amounting to a dozen in all:—and I am not aware that my case is an exceptional one.

Mr. Hicks writes as if he thought I was bringing an accusation. Surely the figure, of *malady*, which I was careful to employ, cannot be so construed.

P. G. TAIT

THE "TALISMAN" EXPEDITION[1]

AT the public meeting of the five Academies on October 29, 1882, I had the honour of reporting on the explorations of the *Travailleur*, and I announced that this year a new scientific campaign would be undertaken in the Atlantic. The Minister of Marine, responding to the desire expressed by his colleague, the Minister of Public Instruction, and by the Academy, had, in fact, issued the necessary orders to have the *Talisman* equipped for this purpose. The *Talisman* is an excellent screw steamer, provided with a good spread of canvas, sufficient to make good way without the aid of its engines. For several months it was placed in dock at the Rochefort Arsenal, where the naval engineers undertook to refit it for the service to which it had been appointed. The old hempen ropes intended for raising the dredges were replaced by a steel cable of great strength and flexibility, capable of a strain of about 4500 kilogrammes, and worked by two steam-engines. One of these set in motion the enormous bobbin on which the cable was wound. The other, a still more powerful engine, was intended for raising the dredges.

Large bag-nets, or trawls, with an opening of two or three yards, advantageously replaced the heavy drags we had formerly used. The soundings were executed by means of an apparatus perfected by M. Thibaudier, naval engineer, and so disposed as to prevent the motions of the vessel from in any way affecting the tension of the steel cable, which was arrested by an automatic break as soon as the sounder touched the bottom.

In order to gauge the temperature at great depths I had an apparatus constructed by which a mercurial thermometer (Negretti and Zambra) could be turned over at any moment. At the same time the capillary extremity of a glass tube, where a vacuum had been made, and into which the sea water then rushed, broke, supplying perfectly pure specimens, capable of being preserved for any length of time by soldering the tubes. Our friend, Colonel Perrier, had kindly lent me a Gramme machine, which generated the electricity for some Edison lamps, so disposed as to light up our apparatus, or, when needed, to penetrate to depths not exceeding 35 metres. At my request the command of the *Talisman* had been intrusted to M. Parfait, frigate captain, who had held the same position the year before on board the *Travailleur*.[2] I may here be permitted to express to the officers of the *Talisman* the feelings of gratitude inspired in us by their devotion. They cooperated with us with unflagging zeal, and for whatever success attended our mission we are indebted to them.

On May 30, the scientific mission[3] met at Rochefort, and on June 1 the *Talisman* set sail. The voyage of 1883 may be divided into several distinct stages. Our object was to study the coast of Africa as far as Senegal, then the waters of the Cape Verde, Canary, and Azores Archipelagos, volcanic lands which could not fail to supply us with interesting materials. Lastly, we hoped to be able to devote our attention to the Sargassum Sea, its fauna, and the nature of its bed.

The sea bed stretching westward of Morocco and the Sahara is extremely uniform, no longer presenting those rugged reliefs that had so impeded our operations on the coast of Spain. On the contrary, the slope is here so gentle that at greater or less distances from the land it was always possible almost infallibly to light upon the needed depths. In these waters we made about 120 dredgings, and in a few days we had determined the bathymetric distribution of the local fauna with sufficient accuracy to enable us to indicate the levels explored from the contents of our nets.

At 500 or 600 metres live numerous fishes, such as Macrurus, Malacocephalus, Hoplostethus, Pleuronectes, as well as prawns of the genus Pandalus, belonging to a new species with a rostrum pointed like a sword; some Peneæ, Pasiphaæ, a few small crabs (Oxyrhynchidæ, Portunidæ, Ebalidæ), pink Holothurians, some rare specimens of Calveria, that soft Echinoderm discovered in our waters by the naturalists of the *Porcupine*, and previously known in the fossil state; several very large sponges, such as Askonema and Farrea.

At greater depths, from 1000 to 1900 metres, fishes still abound,[1] and often formed the bulk of our captures. They were generally of a dull colour, with gelatinous flesh, and their skin covered with a thick mucous coating. Several had phosphorescent spots, serving to give them light in the dark regions they inhabit. Here Pandali give place to the new genus Heterocarpus, and to gigantic blood-red prawns with enormously long antennæ, which were new to science and may be placed in the genus Aristeus. The Nephropsis make their appearance at this level. They are blind, coral-tinted Crustaceæ, who seem to be distributed over a wide geographical range, for they have been found on the other side of the Atlantic in the Caribbean Sea, and a closely allied species has been fished up at a great depth near the Andaman Islands. The blind Polycheles, which in the present epoch represent the Jurassic Eryons, burrow in the mud, leaving nothing visible except their long hooked nippers, adapted for seizing the passing prey. Some crabs are still found, such as Maiadæ (Scyramathia, Lispognathus), a new species of Homolia, and Lithodes, hitherto supposed to be peculiar to Arctic and Antarctic seas. Lastly, numerous forms were also observed of the genus Galathea, several of which have their eyes transformed to spines. Sponges are extremely common, most of them with siliceous skeletons. We brought up great numbers of Rosella, Holtenia of several species, the rock crystal-like beards white as snow were buried in the mud, the sponge mass alone emerging; some Aphrocallistes, with solid skeletons of the most elegant form. Calveria became more numerous; Holothurians of the genus Loetmogone, and other species of the same family, crawled on the bottom in the midst of Asteria, Ophiuria, and Brisinga. The nets often returned filled with so much treasure that they could not all be classed within the day.

While rounding Cape Ghir and Cape Nun, some 120 miles from the coast, the *Talisman* spent several days in exploring a very regular bank at a depth of about 2000 to 2200 metres. It was on this ground that on Aug. 2, 1882, the *Travailleur* had captured the curious fish described by M. Vaillant under the name of *Eurypharynx pelecanoïdes*, and two specimens of which were taken this year.

Our prizes were again of great value. Magnificent sponges, allied to those that have been described under the name of *Euplectella suberea* were here found mingled with large violet Holothurians of the genus Benthodytes, and with other species of the same genus, remarkable for their dorsal appendices. A Calveria, distinct from those found at lesser depths, some Brisingæ, Polyps of rare beauty (Flabellum, Stephanotrochus), a Democrinus and a Bathycrinus, not yet described, very numerous Crustaceæ, nearly all new to us and belonging to the group of the Galatheæ (Galathodes, Galacantha, Elasmonotus), completed the list of invertebrates. The fishes were very varied, and their study will furnish new facts of the greatest interest to science. Amongst the most remarkable I may mention *Melanocetus johnsoni*, Bathy-

[1] Preliminary Report on the *Talisman* Expedition to the Atlantic Ocean. By M. Alphonse Milne-Edwards, President of the Submarine Dredging Commission. Communicated by the author.

[2] The staff consisted of M. Antoine and M. Jacquet, lieutenant, of MM. Gibory and Bourget, midshipmen, of M. Vincent, doctor of the first class, of M. Huas, assistant doctor, and of M. de Plas, chief mate.

[3] The mission consisted of M. A. Milne-Edwards, Member of the Institute, President, of M. de Folin, MM. Vaillant and Perrier, professors in the Museum, MM. Marion and Filhol, professors in the Faculty, M. Fischer, assistant naturalist in the Museum, MM. Ch. Brongniart and Poirault, added as assistants.

[1] To Macrurus are here added the following genera: Bathynectes, Coryphenoides, Malacocephalus, Bathygadus, Argyropelecus, Chauliodus, Bathypterois, Stomias, Malacosteus, Alepocephalus.

trochtes, a Stomias with phosphorescent spots, and several Malacostei.

Between Senegal and the Cape Verde Islands our trawls reached depths varying from 3200 to 3699 metres, and brought up most of the preceding species besides many others (Crustaceans, Mollusks, Zoophytes, Sponges) which had never elsewhere been met.

These last takes brought to a close the first part of our programme, and on July 20, after ninety-one days of navigation, we cast anchor in the Bay of La Praia, at Santiago in the Cape Verde Archipelago. This volcanic group detained us a few days, and while zoological, botanical, and geological excursions were being made ashore, the *Talisman* was searching the irregular beds on the coasts for marine animals, and especially for the red coral, which for some years back has formed the object of an active trade in these islands. I will not dwell on these in-shore explorations, nor on those of the islet Blanco, where we were able to study on the spot the large Saurians (*Macroscincus coctei*) which seem limited to this isolated rock.

All these details are recorded in the report which I have addressed to the Minister and which will soon be published.

In the deep waters of the Cape Verde Archipelago life displays a surprising energy. Our nets came up overflowing with specimens after a single plunge. We captured at one take more than 1000 fishes belonging mostly to the genus Melanocephalus, about 1000 Pandali, 500 prawns of a new species of the genus Nematocarcinus, with disproportionately long claws, as well as many other species.

On the evening of July 30 the *Talisman* took a northwesterly course in the direction of the Sargassum Sea. I need not enter into details on this part of our journey, and it will suffice to say that we nowhere met those dense floating masses of vegetation mentioned by the old navigators. The Gulf weed was seen in isolated patches drifting either with the marine or atmospheric currents, and harbouring a whole pelasgic population, whose colours harmonised admirably with those of the algæ that afforded them a refuge. Our naturalists made a careful study of these forms.

The soundings of the *Talisman* in this region show in a general way that, starting from the Cape Verde Islands, the marine bed falls regularly as far as about the 25th parallel, where it attains a depth of 6267 metres. Then it gradually rises towards the Azores and the 35th parallel, where it is about 3000 metres. These results are far from agreeing with the curves indicated on the most recent bathymetric charts. The bed of the Sargassum Sea seems formed of a thick layer of a very fine mud of a pumice nature, covering fragments of pumice and volcanic rocks. Here there would appear to stretch, at over three miles from the surface of the ocean, a vast volcanic chain parallel with the African seashore, and of which the Cape Verde Islands, the Canaries, Madeira, and the Azores are the only parts not submerged. The submarine fauna is poor, consisting of few fishes, some Crustaceans, such as Paguri, which lodge in colonies of Epizoanthus, prawns of the genus Nematocarcinus, Pasiphaæ, a few mollusks (Fusus, Pleurotoma, and Leda), which scarcely sufficed to repay the time required for such deep dredgings. Not that our captures did not again become abundant towards the northern limit of the Sargasse Sea, when the depths shrank to 3000, 2000, and 1500 metres. It was here that we took the giant of the family of the Schizopodes, a Gnathophausia of a blood-red colour measuring nearly 25 centimetres in length.[1]

A short delay at Fayal, and again at San Miguel in the Azores, enabled us to compare the volcanic phenomena still active at certain points with those we had studied on the summit of the Peak of Teneriffe. The analogy is very striking between the rocks, the gaseous products, and the sulphur deposits of the two islands. From what is now taking place on the surface of the ground, an idea may be formed of the submarine convulsions which have covered the bed of the Sargassum Sea with pumice and igneous rocks.

[1] *Gnathophausia goliath*, new species.

The return voyage from the Azores to France was effected under the most favourable conditions, and we were able to make daily dredgings in depths of from 4000 to 5000 metres. These difficult operations, very skilfully carried out by Captain Parfait, brought us an extremely valuable harvest. Under this tremendous pressure, in perfect darkness, and without a trace of vegetation, animal life is still vigorous. Large fishes of the genus Macrurus, as well as some Scopeli and Melanoceti seem to be here far from rare. Some Pagures and Galatheæ of new form, a gigantic Nymphon of the genus Colossendeis, some unknown Ethusæ, besides Amphipods and Cirrhipeds represent the Crustacean group. But this abyssal fauna owes its peculiar physiognomy to the number, variety, and size of the Holothurians.

The marine bed is carpeted throughout this region with a thick white mud, composed almost exclusively of Globigerini, and covering pumice deposits and fragments of various kinds of rocks. Some of these rocks brought up in our nets bore the impress of fossils, amongst others of Trilobites. But what still more surprised us was to find at a distance of over 700 miles from the European coast pebbles polished and striated by the action of ice. The sharpness of the striæ excludes the supposition of transport by the currents. The presence of these pebbles is probably due to the action of the icebergs, which in the Quaternary epoch advanced further southwards than at present, and which, by melting in the region of the Atlantic comprised between the Azores and France, deposited on the bottom of the sea the stones carried off from the glacier beds and conveyed to this distance from Europe.

On August 30 we dredged for the last time on the steep slope by which the oceanic depths are connected with the Bay of Biscay, and our captures added to the fauna of the French waters a large number of new or interesting species.

It was high time to return to Rochefort. Our casks and cases were full, our alcohol exhausted. This voyage has furnished us with unrivalled materials for study, materials which must now be put in order. The Minister of Public Instruction has recognised their importance, and has supplied me with the means of beginning the publication of the results. It is my intention to place before the public the collections that have been made during the explorations of the *Travailleur* and *Talisman*. These treasures will be exposed in a special exhibition, which will be held in one of the halls of the museum towards the beginning of January.

MUSIC AND SCIENCE[1]

IT would seem that Science, like History, may at times repeat itself: for in this bright little pamphlet we have a revival of the Old World controversy, which dates from the days of Pythagoras, Plato, Aristotle, and Euclid. The author takes, however, for its text, a somewhat declamatory and *ad captandum* modern passage from the *Revue de Paris*, which declares, with an emotional warmth totally uncalled for under the circumstances, that harmony is not a science, and that music is an art, "but a divine art." To appreciate thoroughly the question in debate it is necessary to go back to the sense of the original Greek words—*ἁρμονία* and *μουσίκη*. The former means "mathematical agreement"; the second "artistic culture." It is with their "second intentions," or acquired and more limited meanings, that we now have

[1] "La Musica è una Scienza." Saggio Acustico fisiologico Del Dott. Primo Crotti. Pp. 55. Luigi Battei Editore. (Parma, 1883.)

to deal. Is music, in the English sense of the word, which no wise differs from the Italian, an art or a science? It is clearly both; but the art, μουσική, so far predominates in public acceptance and cultivation over the science, ἁρμονία, that the latter is, and has been for many centuries, in danger of succumbing altogether. Indeed, though excellently begun by Euclid in his "Sectio Canonis," it remained all but unadvanced until the recent researches of Helmholtz. It is to Aristotle that we owe the general test by which to distinguish an art from a science; a test so satisfactory and so neat, that it produces the effect on the mind of a mathematical demonstration; a form of proof which is too often only a roundabout way of re-stating a self-evident proposition. Aristotle said that art at its best only works by "rule of thumb"; and states that τέχνη is governed by rules. When these rules are found to rest on recognised laws, the art becomes an ἐπιστήμη, or science. This observation, made two thousand years ago by the shrewdest of all shrewd observers, remains as true and as fresh as on the day when it was promulgated. To no branch of human learning does it apply with such force and directness as to music. For perfection in this art has always been, is now, and must continue to be, confined to a few sensitive, delicate, finely-strung natures, which differ from those of their fellow-creatures in possessing a peculiar technical power and organisation such that they instinctively reproduce, and as it were consonate to the musical conceptions of other minds. In all other respects they may be self-indulgent, unbusinesslike, unpractical; even, as indeed not uncommonly they are, over-sensitive and disagreeable. Types of this class are Beethoven, Cherubini, Mozart, Weber, and Berlioz. In them, in fact, the full development of artistic perfection has eaten up all other good qualities, and left no time or inclination for what Plato calls "the practice of virtue." The world at large, secretly conscious of its special inferiority, and always willing to discharge itself of an unwelcome responsibility, too commonly looks upon these exceptional natures as representing the whole, and not only the artistic and executive side of music. But the other exists notwithstanding; and its fuller cultivation will tend much to restore the balance so disturbed. In this respect the little book of Dottore Crotti has special value. It deals with the foundation of rhythm and of music, and with the strange and hitherto unexplained emotional difference between the major and minor scales, which in the Italian are prettily and correctly named *Gaia* and *Triste* respectively. The ratios of musical intervals and their combination are fully treated, and with some features of novelty, especially as concerns their physiological effects on the ear. The great fact, so much forgotten in this century since the brilliant jigs of the Rossinian school have become popular, that it is the bass, and not the treble or melody, which is fixed and fundamental, is stated with abundant emphasis, and distinction is made between the characters of repose and of movement in different kinds of music. The assumption that the scale is founded principally on the fractions representing the major and minor tones with only a simple semitone of $\frac{16}{15}$ seems hardly sufficient to meet theoretical requirements; but otherwise there is much of interest comprised within the 55 pages of which the pamphlet consists. It has the merit, moreover, beyond the historical point already noted, of bearing out its title of "acoustico-physiological," and of adverting to the mental or receptive side of musical impressions more than occurs in some modern treatises.

W. H. STONE

THE REMARKABLE SUNSETS

THE following letter has been sent to Mr. Norman Lockyer:—

The remarkable sunsets which have been recently witnessed upon several occasions have brought to my recollection the still more remarkable effects which I witnessed in 1880 in South America, during an eruption of Cotopaxi; and a perusal of your highly-interesting letter in the *Times* of the 8th inst. has caused me to turn to my notes, with the result of finding that in several points they appear to have some bearing upon the matter which you have brought before the public.

On July 3, 1880, I was engaged in an ascent of Chimborazo, and was encamped on its western side, at 15,800 feet above the sea. The morning was fine, and all the surrounding country was free from mist. Before sunrise, we saw to our north the great peak of Illiniza, and twenty miles to its east the greater cone of Cotopaxi, both without a cloud around them, and the latter without any smoke issuing from its crater—a most unusual circumstance; indeed, this was the only occasion on which we noticed the crater free from smoke during the whole of our stay in Ecuador. Cotopaxi, it should be said, lies about forty-five miles south of the equator, and was distant from us sixty-five miles.

We had left our camp, and had proceeded several hundred feet upwards, being then more than 16,000 feet above the sea, when we observed the commencement of an eruption of Cotopaxi. At 5.45 a.m. a column of smoke of inky blackness began to rise from the crater. It went up straight in the air, rapidly curling, with prodigious velocity, and in less than a minute had risen 20,000 feet above the rim of the crater. I had ascended Cotopaxi some months earlier, and had found that its height was 19,600 feet. We knew that we saw from our station the upper 10,000 feet of the volcano, and I estimated the height of the column of smoke at double the height of the portion seen of the mountain. The top of the column was therefore nearly 40,000 feet above the sea. At that elevation it encountered a powerful wind blowing from the east, and was rapidly borne for twenty miles towards the Pacific, seeming to spread very slightly and remaining of inky blackness, presenting the appearance of a gigantic inverted ⌞, drawn upon an otherwise perfectly clear sky. It was then caught by a wind blowing from the north, and was borne towards us, and appeared to spread rapidly in all directions. As this cloud came nearer and nearer so of course it seemed to rise higher and higher in the sky, although it was actually descending. Several hours passed before the ash commenced to intervene between the sun and ourselves, and when it did so we witnessed effects which simply amazed us. We saw a green sun, and such a green as we have never, either before or since, seen in the heavens. We saw patches or smears of something like verdigris-green in the sky, and they changed to equally extreme blood-reds, or to coarse brick-dust reds, and they in an instant passed to the colour of tarnished copper or shining brass. Had we not known that these effects were due to the passage of the ash, we might well have been filled with dread instead of amazement; for no words can convey the faintest idea of the impressive appearance of these strange colours in the sky, seen one minute and gone the next, resembling nothing to which they can be properly compared, and surpassing in vivid intensity the wildest effects of the most gorgeous sunsets.

The ash commenced to pass overhead at about mid-day. It had travelled (including its detour to the west) eighty-five miles in a little more than six hours. At 1.30 it commenced to fall on the summit of Chimborazo, and before we began to descend it caused the snowy summit to look like a ploughed field. The ash was extraordinarily fine, as you will perceive by the sample I send you. It filled our eyes and nostrils; rendered eating and drinking impossible; and reduced us to breathing through handkerchiefs. It penetrated everywhere, got into the working parts of instruments, and into locked boxes. The barometer employed on the summit was coated with it, and so remains until this day.

That which passed beyond us must have been finer still. It travelled far to our south, and also fell heavily upon ships on the Pacific. I find that the finer particles do not weigh the 1/25,000 part of a grain, and the finest atoms are lighter still. By the time we returned to our encampment the grosser particles had fallen below our level, and were settling down into the valley of the Chimbo, the bottom of which was 7,000 feet beneath us, causing it to appear as if filled with thick smoke. The finer ones were still floating in the air, like a light fog, and so continued until night closed in.

In conclusion, I would say that the terms which I have employed to designate the colours which were seen are both inadequate and inexact. The most striking features of the colours which were displayed were their extraordinary strength, their extreme coarseness, and their dissimilarity from any tints or tones ever seen in the sky, even during sunrises and sunsets of exceptional brilliancy. They were unlike colours for which there are recognised terms. They commenced to be seen when the ash began to pass between the sun and ourselves, and were not seen previously. The changes from one hue to another, to which I have alluded, had obvious connection with the varying densities of the clouds of ash that passed; which, when they approached us, spread irregularly, and were sometimes thick and sometimes light. No colours were seen after the clouds of ash passed overhead and surrounded us on all sides.

I photographed my party on the summit of Chimborazo whilst the ash was commencing to fall, blackening the snow furrows; and, although the negative is as bad as might be expected, it forms an interesting souvenir of a remarkable occasion. EDWARD WHYMPER

December 21

NOTES

THE announcement that Prof. Flower has accepted the appointment of superintendent at the Natural History Museum, vacated by the resignation of Prof. Owen, is premature, though we believe that steps are being taken to secure Prof. Flower's services for that important appointment.

WE regret to have to record the death of M. Yvon Villarceau, one of the astronomers of the Paris Observatory and a member of the Academy of Sciences for more than twenty years. M. Yvon Villarceau had been a pupil of the École Central des Arts et Manufactures, and was regarded as one of the most eminent of French mathematicians.

IT has been arranged by H.M. Trawling Commissioners that Prof. McIntosh, of the University of St. Andrews, will proceed systematically at intervals (probably once a fortnight) to the trawling grounds on the east coast of Scotland for the next six months, and undertake certain investigations concerning the grounds and their inhabitants. Each trip will probably occupy about two days. The Granton General Steam-Fishing Company's steam-trawler *Wallace*, which is fitted with all the recent appliances for such work, and is a swift and powerful steamer, will be used for the investigations, which will be at once commenced. An experienced long-line fisherman and trawler from St. Andrews (Alex. W. Brown) will accompany the professor as assistant.

THE friends of the late Mr. W. A. Forbes, the Prosector of the Zoological Society of London, have decided to collect his most important papers in a memorial volume, and the following gentlemen have been appointed to act as a committee for this purpose:—Prof. Flower, Prof. Bell, Mr. H. H. Johnston, Mr. Mivart, and Mr. Sclater. The committee find that Mr. Forbes's papers can be most suitably republished in a form similar to that adopted in the memorial volume of the memoirs and papers of Mr. Forbes's predecessor in the Prosectorial office (the late Prof. Garrod). Following the precedent of the "Garrod Memorial Committee," they propose to ask for subscriptions of one or more guineas, and to give to subscribers a copy of the work for every guinea subscribed. Mr. Sclater will edit the Forbes Memorial Volume, Mr. Johnston will prepare a biographical notice and portrait, and Mr. F. Jeffrey Bell, 5, Radnor Place, Gloucester Square, W., will act as Secretary and Treasurer.

THE appointment of a Japanese student as assistant to the Professor of Anatomy at Berlin has been approved by the Minister of Public Worship.

MR. FRANCIS ELGAR, Consulting Naval Architect and Engineer in London, has been unanimously elected by the Glasgow University Court to the John Elder Chair of Naval Architecture.

AN expedition is at last being organised under the auspices of the British Association to proceed to Mount Kilimanjaro, the snow clad peak of Eastern Equatorial Africa. The party will be under the charge of Mr. H. H. Johnston, who has recently returned from the Congo. The party will leave England at the beginning of March.

HEAVY indeed is the burden of educating laid upon the Southern States! With only one half at school of a population the illiterate proportion of which, among both whites and negroes, is increasing, and in some States this increase of illiteracy greater among the whites than among the negroes; with the negro, the non-taxpaying element, increasing fastest, notwithstanding white immigration; with trades destroyed, and property in consequence reduced in value 40 per cent., and in some States still falling in value; with the franchise, nevertheless, given to this increasing body of ignorance; evil indeed may be the result to a republic if the whole Union does not assist to correct it. Emancipation was a national act, and the nation ought to meet the inevitable consequence. So urges Dr. Haygood, in the United States educational circulars referred to last week, with the warning that no white men will agree for long to be voted down by a majority of illiterate blacks and whites.

ON Thursday, at 9.21 p.m., a shock of earthquake was felt in Fünfkirchen, a town in the south of Hungary, not far from the confluence of the Danube and Drave. The shock lasted two seconds, and was accompanied by a loud underground rolling noise. At the same time a similar earthquake and noise occurred at Barcs, a place to the south-east of the former, on the banks of the River Drave. Both shocks moved northwards. An earthquake shock was also felt at Lisbon at 1.30 a.m. on the 22nd inst., but did not excite much notice. A second shock, which lasted twelve seconds, occurred two hours later; being accompanied by subterranean rumblings, it awoke the entire population, and caused a panic among the inhabitants in the narrow streets. The seismic wave passed from north-west to south-east.

THE fourteenth Annual Report of the Botanic Garden Board of New Zealand (1883) contains valuable information as to the ravages of certain scale insects (*Coccidæ*) in the colony. They appear to be principally of two kinds: one is an *Icerya*, nearly related to the sugar-cane pest of Mauritius, &c., the other a *Mytilaspis* allied to the common "apple scale" (*M. pomorum*). The *Icerya* is called the "wattle blight," but appears by no means to confine its ravages to the wattle trees. According to Mr. Maskell, it is the *Mytilaspis* that is the more serious, for it overruns in countless millions all kinds of fruit and other trees (fortunately it appears to be enormously infested and destroyed by a parasite). With regard to remedies, there is a little vagueness in the Report, owing apparently to the confusion of the two insects. The first portion speaks only of the *Icerya*, and states that Mr. Engle of Nelson had completely destroyed it by the application of kerosene and fish oil. Subsequently Mr. Maskell, dealing with the *two* species, says that a mixture of kerosene and linseed oil (one-third or one-fourth of the former) as recommended by Mr. Comstock in America, had been perfectly successful so far as regards the *Mytilaspis*, which he does not regard as serious in its probable effect upon wattles (*Acacia*), but very serious with respect to fruit and other trees. On the other hand, he considers all remedies useless against the *Icerya* of the wattle other than the radical one of cutting down and destroying the affected trees. No indication is given, however, of the use of a force-pump in distributing the kerosene; if this were used, the remedial agent might be distributed to a greater height than would be possible by mere hand application, and moreover it might be made to penetrate dense hedges, &c., the interior of which it would be impossible to drench by hand labour. The improved form of application, as a "kerosene emulsion," recommended by Prof. Riley and Mr. Hubbard, did not appear to be known in New Zealand at the time the Report was drawn up. Any way it is satisfactory to hear that the *judicious* application of kerosene will certainly destroy scale insects without necessarily damaging the plants.

THE same Report speaks very hopefully of the ultimate success of attempts to cultivate hops in the province of Wellington; in Nelson success has been already secured. The great drawback is the expense of providing the necessary *poles*, and much stress is laid upon the necessity for cultivating oak, ash, birch, and species of *Eucalyptus* for that purpose. Of the indigenous poles, those of *Myrsine urvillei* are said to be the most durable.

THE additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus* ♀) from Ceylon, presented by Mr. J. H. Barker; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. Douglas; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Mrs. Archer; a Moorhen (*Gallinula chloropus*), British, presented by Mr. T. E. Gunn; a Gannet (*Sula bassana*), British, presented by Mr. J. C. Baxter; two St. Thomas's Conures (*Conurus xantholæmus*) from St. Thomas, West Indies, presented by Mr. C. Wallis Enslie; two Fringed-lipped Lampreys (*Petromyzon branchialis*), British, presented by the Rev. F. T. Wethered; a Pied Wagtail (*Motacilla lugubris*), British; a Slaty Egret (*Ardea gularis*), European, purchased.

INTERNATIONAL POLAR OBSERVATORIES

I BEG to inclose you an extract from a letter just received from Prof. Wild, President of the International Polar Committee, and which gives information as to the several expeditions which conducted observations in the circumpolar regions during the twelve months ending August 31, 1883.

ROBERT H. SCOTT

"I take this opportunity of stating concisely what I have hitherto learnt as to the present condition or the return of the various expeditions.

"1. The United States—Point Barrow.—The Expedition was to have returned in the summer of 1883. Definite information as to its return has not yet been received.[1]

"2. England and Canada—Fort Rae, on the Great Slave Lake.—According to a communication received from Mr. Scott, dated November 21 last, the Expedition has safely returned to England.

"3. United States—Lady Franklin Bay.—The attempts to relieve the Expedition this summer by ship have, like those of last year, failed owing to the unfavourable condition of the ice. (Extract from newspapers.)

"4. Denmark—Godhavn, in Greenland.—According to a communication from Captain Hoffmeyer, dated December 8, the Expedition has safely returned to Copenhagen with a rich store of observations.

"5. Germany—Cumberland Sound (Davis Strait).—According to a communication received from Dr. Neumayer, dated November 1, the Expedition has safely returned to Hamburg, having completed its task in a satisfactory manner.

"6. Count Wilczek's Station (Austria)—Jan Mayen, in Marymuss Bay.—The Expedition has safely returned to Vienna, having completely carried out its programme. A short report of its operations has been published by M. von Wohlgemuth, the Chief of the Expedition.

"7. Sweden—Spitzbergen (Cape Thordsen, in the Ice Fjord).—Dr. Rubenson states that the Expedition has safely returned to Stockholm.

"8. Norway—Bossekop, near Alten.—From a letter from Prof. Mohn, dated September 7, the Expedition stopped work on August 31, having completely carried out its programme, and on September 17, according to a report in *Naturen* (October, 1883) it safely returned to Christiania.

"9. Finland—Sodankyla.—The Expedition completed its task for the first year, but, according to a communication from Prof. Lemström, dated August 5, the observations will be continued another year, as the Government of Finland has provided the funds for the purpose.

"10. Russia—Nova Zembla (Möller Bay).—The Expedition returned to St. Petersburg in October with a rich store of observations.

"11. Holland—The Kara Sea.—The Expedition could not reach its original place of destination, Port Dickson, but was surrounded by ice in the Kara Sea, and has, according to a letter from Prof. Buys Ballot, dated October 1, safely returned to Utrecht, having under the circumstances only imperfectly carried out its programme.

"12. Russia—Mouth of the Lena (Sagastyr).—The Expedition, which suffered from storms during the passage down the Lena, was not properly established until October 20, 1882; from that date it has been able to carry out all the work laid down in the programme. It will continue its observations for another winter.

"13. France—Cape Horn (Orange Bay, Terra del Fuego).—According to a report from Prof. Mascart, dated November 17, the Expedition has returned safely to Paris, with a rich store of materials.

"14. Germany—The Island of South Georgia (Moltke Harbour).—This Expedition has also safely returned, according to a communication from Dr. Neumayer.

"Of the fourteen Expeditions, therefore, three will continue their observations for about another year (Lady Franklin Bay, Sodankyla, and Lena delta); the continuance of a fourth (Point Barrow) is at present unknown, the other ten have safely returned."

[1] We believe this party arrived at San Francisco some weeks ago.—ED.

MOVEMENTS OF THE EARTH[1]

III.—*Rotation of the Earth*

THE several ideas concerning the movements of the earth which were introduced in the last lecture will in the present one have to be dealt with in greater detail.

It was then agreed that if the whole expanse of the heavens were to travel with a perfectly equable motion in one direction, such a motion for instance as would result from all the stars being fixed to a solid transparent substance like those crystal spheres that the ancients really believed to exist; or if, on the other hand, the earth herself, instead of being free to turn as she listed with varying velocity in any direction, really went with perfect constancy in the direction opposite to the apparent motion of the stars, the visible effects would be the same in both cases, so that an appeal to our eyes would not suffice to enable us to say whether the earth moved or whether she remained at rest while the celestial sphere revolved around her.

Under these circumstances what is to be done? It has been seen how, both with regard to the measurement of space and the measurement of time for astronomical purposes, those interested in the physics and beauties of the various classes of celestial bodies outside our own earth have picked and chosen now one bit of physical science and now another to help them in their inquiries; and with regard to this very important question, "Does the earth move or is she at rest?" we shall see how very beautifully and perfectly the question has been answered by the application of certain mechanical principles.

The majority of people, I suppose, have some acquaintance, however slight, with machinery—with steam engines for in-

[1] Continued from p. 69.

stance; and it is a familiar fact how very important a part is played in the steam-engine by the flywheel. Why should that be? Why should this flywheel be so important that it is only quite recently that mechanicians have learned to do without it? For this reason: if a mass of matter such as a flywheel is once made to revolve, it will retain that motion for a long time, resisting any tendency to an increase or decrease of its velocity. It is in consequence of this property which the revolving flywheel possesses that an engineer is able to get over the dead points in his engine, whilst

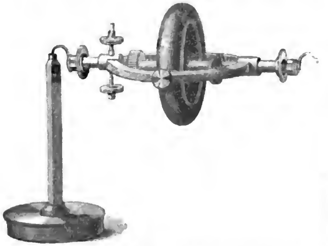


FIG. 27.—Rapidly rotating wheel supported at one end of its axis.

it also acts in preventing the engine making too sudden a start. In addition to this, when we have a mass of matter in the condition of the revolving flywheel it has some very peculiar qualities, only observed when such a mass of matter is in motion. If, then, we have a wheel so arranged that a very rapid rotation is being imparted to it, it does not behave as it would when at rest. These properties possessed by a rotating body can be well shown by an instrument known as the gyroscope, of which we shall speak more fully later on. It consists essentially of a

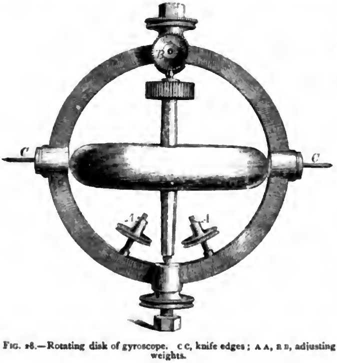


FIG. 28.—Rotating disk of gyroscope. C C, knife edges; A A, B B, adjusting weights.

disk to which a very rapid rotation can be imparted by a train of wheels or by other means. If the disk be set rotating, it is found to possess those curious qualities of which I have spoken. If whilst rotating at a high velocity it be placed in the position shown in Fig. 27, it will not fall, but will take on a movement of revolution round the stand.

From considerations suggested by this and other similar experiments, Foucault pointed out that it might be demonstrated whether the earth moved or whether she remained at rest. It struck him that the problem should be attacked somewhat in this manner:—

Suppose the earth to be at rest, and that either at the north or south pole a pendulum, suspended so that its point of support had as little connection with the earth as possible—so that it should, in fact, like the rotating flywheel, be independent of external influences, were set vibrating. Then an observer at the north or south pole would note that the swinging pendulum (the earth being considered as at rest) always had the same relation to the objects on his horizon. But, said Foucault, suppose that the earth does move. Then the swing of such a pendulum would not always be the same with regard to the places on the observer's horizon. Let the earth be represented by a globe. Suppose it to rotate from west to east. Place it with the north pole uppermost, and set the pendulum, whose point of support is disconnected from the rotating earth, vibrating. Then the pendulum will appear to travel from left to right as the earth rotates from right to left beneath it. Now suppose the pendulum to be suspended in the same way at the south pole, right and left now being changed. The earth of course rotates in the same direction as before, but the pendulum now appears to change the

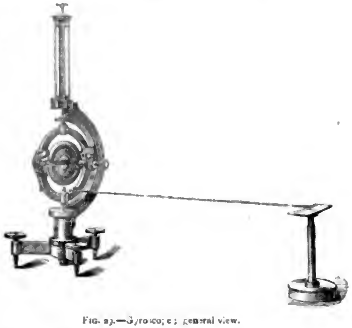


FIG. 29.—Gyroscope; general view.

plane of its swing from right to left. At the equator the earth simply rotates straight up and straight down beneath the swinging pendulum.

From these considerations it became evident to Foucault that, if there were any possibility of demonstrating the movement of the earth by means of the pendulum, the demonstration would take this form. Provided it were possible to swing a pendulum so that it should be as free as possible from any influence due to the rotation of the earth, and take that pendulum to the north pole, it would appear to make a complete swing round the earth in exactly the same time that it really takes the earth to make a complete rotation beneath it. At the south pole exactly the same thing would happen except that the surface of the earth would appear to move in the opposite direction to what it did at the north pole. Now it will be perfectly clear that if we thus get a pendulum appearing to swing one way on account of the true motion of the earth at the north pole and in the opposite direction on account of the true motion of the earth at the south pole; at the equator, as we found in dealing with our model earth and model pendulum, it will not change the plane of swing either way, that is to say, the time taken by a pendulum to make a complete swing will be the smallest possible at the poles, whilst at the equator it will be infinite.

At all places, therefore, between either pole and the equator the period of swing will be different, and the time taken to make a complete swing will increase or decrease as the equator is approached or receded from. So much for theoretical considerations. Can they be put to the test of experiment, and an answer obtained from nature herself? The fact is that this idea of Foucault's is so beautifully simple that anybody can make the experiment providing he has the means of using a very long pendulum. This pendulum must be rigidly, but at the same time very independently, supported.

Beneath the pendulum, in contact with the earth, and therefore showing any movement of rotation which the latter may possess, is a board, on the centre of which the pendulum nearly rests. From the central point of this board lines are described showing so many degrees from the central line over which the pendulum bob swings. These preliminaries being arranged, let the pendulum be started. This is done by drawing it out of the vertical and tying it by a thread which is burnt when it is desired to start the experiment.

Then, in consequence of that quality the existence of which was revealed to us by the rotating disk and which is possessed by this vibrating pendulum, and in consequence of the precautions which have been taken to prevent its swing being interfered with by the motion of the earth or other perturbing influences, it should be found, if Foucault's assumption be correct, that the earth is moving beneath the pendulum. And if all the conditions of the experiment have been complied with it is found that the pendulum moves over the scale as the earth rotates beneath it. That then is one demonstration of the existence of the earth's rotation.

The question now arises whether there be any other method of determining the same thing. There is, but in answering the question in the affirmative it must be said that this second method is neither so simple nor so satisfactory as the first.

We owe it also to the genius of this same man, Foucault. It depends upon the same principles and is connected with the same series of facts as the other. But before proceeding to

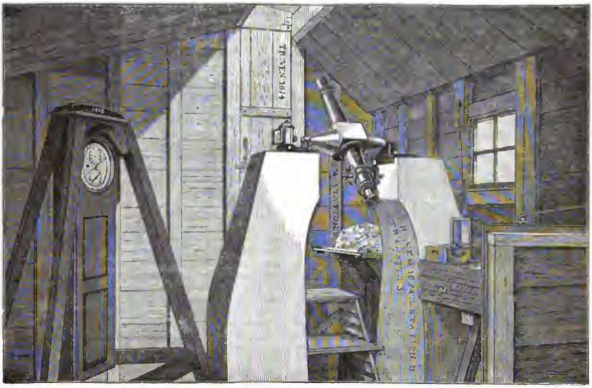


FIG. 30.—Transit instrument and clock.

discuss this second experiment it will be well to consider these two tables, which have been taken from Galbraith and Haughton's "Astronomy," because they show not only what the swinging pendulum should do if it behaves properly, but also what the gyroscope, the instrument used in the second experiment, should do if it behaves properly.

The first table is called

Hourly Motion of Pendulum Plane.

Place	North Lat.	Observed motion per hour	Calculated motion per hour	Observer
Ceylon	6° 56′	1°·870	1°·815	Schaw and Lamprey.
New York	40 44	9·733	9·814	Loomis.
Providence, R.I.	40 49½	9·955	9·833	Carswell and Norton.
New Haven, Ct.	41 18½	9·970	9·929	
Geneva	46 12	10·522	10·856	Dufour and Wartman.
Paris	48 50	11·500	11·323	Foucault.
Bristol	51 27	11·788	11·763	Bunt.
Dublin	53 20	11·915	12·065	Galbraith and Houghton.
Aberdeen	57 9	12·700	12·636	Gerard.

The second is

Rotation of Earth deduced from Pendulum.

Place	Time of Rotation		
	h.	m.	s.
Colombo, Ceylon	23	14	20
New York	24	8	9
Providence, R.I.	23	38	29
New Haven, Ct.	23	50	7
Geneva	24	41	39
Paris	23	33	57
Bristol	23	53	2
Dublin	24	14	7
Aberdeen	23	48	49
Mean value	23	53	0

The pendulum plane is of course the plane in which the pendulum swings. The first column in Table 1 gives the place where the pendulum was set swinging, the second the latitude, the third the observed motion per hour, and the fourth the calculated motion. The table has been so drawn up that it begins with places nearest the earth's equator and passes gradually to others further away, going from Ceylon at 6° N. lat. to New York at 40° N. lat., New Haven at 41°, and ending with Aberdeen at 57°. At the first-named place it will be seen that the pendulum swings through less than 2° per hour, whilst at Aberdeen it swings through nearly 13°, which is an approximation, at least, to the statement I have made, that, since the rotation of the pendulum plane will be most rapid at either pole, the further from the equator we swing it the greater will be the number of degrees passed over per hour.

To turn now to the gyroscope. We shall expect, if we succeed in imparting to it a rotation which is independent of and unaffected by the earth's rotation, that the angular change shown by it will be the same as that indicated by the pendulum, or, in other words, that the number of degrees passed over will be the same in both cases.

In the gyroscope, that portion which corresponds to the swinging part of the pendulum is the heavy disk seen in Fig. 28, to which a very rapid rotation can be imparted. This disk is mounted upon the horizontal circle shown in the figure, which circle in its turn is mounted in a vertical one suspended by a bundle of raw silk fibres which depend from the little screw shown at the top, by means of which the whole system can be raised, so preventing the vertical circle from resting its whole weight upon the pivot below, the use of which is not so much to support the apparatus as to guide it in its movements.

Now in order that the rotation of the disk shall be uninfluenced by the motion of the earth a great number of precautions have to be taken. The first of these is to insure that the whole of the apparatus shall be perfectly free to rotate, and that, however

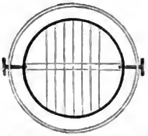


FIG. 31.—Wires in transit eyepiece.

much the silk fibres supporting the vertical circle may be screwed up in order that it may not rest its weight upon the pivot, its motion shall not be interfered with—that there shall be no twist in the thread. This is the first precaution; and, when this has been done, a condition of things is obtained in which the apparatus is perfectly free to move round a vertical axis represented by the silk fibres prolonged. Then, having fulfilled this condition, the next matter of importance is to see that the disk is perfectly free to move on the horizontal axis. For this purpose the wheel which holds the two extremities of the axis of the rotating disk is armed with counterpoise weights (see Fig. 28), two in a horizontal plane, A A, and two in a vertical plane, of which one is seen at B.

Then the knife edges, C C, which are exactly in the plane of the centre of motion of the whole system, are made to rest on two steel plates mounted on a separate stand, in order to ascertain if the moving parts are perfectly balanced, the perfection of balance being determined by the slowness with which it oscillates up and down. But this is not all; it must not only be so adjusted by these weights, A A, that the ring shall remain horizontal, but it must be so perfectly balanced by the two weights, one of which is seen at B in Fig. 28, that if a considerable inclination be made from the horizontal it will be taken up equally on both sides. Finally, the instrument must be so adjusted that when the two delicate knife edges are placed on the two steel plates in the outer ring (see Fig. 28) the ring carrying the disk shall be perfectly free to move and have its centre of motion exactly identical with the centre of motion of the outer ring and of the disk itself. Then, when all these precautions have been taken, and the disk is set rotating with considerable velocity by means of a multiplying wheelwork train, we have, as far as the mechanics of the thing are concerned, an experiment just like the other, with this important difference, however, that, whereas the pendulum experiment always succeeds, much trouble is often experienced in experimenting with the gyroscope. But, when the multiplicity of the conditions necessary to the success of the experiment is considered, this is not surprising. If, however, all the conditions have been adhered to, the pointer with which the instrument is fitted (see Fig. 29) ought to move over the scale at exactly the same rate that the pendulum moves over the scale beneath it. But even supposing that the pointer of the gyroscope does move over the paper and in the right direction when the apparatus rotates one way, this is not enough. The demonstration of the validity of the result given by it is that an equivalent deviation is obtained when the apparatus is turned about in every possible direction. The first test of course is to rotate in the opposite way, then, if all the adjustments have been properly made, the deviation obtained will be the same in amount and direction as before, and it may be taken that the result obtained is then really due to the earth's rotation.

With this reference to the most important points connected with the gyroscope, we may bring our inquiries under this head to a close. So many men have worked with the instrument in so many lands, and under such rigid conditions, that there can be no doubt that the rotation of the earth is demonstrable by it, although certainly its verdict is not anything like so sharp, or so clear, or so easily obtained, as that given by the pendulum.

Our appeal to physics has at once put out of court the old view of the arrangement of the universe, which placed an immovable earth at its centre. How Copernicus was the first to point out that this old view was incorrect, and that it was the earth which moved, and how Galileo was persecuted because he, in times much less fortunate than our own, had the courage to say so,—these are familiar points in the history of the discovery of the earth's rotation.

Having then demonstrated the existence of this particular movement of the earth, we must now proceed to a consideration of the rate, direction, and results of the movement,—connect in fact the pendulum of Foucault with that of Huyghens, and regard the physical pendulum as giving an important use to the experiments of Galileo and of Huyghens in which they caused it to act as a controller of time.

Turn back to our two tables. They are not without interest at the present moment. In the first table, "Hourly Motion of Pendulum Plane," the observed motion of the pendulum plane per hour is connected with the latitude of the place at which it swings, varying as that varies; and therefore the observed motion in any latitude ought to give the same value for the earth's rotation, the closeness of which to the real value will at the same time be a measure of the accuracy of our pendulum observations.

Let us endeavour then to find out in what time the earth must go round in order that the pendulum plane may vary (say) $1\frac{8}{10}°$ per hour in Ceylon, $11\frac{6}{10}°$ in Dublin, and so forth.

Taking our clock as being divided into twelve hours, each hour into sixty minutes, and each of these again into sixty seconds, it is found (see Table 2) that the value for Ceylon is 23h. 14m. 20s., and for Dublin 24h. 14m. 7s., the mean value of the observations at the various places mentioned in the table being 23h. 53m., so that according to that table the earth rotates on its axis in a few minutes less than twenty-four hours.

Now although such an approximation to the real value may suffice for the great mass of mankind, it is not an astronomical way of dealing with the question. We have seen the circumference of a circle divided first into degrees, then into ¼ degrees, next into seconds, and finally into tenths of seconds; by the application of electrical principles, time has been even more finely divided, and the question naturally arises, Are there any means of determining the exact period of the earth's rotation?

There are means of doing this. In the last lecture occasion was taken to point out that the stars are infinitely removed from the earth; the stars being so infinitely distant, a slight change in their position will not be perceptible to an observer on the earth, and the place of a star to-day and its place to-morrow are the same so far as relates to any parallactic change of position.

This being premised, it will be clear that, in order to get out the exact period of the earth's rotation, one only has to make an observation of any star on one particular day (such observation being of course made with a clock), and repeat the observation when the star is in the same position on the succeeding day. The time which elapses between the observations must be the time taken by the earth to make a complete rotation. But it will be asked, How are these observations made, and how is it known when the star *is* in the same position when the second observation is made?

For this purpose a transit instrument is used (see Fig. 30). This differs from an ordinary telescope, being so mounted as to move only up and down, and is armed not with simple cross wires, but with an odd number of parallel and equidistant vertical wires crossed by a single horizontal wire. It is also usually provided with a circle to give declination. If from any part of the earth an observation be made on any particular star on one day, and then another observation made on the same star when it is in the same position the next day, as has been said, the interval between the two observations must be the time taken by the earth to move round once.

By having such an arrangement as exists in the transit instrument, by which it can swing in the plane which coincides with the axis on which the earth turns, any star may be chosen for the observation. Suppose, for instance, the instrument be pointed to the north pole star, then, in consequence of the tremendous distance of the stars, the axis of the telescope is practically coincident with the axis of the earth. But suppose another star to be observed, it will be quite clear that we may make the observation on it, or any other star we choose. When the instrument is upright it points to the zenith. A star in the zenith may therefore be selected for the observation.

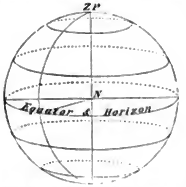


Fig. 32.—Showing that the true horizon of a pole is the equator.

It is observed when crossing the central wire of the instrument one day, and noted again when it crosses that wire on the succeeding day. But the observer does not limit his observation to the one central wire, in order to ascertain when the star is in the centre of the field. If he did so, he might miss his observation. That is why the simple cross wires have been replaced by a system of wires (see Fig. 31). As the star crosses the field of view, the observer, listening to the beats of the clock alongside, notes the time when it crosses each of the wires, and takes the mean of these observations, thus attaining to a much greater accuracy than if he had merely observed the transit over the central wire. With an ordinary clock it is found that a period, less by a few moments than twenty-four hours, elapses between two successive transits.

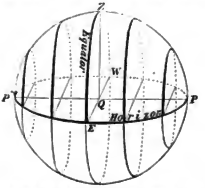


Fig. 33.—Showing that the poles lie in the horizon at the equator.

In order to get an absolutely perfect measure of time, the clock may be so rated that it should not be any indeterminate number of hours, minutes, and seconds, but twenty-four hours exactly between the two transits of that star. With a clock thus arranged, the time at which a star crossed the central wire of the transit instrument would really give a most perfect method of determining that star's place in the heavens, because, if the earth's rotation is an equable one and takes place in a period which we choose to call twenty-four hours, then two stars 180° apart will be observed twelve hours after one another, four stars 90° apart will be observed six hours apart, and so on; and clocks like this, regulated to this star time, exist in our observatories, being called sidereal clocks, because the time they give, which is not quite familiar to everybody, is called sidereal time.

Now let us consider our position on the earth with regard to the stars. This is a very interesting part of our subject, not only in its scientific aspect, but from the point of view of its usefulness, whether we wish to study the stars or define places on the earth's surface, the latter matter, however, being so intimately connected with astronomy proper that it is impossible to talk about the one without talking about the other.

Since we divide all circles into 360°, the circumference of the earth may be so divided, and the method in use of defining positions on the earth is to say of a place that its latitude is so much and its longitude is so much. Latitude begins at the equator with 0°, and terminates at the poles with 90°, being north latitude in the one case, and south latitude in the other. In the case of longitude, there is no such simple starting point, for whilst latitude is counted from the equator by everybody all over the world, longitude may commence at any point. In England we count longitude from the meridian of Greenwich. When the transit instrument at Greenwich is swept from the north point through the zenith to the south point it describes a half circle, which is called the meridian of Greenwich.

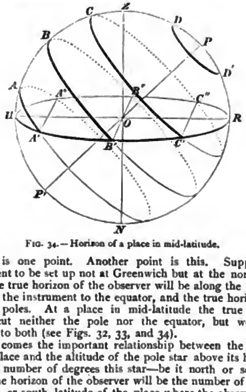


Fig. 34.—Horizon of a place in mid-latitude.

That is one point. Another point is this. Suppose the instrument to be set up not at Greenwich but at the north pole. Then the true horizon of the observer will be along the equator. Remove the instrument to the equator, and the true horizon will cut the poles. At a place in mid-latitude the true horizon would cut neither the pole nor the equator, but would be inclined to both (see Figs. 32, 33, and 34).

Then comes the important relationship between the latitude of the place and the altitude of the pole star above its horizon; that the number of degrees this star—be it north or south—is above the horizon of the observer will be the number of degrees of north or south latitude of the place where the observation is made. A place therefore in 10° N. lat. will (roughly) have the north pole star at a height of 10° above its horizon.

So much for this part of our subject. Let us now leave it, because, interesting as it is, it refers to a branch of astronomy with which at present we have less to do than with the more physical one; but it was well that we should pause for a few moments to note the tremendous importance to mankind of that particular movement of the earth which we have been considering.

J. Norman Lockyer

(*To be continued.*)

PROBABLE NATURE OF THE INTERNAL SYMMETRY OF CRYSTALS[1]

THE theory of the modification of crystal angles, just offered in dealing with quartz, is manifestly applicable to all crystals not of the cubic system, and it is submitted that for every such

[1] Continued from p. 188.

crystal there is an *ideal* or *root form* proper to one or other of the five kinds of internal symmetry which have been presented, from which root form the actual form can be derived by a proper proportionate increase of dimension in one or more directions.

It is evident that, while our path must become more and more intricate as we endeavour to establish in the cases of more complex compounds relations similar to those above traced, the reference of whole classes of analogous forms, differing only in their angles, to one root form, removes a very important difficulty, and the wide applicability which it confers on the five kinds of internal symmetry with which we started appears in the fact that there is no crystal form which cannot be thus referred to an appropriate root form in harmony with one or other of these five kinds of internal symmetry.[1]

One more case may be mentioned in which a probable internal symmetry can be assigned to a compound in harmony with its actual crystal form; it is a more difficult one.

The molecule of *Iceland* or *calc-spar* is usually believed to consist of one atom of calcium, one atom of carbon, and three of oxygen. We shall, however, take a liberty, and suppose that the atoms of calcium or the atoms of carbon have but half the mass attributed to them; that in the formula of this compound we should write either two atoms of calcium or two atoms of carbon in place of one.[2]

Making this supposition, we observe that if the calcium and carbon atoms were alike we should have six atoms, three of one kind, three of another; in other words, we should have equal proportions of two kinds of atoms, from which, since the form of Iceland spar is but little removed from a cube, we naturally argue that just before crystallisation its atoms were arranged according to the first or second kind of internal symmetry; these two kinds being, it will be remembered, those in harmony with the cubic form which admit of very symmetrical arrangement of particles of two kinds present in equal numbers.

Since Iceland spar is a uniaxal crystal, the arrangement of the three kinds of atoms, whatever it is, must be symmetrical about one axis only; and we shall now endeavour to show that the atoms can be thus arranged in either the first or second kind of symmetry.

We will show first that they can be thus arranged in the second kind.

Where there are but two kinds of particles present in equal numbers, symmetry requires that the alternate layers of this kind of symmetry (see Fig. 3) shall consist entirely of similar kinds, and therefore in the case before us, one set of alternate layers will represent oxygen atoms; the other, atoms of calcium and carbon. Now particles present, as we suppose the calcium and carbon atoms to be, in the proportion 1 : 2 can be quite symmetrically arranged in these layers (plan *f*), as the sphere centres were in the layers depicting the fourth kind of symmetry (plan *e*), and therefore the only question remaining is the relative disposition of the layers of calcium and carbon atoms with respect to one another.

Now the spheres in alternate layers of the second kind of symmetry considered alone have the relative arrangement of the third kind of symmetry (Fig. 4), and in determining the relative disposition of the calcium and carbon atoms, we may therefore neglect the oxygen atoms, and treat the case as belonging to the third kind of symmetry. The two spiral arrangements in this kind of symmetry, in which the less numerous spheres in the fourth layer are vertically over those in the first (see *ante*), have the necessary symmetry about a single axis, and if the calcium and carbon atoms have one of these arrangements, the requirements of the case are entirely met.

We will now show that the three kinds of atoms can also be arranged symmetrically about a single axis in the first kind of symmetry.

One half the spheres depicting this kind of symmetry will in this case represent the oxygen atoms, and the remaining half the atoms of calcium and carbon (see Fig. 2), and, as previously noticed, the arrangement of either half will be that of the second kind of symmetry. It follows that the question of the relative disposition of the atoms of calcium and carbon is simply the question of the symmetrical arrangement about a single axis of atoms of two kinds present in the proportion 2 : 1 in the second kind of symmetry (Fig. 3). And since the layers of spheres depicting this kind of symmetry have a triangular arrangement (plan *b*), it is evident that this can be accomplished here just as in the former case.

In either of the two arrangements just described we have only to suppose that when the symmetrically placed atoms change volume at the time of crystallisation the dimensions transversely to the axis of symmetry are increased relatively to those in the direction of this axis, and we have an obtuse rhombohedron where formerly we had a cube. And the significant fact that the angle of a rhombohedron of calc-spar diminishes when the crystal is heated supports this theory of its production. Perhaps the arrangement of the atoms according to the first kind of internal symmetry is the more probable of the two, as this would give the cleavage directions coincident with the directions of layers of similar atoms (oxygen).

An important fact supporting our conclusions is that certain definite relations as to their proportions which are found subsisting between the allied forms taken by crystals of the same substance are found inherent in one or other of the five kinds of internal symmetry.

Thus it is well known that if a particular substance is found crystallised in hexagonal pyramids of various kinds—that is, whose sides have various different degrees of inclination to the base—the number of kinds is strictly limited, and they are strictly related to each other. If x be the side of the hexagonal base of the pyramid and y the height for the same substance, while x remains constant, y has not more than fourteen different values, seven related thus: $c, \frac{3}{4}c, \frac{1}{2}c, \frac{1}{4}c, \frac{1}{8}c, \frac{1}{12}c, \frac{1}{16}c$; and the other seven similarly related thus: $d, \frac{3}{4}d, \frac{1}{2}d, \frac{1}{4}d, \frac{1}{8}d, \frac{1}{12}d, \frac{1}{16}d$; and c bearing to d the ratio $2 : \sqrt{3}$.

Now, if we turn to the fourth kind of internal symmetry (Fig. 5) to ascertain the possible varieties of inclination of the sides of hexagonal pyramids which can be depicted, we find that the greatest possible height to which we can build a hexagonal pyramid of equal spheres is exactly double the height of a tetrahedron with the same side as the hexagonal base of the pyramid. Thus, if twenty-five spheres form each side of the hexagonal base, giving twenty-four equal distances between the sphere centres in any one side, we find that the highest possible pyramid has forty-nine layers of spheres giving forty-eight equal spaces between consecutive layers.

If we call this height c, it is evident that pyramids corresponding with the first of the above series of actually observed forms will have respectively—

49 layers	of balls,	giving	48	spaces between	consecutive layers.
37	,,	,,	36	,,	,,
25	,,	,,	24	,,	,,
13	,,	,,	12	,,	,,
7	,,	,,	6	,,	,,
5	,,	,,	4	,,	,,
4	,,	,,	3	,,	,,

We find, moreover, that such a series can be readily depicted, and that, upon examination, no additional terms appear admissible.

Again, a further inspection of the stack of spheres shows us that with the same heights—that is, with the respective numbers of layers just enumerated—we may, in place of the base layer which forms a hexagon whose sides have twenty-five spheres each, have a base derived from this in which each of the six spheres at the angles becomes the centre of a side, the outline of the base layer being now a larger hexagon described about the hexagon which bounded the former base layer. The sides of this new base thus bear to the sides of the old the ratio subsisting between the side and the perpendicular of an equilateral triangle, *i.e.* the ratio $2 : \sqrt{3}$. And finally, since the distance between the planes containing the centres in successive layers bears to the distance between centres in the same layer the same ratio which the perpendicular from the angle of a tetrahedron upon its opposite face bears to its edge, that is the ratio $\sqrt{2} : \sqrt{3}$, it follows—

That the two allied series of possible altitudes of hexagonal pyramids thus formed, if we take *the same length of side a* for both, will be—

First Series

$$\frac{2\sqrt{2}}{\sqrt{3}}a;\ \frac{3\sqrt{2}}{2\sqrt{3}}a;\ \frac{\sqrt{2}}{\sqrt{3}}a;\ \frac{\sqrt{2}}{2\sqrt{3}}a;\ \frac{\sqrt{2}}{4\sqrt{3}}a;\ \frac{2\sqrt{}}{6\sqrt{3}}a;\ \frac{\sqrt{2}}{8\sqrt{3}}a.$$

Second Series

$$\sqrt{2}.a;\ \tfrac{3}{4}\sqrt{2}\,a;\ \tfrac{1}{2}\sqrt{2}.a;\ \tfrac{1}{4}\sqrt{2}\,a;\ \tfrac{1}{8}\sqrt{2}\,a;\ \tfrac{1}{12}\sqrt{2}\,a;\ \tfrac{1}{16}\sqrt{2}.a.$$

[1] The very symmetrical form the pentagonal dodecahedron is not in harmony with either of the five kinds of symmetry, nor is it found in crystals.

[2] It has already been remarked that the crystal form of fluor-spar favours the supposition that calcium has half the atomic weight usually attributed to it.

Surely the fact thus established, that each term of a series of relative altitudes of the hexagonal pyramids in which a particular substance crystallises always has to some term of the series thus theoretically derived a particular ratio peculiar to the substance, constrains us to conclude that the above fourteen "root" forms are those to which all crystal forms involving regular six-sided pyramids are referable, and that the actual forms are produced from the "root" forms by difference in the degree of expansion in the direction of the axis of the crystal as compared with other directions at the time of crystallisation.

Other allied forms, as allied octahedra or rhombohedra, can be in the same way connected with some one of the five kinds of internal symmetry.

The peculiarities of *crystal-grouping* displayed in twin crystals can be shown to favour the supposition that we have in crystals symmetrical arrangement rather than symmetrical shape of atoms or small particles. Thus if an octahedron be cut in half by a plane parallel to two opposite faces, and the hexagonal faces of separation, while kept in contact and their centres coincident, are turned one upon the other through 60°, we know that we get a familiar example of a form found in some twin crystals. And a stack can be made of layers of spheres placed triangularly in contact to depict this form as readily as to depict a regular octahedron, the only modification necessary being for the layers above the centre layer to be placed as though turned bodily through 60° from the position necessary to depict an octahedron (compare Figs. 7 and 8). The modification, as we see,

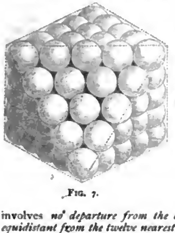


FIG. 7.

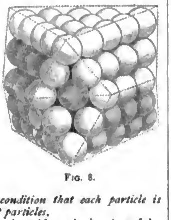


FIG. 8.

involves *no departure from the condition that each particle is equidistant from the twelve nearest particles.*

Before closing, a few words may be said on the bearing of the conclusions of this paper on *isomorphism* and *dimorphism*.

First, as to isomorphism.

The conclusion that there are but five kinds of internal symmetry possible, three of which indicate a cubic form, evidently accords with the fact that not only the simplest combinations—those in which two kinds of atoms are present in equal proportions—but also many very complicated compounds crystallise in cubes.

Out of the regular system we generally find that for the angles of crystals of different compounds to be the same there must be some resemblance in their atom-composition, and the explanation suggested is that the atoms which are common to two isomorphous compounds, *e.g.* the carbon and oxygen atoms in calc-spar and spathic iron ore, have similar situations in the two different crystals, and that the change of bulk which occurs when crystallisation takes place is due to a change in *these atoms only*, the atoms not found in both remaining *passive*.

There are, however, some cases which do not at first seem to be met by this view—cases in which the atom composition of isomorphous compounds has only a very partial similarity. Ammonia compounds may be specially mentioned. Thus, ammonic sulphate, $(NH_3)_2H_2SO_4$, is isomorphous with potassic sulphate K_2SO_4.

The following suggestion would seem to enable us to suppose that in this, as in other cases of isomorphism, the phenomenon is referable to the passivity of some of the atoms in the change of bulk which accompanies crystallisation. Let us write ammonic sulphate thus $(NH_3)_2H_2SO_4$, and let us suppose that the symmetrical arrangement is such that the groups, $(NH_3)_2$ just occupy places which might, without altering the symmetry, be filled by additional groups H_2SO_4; that, in other words, the relative position of the groups H_2SO_4 which are present in the symmetrical arrangement is precisely the same as it would be if the entire mass consisted of these groups instead of consisting partly of NH_3 groups. If now, in addition to supposing that in both compounds the active atoms in the process of crystallisation are the sulphur and oxygen atoms, and these only, we suppose that the expansion of some of the atoms of the active kind checks the expansion of others; that only a certain proportion of these atoms expands, we perceive that we may have both the same amount and kind of atom expansion in the two cases, and, as the natural result, isomorphism.

Next, as to dimorphism.

It is evident that a very small change is requisite to convert one kind of internal symmetry into another. Thus we have already had occasion to notice that the only difference in depicting the third and fourth kinds of symmetry is that for the former the centres of the spheres in the first and fourth layers, those in the second and fifth, and so on, range vertically, while for the latter the centres in the first and third, in the second and fourth, and so on, range in this way.

In the case of a dimorphic compound consisting of two kinds of atoms in the proportion of 2 : 1, *e.g.* water, H_2O, we have only to suppose therefore that the same layers of atoms which under one set of conditions produce hexagonal prisms, are by some alteration in conditions arranged in the slightly different way necessary to produce rhombohedral forms. Other cases of dimorphism are probably to be accounted for much in the same way.

Thus the following interpretation of the fact that calcic carbonate, which we have seen crystallises in obtuse rhombohedra as calc-spar, sometimes crystallises in six sided trimetric prisms as aragonite may be offered.

We have already endeavoured to show that the first or second kind of internal symmetry is that proper to calc-spar. We will now endeavour to show that the fifth kind of internal symmetry (Fig. 6) is proper to aragonite.

Alternate layers of spheres (plan *b*) will represent the oxygen atoms, and the other alternate layers the calcium and carbon atoms; the central layers of the triplets above alluded to, viz. the second, the fourth, the sixth, &c., being the oxygen layers; the calcium and carbon atoms in the remaining layers will be symmetrically arranged (plan *f*). From the fact of the crystals being trimetric, the layers containing the last-named atoms, which, considered apart from the oxygen layers, are in the fourth kind of symmetry, probably have the arrangement above described, in which the less numerous spheres form zigzags, the stack in this case having a different symmetry about three axes at right angles to each other (Fig. 6).

The fact that the dimorphic varieties of the same substance have different densities is in harmony with the supposition that different sets of the atoms are concerned in the different cases; that the active atoms which produce one form are not those, or those only, which produce the other.

It is not always necessary to refer two incompatible crystal forms of the same substance to two different kinds of internal symmetry: for example, from the third kind of internal symmetry we can produce square-based octahedra, and we can also produce right-rhombic prisms, and in accord with this we have the well-known fact that right-rhombic prisms of sulphate of nickel, $N_2SO_47H_2O$, when exposed to sunlight are molecularly transformed, and, though they neither liquefy nor lose their form, when they are broken are found to be made up of square-based octahedra several lines in length. WILLIAM BARLOW

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following awards (among others) have been made at St. John's College on the results of the examination for candidates who have not yet commenced residence:—

For Mathematics: H. F. Baker (Perse Grammar School, Cambridge), Foundation Scholarship, raised for two years to 75*l*. a year; A. W. Flux (Portsmouth Grammar School), Minor Scholarship of 75*l*. a year; P. T. Fagan (Highwood School, Weston), Exhibition of 50*l*. a year; H. R. Norris (University College School), Exhibition of 30*l*. a year.

For Natural Science: G. S. Turpin (Nottingham High School and Owens College, Manchester), Foundation Scholarship raised for two years to 75*l*. a year; P. Lake (Newcastle College of Science), Minor Scholarship of 75*l*. a year; W. Harris (Bradford Grammar School), Exhibition of 50*l*. a year; W. M. Mee

(Trinity College, Dublin), Exhibition of 32*l.* a year [Mathematics and Physics].

For Hebrew: G. C. Ewing (Merchant Taylors' School, London), Exhibition of 33*l.* 6*s.* 8*d.* a year.

SOCIETIES AND ACADEMIES

London

Royal Meteorological Society, December 19.—Mr. J. K. Laughton, M.A., F.R.A.S., president, in the chair.—The following were elected Fellows:—R. Bentley, W. Bonallo, Miss E. Brooke, Rev. A. Conder, T. H. Cowl, J. A. W. Olivér, C. M. Powell, W. B. Tripp, and Fung Yee. The papers read were:—On the explanation of certain weather prognostics, by the Hon. Ralph Abercromby. The author explains about forty-four well-known prognostics belonging to the following groups—(1) diurnal; (2) sun, moon, and stars; (3) sky; (4) rain, snow, and hail; and (5) wells, springs, and coal-mines—by referring them to the isobaric conditions in which they are observed. By this means he is able to indicate the circumstances under which any prognostic fails, as well as those under which it succeeds.—Preliminary inquiry into the causes of the variations in the reading of black-bulb thermometers *in vacuo*, by G. M. Whipple, B.Sc. It has long been known that there is a want of accordance between the different instruments used for measuring the intensity of radiation, and with a view of ascertaining the cause of the variations in the readings of the black-bulb thermometers *in vacuo*, the author has made a comparison with a number of these thermometers, the results of which are given in the paper. It is shown distinctly that the effect of an increased coating of lamp-black on the bulb is to raise the temperature, and also that the size of the thermometer-bulb is a most important factor in the case of this instrument.—Report on the phenological observations for 1883, by the Rev. T. A. Preston, M.A.—Mr. J. S. Dyason exhibited a series of coloured sketches illustrating the recent atmospheric phenomena during November and December.

Geological Society, December 5.—J. W. Hulke, F.R.S., president, in the chair.—George Jonathan Binns, Horace T. Brown, James Dairon, Rodolph De Salis, Hugh Exton, John Forrest, Prof. Bernard J. Harrington, James Patrick Howley, John Sylvester Hughes, Prof. George T. Kennedy, Rev. Arthur Noel Malan, Robert Sydney Milles, Edwin Radford, Edward Pierson Ramsay, William Henry Rands, Thomas Roberts, Joseph Ridgway, and Harry Page Woodward were elected Fellows of the Society.—On the Cambrian conglomerates resting upon and in the vicinity of some pre-Cambrian Rocks (the so-called intrusive masses) in Anglesey and Carnarvonshire, by Henry Hicks, M.D., F.G.S. In a former paper the author had maintained that there was no evidence to show that the so-called intrusive granite in Anglesey had altered the Cambrian and Silurian rocks in its immediate vicinity, or that they had been entangled in it as described, but that it seemed to be a rock of metamorphic origin, varying much in its general appearance at different points. He contended that, instead of being an intrusive granite, as supposed by the officers of the Survey, it was in all probability the oldest rock in Anglesey. The basal Cambrian conglomerate in contact with it is in an unaltered condition, and at Llanfaelog contains an extraordinary proportion of well-rolled pebbles, identical in mineral composition with the so-called granite immediately below. Fragments of all the varieties of rock found in the granitoid axis are recognisable in the conglomerate, and in precisely the same condition as in the parent rock. Fragments of the various schists of the area were also present; so that he thought there cannot be the shadow of a doubt that the so-called granite and the metamorphic schists are older than the conglomerate, and therefore pre-Cambrian. The view maintained by the Survey that the schists are altered Cambrian and Silurian strata, and the granitoid rock an intrusive granite of Lower Silurian age, is consequently quite untenable. In Carnarvonshire equally conclusive evidence was obtained from many areas. Fragments of the Dimetian (Twt Hill type) occurred abundantly in the basal Cambrian conglomerates at Dinas Dinorwig, Pont Rothel, Moel Tryfane, and Glyn Llifon. Quartz-felsite pebbles in every respect identical with the varieties found in the so-called intrusive ridges between Bangor and Carnarvon, and to the north and south of Llyn Padarn, were found on the shores of the Menai Straits, in the railway-cutting at Bangor, at Liandeiniolen, Dinas Dinorwig, Llyn Padarn, and elsewhere. This evidence, supplementary to that previously furnished by Prof. Hughes, Prof. Bonney, and the author, is conclusive as to these areas, since the basal Cambrian conglomerates, which are in contact with these supposed intrusive masses, are composed almost entirely of rocks identical with the latter; and this could not possibly be the case if the granitoid masses had been intruded among the conglomerates after their deposition.—On some rock-specimens collected by Dr. Hicks in Anglesey and North-West Carnarvonshire, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author stated that pebbles in the blocks of conglomerate collected by Dr. Hicks to the north of Llanfaelog were practically undistinguishable macroscopically and microscopically from the granitoid and gneissic rocks which occur *in situ* between that place and Ty Croes, and that the matrix contained smaller fragments, probably from the same rock, with schist bearing a general resemblance to members of the group of schists so largely developed in Anglesey, and with grits, argillites, &c. Pebbles of granitoid aspect in the Cambrian conglomerate near Dinas Dinorwig, &c., bear a very close resemblance to the Twt Hill rock, and are associated with abundant rolled fragments of rhyolite resembling those already described from the Cambrian conglomerate and the underlying conglomeratic beds and rhyolites. Two pebbles of rather granitoid aspect in the Cambrian conglomerate by the shore of the Menai Straits, near Garth, prove to be spherulitic felsite, somewhat resembling that already described by the author from Tan-y-maes. He pointed out that the evidence of these specimens collected by Dr. Hicks, added to that already obtained, led irresistibly to one of two conclusions—either that, when the Cambrian was formed, an area of very ancient metamorphic rock was exposed near Ty Croes and in the Carnarvonshire district, or that the rhyolitic volcanoes were so much older than the Cambrian time that their granitic cores were already laid bare by denudation. Hence, in either case, the existence of Archæan rock in North Wales was proved. To one or other of these conclusions he could see no possible alternative, and he considered the former to be (even if some of the granitoid rock were granite) far the most probable.—On some post-Glacial ravines in the Chalk Wolds of Lincolnshire, by A. J. Jukes-Browne, F.G.S.

Edinburgh

Mathematical Society, December 14.—Mr. Thomas Muir, president, in the chair.—Mr. J. S. Mackay read a paper on the medioscribed circle of a triangle with its analogous and associated circles viewed from their centres of similitude.—Prof. Chrystal stated some propositions in geometry for which he wished proofs.—Mr. Muir made a communication on determinants with p-termed elements.—The Secretary gave a new construction by the Rev. G. McArthur for Euclid ii. 9, 10; and Mr. James Taylor Dollar proposed for solution a theorem in elementary geometry.

CONTENTS

THURSDAY, JANUARY 3, 1884

THERMAL CHEMISTRY

Thermochemische Untersuchungen. Von Julius Thomsen, Dr. Phil. et Med., &c. Volumes I., II., and III. (Leipzig: Johann Ambrosius Barth, 1882-83.)

A PAPER was published in this journal a short time ago calling attention to "The Backward State of Chemistry in England" (vol. xxviii. p. 613); the writer regrets that so little attention is paid to the chemistry of the carbon compounds, and that so much time is spent in our chemical schools in elementary and routine instruction. In the second of these regrets I can thoroughly sympathise; our so-called students of chemistry are becoming mere machines which perform, and generally perform badly, mechanical processes known as qualitative and quantitative analyses. We hear complaints from physical laboratories that practical physics is taught in an unsystematic manner; we sometimes have comparisons drawn between the desultory methods of teaching pursued in these laboratories and the orderly and systematic courses of practical chemistry conducted in the workrooms of the sister science. But I am afraid it is rather the chemist who is to be pitied: his method is too methodical; it seems to succeed because it neglects the really scientific aspects of chemistry. Chemistry is a great branch of science; but what is the so-called practical chemistry of the schools or the examination? It is but a weary round of dull repetition; it consists of obtaining black precipitates, and yellow precipitates, and colourless precipitates, precipitates which are soluble and those which are insoluble; it occupies itself with filtering and washing, and drying, and burning, and weighing; it has little or no connection with the problems which belong to the science of chemistry. But when the author of the article to which reference has been made attributes the backward state of chemistry in England to the comparatively small amount of attention which is given to organic chemistry, I find myself unable to agree with him. I think we are apt to be dazzled by such things as the synthesis of indigo, or the artificial manufacture of alizarin: we forget to inquire whether the study of organic chemistry has in recent years added any great general principle to chemical science. The conception of the valency of elementary atoms is certainly an outcome of the study of the carbon compounds, or rather of the application of the atomic theory to this study; but have we not of late made too much of this conception? has it not rather stopped than aided inquiry? is it not time we had given up our "bonds," our "units of affinity," which are chiefly remarkable as being changeable almost at pleasure? Organic chemistry, as pursued in the German laboratories, it seems to me, has almost if not quite entered on the same path as that which has led qualitative and quantitative analysis to so sad a fall: it is in danger of ceasing to be a branch of science and of becoming an art of manufacture. Any student who goes through the course of preparation of organic compounds, systematised so well in the laboratories of the German universities and elsewhere, is ready to manufacture new compounds by the score; the difficulty consists in not making such compounds. There are whispers abroad that he who is not in the trade is regarded by the German professors as "no chemist."

I think the evil lies deeper: we are so anxious to act that we have no time to think. The chemist may gain a kind of reputation by making new compounds; the process requires no thought, no scientific training, no originality. It has also something to be said in its favour. Nature is so vast that we can scarcely hope to gain any accurate knowledge save by attacking the problems in detail. In chemistry, as in other branches of science, we must be content to gain "a series of small victories" over nature. But in fighting nature in detail we are apt to lose sight of general principles by the help of which alone can empiricism become science. I think that in chemistry, and more especially perhaps in organic chemistry, we are specialising too much: we are trying to solve large and complex problems by a series of small attacks all delivered from the same point. What then is the remedy? I would answer: Vary the points of attack; remember that the victory is to be gained only by boldness, and that it is emphatically worth gaining. Do not let chemistry remain the battlefield of the Philistines, but enliven it with the true spirit of science, with that spirit which will not believe that the universe is a "rubbish-heap of confused particulars," but will rather regard it as a vast organism in which while "everything is distinct yet [is] nothing defined into absolute independent singleness."

That the points from which the problems of chemistry may be attacked are many is witnessed by the book before us. Why is there no handbook of thermal chemistry in English? Will not some one at least translate Naumann's "Handbuch"? M. Thomsen has for years been known as one of the two great workers in the field of thermal chemistry; his contributions to this branch of science have been numerous and important; we cannot be too thankful that he has gathered these contributions together, and arranged and digested them in this series of volumes, which must remain as the groundwork of the science. Three volumes have appeared, and a fourth (to treat of organic compounds) is promised. Let me try to give some account of one or two points in Thomsen's work.

The notation of thermal chemistry is simple: Let r = the thermal value (stated in gram-units) of a chemical change; if the change consist in the formation of a definite quantity of a compound $X_a\ Y_b\ Z_c$—made up of a parts of X, b parts of Y, and c parts of Z—then

$$r = [X^a, Y^b, Z^c] + ;$$ [1]

if the same compound is produced in presence of a large quantity of water, then

$$r = [X^a, Y^b, Z^c, Aq] + ;$$

if the same substance already formed is dissolved in an unlimited quantity of water, then

$$r = [X^a\ Y^b\ Z^c, Aq] + .$$

The general expressions for the production and decomposition of a compound $X_a\ Y_b$ are

$$(1)\ X_a + Y_b = X_a\ Y_b + (X^a, Y^b);$$

and

$$(2)\ X_a\ Y_b = X_a + Y_b - (X^a, Y^b).$$

[1] Thomsen always writes the indices above the elementary symbols when these symbols occur in thermal equations

If the compounds X Y and Z V react to produce X Z and Y V then

$$r = [X, Z] + [Y, V] - [X, Y] - [Z, V].$$

These equations illustrate the methods by which the thermal value of a chemical change can be indirectly calculated. The total loss of energy by a chemical system in passing from a definite initial to a definite final state is independent of the intermediate states; assuming, as we may do for most purposes, that the total loss of energy is measured by the quantity of heat evolved, it follows that the total thermal change accompanying a chemical change depends only on the initial and final states of the system. Hence, if we have series of reactions beginning with the same materials in the same condition, and ending with the same products in the same condition, and if all the thermal changes in one series may be measured, and all except one in the other series may be measured, it follows that we can calculate the thermal value of the unknown member of the second series of changes. Thus, it is required to determine the thermal value of the synthesis of 46 grams of formic acid (CH_2O_2). Twelve grams of carbon, 2 of hydrogen, and 48 of oxygen combine to produce 44 grams of carbon dioxide and 18 grams of water: but the same quantities of the same materials might theoretically be combined to produce 46 grams of formic acid, and then from this, 44 grams of carbon dioxide + 18 grams of water would be produced. The following are the thermal values of the various parts of these two series of changes:—

$$[C, O^2] = 96{,}960 \text{ gram-units} + ; [H^2, O] = 68{,}360 + ;$$
$$[CH^2O^2, O] = 65{,}900 + ;$$

but

$$[C, O^2] + [H^2, O] = [C, H^2, O^2] + [CH^2O^2, O] = 165{,}320 +$$
$$\therefore [C, H^2, O^2] = [C, O^2] + [H^2, O] - [CH^2O^2, O] = 99{,}420 +.$$

Such calculations sometimes become very complex; corrections must frequently be introduced for quantities of heat evolved or absorbed during purely physical changes which form integral parts of the cycle of chemical change under investigation.

The thermal study and comparison of classes of chemical changes leads to the conclusion that a chemical change which is accompanied by considerable loss of energy to the changing system will generally occur, unless prevented by the action of forces external to the system. This generalisation, vague though it be, helps to explain many classes of chemical reactions, *e.g.* the action of concentrated and dilute solutions of hydriodic acid on sulphur, and on many hydroxyl-containing carbon compounds; and the action of sulphuretted hydrogen in precipitating certain metallic sulphides in the presence of acid, and others only form alkaline liquids.

Thomsen has devoted much time and care to the thermal investigation of the mutual actions of acids and bases: the greater part of his first volume is devoted to this inquiry. The "heat of neutralisation of an acid by a base" is defined as the number of gram-units of heat evolved on mixing equivalent quantities in grams of the acid and base in dilute aqueous solution, the products of the action being also soluble in water. Thomsen employs a solution of 2 NaOH (grams) in about 200 H_2O (grams) as the standard base: he measures the thermal values of the following reactions:—

[2NaOH Aq, 2HX Aq] in the case of a monobasic acid.
[2NaOH Aq, H_2X Aq] „ „ dibasic „
[2NaOH Aq, $\frac{2}{3}H_3X$ Aq] „ „ tribasic „
[2NaOH Aq, $\frac{1}{2}H_4X$ Aq] „ „ tetrabasic „

The commoner acids may be broadly divided into four groups, according to the values of the "heats of neutralisation." This value is for Group I. about 20,000 gram-units; II., about 25,000; III., about 27,000; and IV., about 30,000 gram-units. The study of heats of neutralisation has led Thomsen to the conception of the *avidity* of an acid, *i.e.* the striving of one acid to displace another from its combination with a base. Thus, when equivalent quantities of NaOH, HNO_3, and H_2SO_4 are mixed in dilute aqueous solutions, two-thirds of the NaOH combines with the HNO_3, and one third with the H_2SO_4; the *avidity* of HNO_3 for NaOH is said to be twice as great as that of H_2SO_4 for the same base. HNO_3 in aqueous solution is therefore a *stronger acid* than H_2SO_4.

Measurements of the heats of neutralisation of monobasic, dibasic, *n*-basic acids has led Thomsen to classify some of these acids in ways different from those generally adopted in the text-books. His results as regards dibasic and tribasic acids may be thus summarised:—

Dibasic Acids

Group I. Typical formula RH_2 *e.g.* $SiF_6 . H_2$
„ II. „ „ $R(OH)_2$ *e.g.* $SO_2(OH)_2$
„ III. „ „ $R(OH)H$. *e.g.* $SO_2(OH)H$.

Tribasic Acids

Group II. Typical formula $R(OH_3)_3$. *e.g.* $C_4H_5O_4(OH)_3$.
„ III. „ „ $HR(OH)H$. *e.g.* $HPO_2(OH)H$.

These examples will serve to show the suggestiveness of the results of thermal chemistry. Thomsen's three volumes teem with suggestions: his results throw light on such questions as are connoted by the expressions allotropy, molecular compounds, classification of elements and compounds, isomerism, and affinity.

It is in examining the subject of chemical affinity from the point of view of thermal chemistry that one becomes aware of the complexity of the problems included under this expression.

From the following numbers,

$$[H, Cl] = 22{,}000 + ; [H, Br] = 8440 + ; [H, I] = 6050 - ;$$

it might be concluded that the affinity of chlorine for hydrogen is much greater than that of bromine, and that the affinity of iodine for hydrogen is much less than that of bromine. But these thermal equations are not comparable; at ordinary temperatures chlorine is a gas, bromine a liquid, and iodine a solid; hence, on this ground alone, no precise conclusions can be drawn from the above data regarding the relative affinities for hydrogen of the three halogen elements. Again, looking at the numbers,

$$[C, O] = 28{,}600 +; [C, O^2] = 97{,}000 +,$$

it might be said that when oxygen combines with carbon in quantities of 16 grams at a time, the union of the second parcel of 16 grams is attended with evolution of much more heat than accompanies the addition of the first parcel of 16 grams. But measurement of the heat of oxidation of carbon monoxide, [CO, O] = 68,400 +, at once negatives this conclusion, and rather points to the number 68,400 × 2 136,800 as representing the thermal value of the transaction, $C + O_2 = CO_2$, where C represents 12 grams of gaseous carbon.

In the ordinary chemical notation almost every chemical change is represented as much simpler than it really is; no indication is given of the fact that in most cases an *excess* of one or other of the reacting substances must be used. Thus the reaction usually written

$$AgCl + HI \text{ (gas)} = AgI + HCl$$

would more correctly represent the distribution of the reacting bodies were it written

$$xAgCl + x'HI = xAgI + x'HCl + (x-1)AgCl + (x-1)HI.$$

If it is assumed that in the thermal study of a chemical reaction allowance is made for all the purely physical changes which accompany the chemical change, for the influence of the masses of the reacting substances and for the possible formation and decomposition of molecular groups during the reaction, there yet remains the consideration that heat is lost or gained to the system in the decompo sitions and formations of elementary molecules, which decompositions and recompositions may form parts of the entire change under examination. Thus, take the comparatively simple reaction

$$2H_2O + Cl_4 = 4HCl + O_2;$$

expanded thermally we have

$$r = 4[H, Cl] + [O, O] - 2[H^2, O] + 2[Cl, Cl].$$

Even the apparently most simple case, the union of two elements, is more complex than at first sight appears. $[H^2, Cl^2] = 44{,}000 +$ simply tells that 2 grams of hydrogen combine with 71 grams of chlorine, and that 44,000 gram-units of heat are evolved. But if we wish to apply these data to questions concerning the affinity of chlorine for hydrogen, we must remember that affinity is the name given to the stress between atoms when regarded from the point of view of one kind of the reacting atoms. Hence, remembering that the molecules of hydrogen and chlorine are diatomic, we must amplify the equation $[H^2, Cl^2] = 44{,}000 +$, and write it thus—

$$r = 2[H, Cl] - [H, H] - [Cl, Cl] = 44{,}000 +;$$

but the value to be assigned to two of the terms in this equation are unknown. Until we are able to assign approximate values to the thermal changes accompanying the decompositions of elementary molecules and the combinations of elementary atoms, we shall not be in a position to apply thermal data to the subject of affinity, provided, that is, we use this term in its most precise meaning.

The statement of Berthelot in the "Essai de Mécanique Chimique," that the quantity of heat evolved in a reaction measures the sum of the physical and chemical changes which occur in that reaction, and furnishes a measure of the chemical affinities, is evidently untrue if we assign any precise meaning to the term "affinity." But if we use this term in a wide sense as summing up the various actions and reactions (other than those which are purely physical) which together constitute any given chemical change, then we may perhaps say that thermal measurements of comparable reactions are also relative measurements of the affinities of the reacting substances. It is in some such sense as this that the term "affinity" is used by Thomsen in his thermal researches on the relative affinities of the non-metallic elements (vol. ii.).

It is worthy of remark that Thomsen's arrangement of the commoner acids in order of relative affinities agrees very well with that given by Ostwald as the result of his investigations conducted on altogether different lines and by very different methods.

If thermal measurements of chemical changes really represent the sums of various partial changes, some of which have a positive and others a negative value, then it becomes doubtful whether any practical result is to be looked for from the application of Berthelot's *law of maximum work*, which runs thus:—

"Every chemical change, accomplished without the addition of energy from without the system, tends to the formation of that body or system of bodies the production of which is accompanied by evolution of the maximum quantity of heat."

Thomsen puts this "law" in a somewhat different form: he says, "Every simple or complex reaction of a purely chemical kind is accompanied by evolution of heat." Thomsen explains that by a purely chemical process he means one which is accomplished without addition of energy from sources external to the system, and consists in the "striving of atoms towards more stable equilibrium." But there are, I think, two principal objections to this statement. Actions "of a purely chemical kind," as thus defined, do not actually occur except as parts of cycles of reactions wherein are included changes not of a "purely chemical kind." And, secondly, we have at present no means of measuring the thermal values of those purely chemical actions—*i.e.* on Thomsen's view, atomic actions—but are obliged to include their values in the total value assigned to the complete cycle of operations which we term a chemical reaction.

Thomsen has it is true attempted to assign thermal values to the decomposition of the molecule of carbon into atoms and the recombination of atoms of carbon to form molecules. The pages of NATURE are scarcely suitable for a detailed discussion of Thomsen's methods; it seems to me, and I think to some others who have tried to follow Thomsen's arguments, both in the second volume of his "Untersuchungen" and also in the original papers in the *Berichte* and elsewhere, that these arguments really bristle with assumptions, and that a comparison of the results deduced by Thomsen with the actual calorimetric measurements obtained by himself and others is sufficient to throw grave doubt on the validity of those assumptions on which his arguments are based. One general result which appears to me to follow from Thomsen's investigation is that the time has come when we may with great advantage give up such expressions as "the carbon atom has four bonds," "such or such atoms are held by double links," and indeed the whole of that unscientific pseudo-dynamical nomenclature which has grown up around the vague and indefinable conception of *atomic bonds*.

There are many other points of interest in Thomsen's "Untersuchungen"; but I have said enough I trust to show the importance and the remarkable suggestiveness of these volumes; and also to establish the statement that the great advances of the future in chemistry are to be looked for, not so much in the domain of organic chemistry as in the application of the methods and generalisations of the science of matter and motion to the problems which we call chemical.

M. M. PATTISON MUIR

A SCIENTIFIC CATALOGUE

Bernard Quaritch's General Catalogue. Part II. Natural History and Science. Part III. Periodicals, Journals, and Transactions. (London: 1881-83.)

IN few instances that a political economist could hold up as an example is the function of the merchant in the processes of supply and demand so clearly and simply displayed as in that of Mr. Bernard Quaritch, the wealthy merchant in the book trade. He is especially a merchant-man seeking goodly pearls, whose great qualification must be that he knows the exact demand for, and the exact scarcity of, what is to be bought and sold. His catalogue does not aim at completeness as did the one which we noticed lately. Scarcely more than one-tenth of the titles carefully entered in Mr. Friedländer's lists are to be found here; but these make a collection, and a very large one, of books brought together by "natural" selection with the same good results in this case of intelligent working, as in the more automatic world around us. Many eminent men in various branches of science have first selected books bearing upon their own subjects, and then, on the dispersion of such libraries, Mr. Quaritch selects those works which have a higher value through their own superior merit, or the often doubtful though highly-prized recommendation of rarity. Accordingly Mr. Quaritch's catalogue is considerably like the sum total of British legislation. Each item of it was the supply of an existing want according to the best light of the time of its production. While circumstances, however, have changed and fresh laws have been devised to meet the changed circumstances, old laws have remained upon the statute book, and the existing code contains at the same time both inconsistent repetitions and grave deficiencies, and lacks both symmetry and completeness. While the catalogue of Mr. Friedländer shows the German love of both these good qualities and the scientific tastes of the compiler, that of Mr. Quaritch does not profess to be complete in any sense; it is a list of an immense stock of books brought together, as their former possessors ceased to require them, by a shrewd man of business who knew their market value. Hence in examining these bound up volumes which contain the many rich prizes of scientific literature constituting Part II. and Part III. of a new "General Catalogue," one is not surprised to find that a book like Agassiz's "Nomenclator Zoologicus" is to be found in four different places in one of them; that five copies of Owen's "Odontography" are offered, and a variety of copies of many others.

In Friedländer's catalogue we had to complain of too much classifying; not because classification is not of extreme value as a ready guide to the contents of a catalogue or library, but because many books refuse to fall under one head only, however discreet may be the arrangement. Mr. Bernard Quaritch's catalogue is just the reverse. In these volumes there is no attempt at either alphabetical or subject-divisions of the whole collection; different divisions are lists of books purchased at particular sales. A concise index makes up perhaps in the best way for this utter confusion of subjects. The table of contents, to which one would look first in trying to understand such a catalogue, is not printed in a way to clearly express the arrangement of those titles which *are* classified in subjects. A list of thirteen natural history headings follows "Egypt and North Africa" in exactly the same way as a nearly similar list of fourteen follows "The British Isles," but the former has nothing to do with Egypt as the latter had to do with the British Isles.

But Mr. Quaritch is the great connoisseur in a different class of books from the works which draw our attention in his catalogue. This class it would hardly come within our province to notice, were it not for the evidence given here, on the one hand, that costly books are purchased now as much as of old by the "patron" of literature, and on the other, that scientific works of original value and present scarcity are bought up by mere book collectors or bibliolaters, who would in many cases fret while one of their precious volumes was being turned over for consultation, lest it should end in a crack in its beautiful binding! Mr. Quaritch labours abundantly, and not without love, we think, for these purchasers. Here are a few of the feminine pomps and vanities with which he tickles the ears of bibliomaniacs:—"Grolier binding," "variegated leathers," "gold scroll tooling," "purple morocco super extra," "veau fauve," "veau marbré," "arms and cypher of ———," "vellum fly-leaves," "large paper," "tall copy," "magnificent specimen of bibliopegistic skill." Here is a titbit:—"First Aldine edition, very large, fine copy, in blue morocco, gold tooling, silk lining, vellum fly-leaves, gilt gaufré edges, by Bozerian."

A distinguishing feature in Mr. Quaritch's catalogues are the valuable notes appended to nearly all the most important of the works he offers. These notes as to the scarcity, completeness, market value, and often the history of the book testify to both the extent of his business and the minute accuracy of his knowledge of it. They are a mine of valuable information to any one whose business is in books, either commercially or as a librarian intrusted with the care and also the completion of important collections. In few cases will a book only professing to be a stock-list itself command a price in the market. Mr. Quaritch's catalogues command a high price, and the new edition of his general one, of which seven parts are now out, and which will probably not be completed for another year, if it should be the last which our veteran publishes, will doubtless remain for some time to come a standard work upon literature.

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.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Elevation and Subsidence

FOR several months past articles and letters have appeared in NATURE on the subject of subsidence and elevation of the earth's crust by addition and removal of weight. In this connection also much has been said in regard to the history of the idea. I wish therefore to draw attention to the fact that in 1859 I read a paper before the American Association for the Advancement of Science on the subject of the "Formation of Continents and Ocean Basins," in which, after giving the views of Herschell and Airy, I bring out this idea very prominently, and illustrate it by many diagrams. An abstract of this paper, by Sterry Hunt, was published in the *Canadian Naturalist*, vol. iv., 1859, p. 293, and reference to it will be found in the "Royal Society Catalogue," vol. iii. p. 919.

A very brief outline of the paper is as follows:—I make two assumptions: (1) an internal liquid with floating crust; (2) the crust of continental areas more conductive and therefore cooling and thickening more rapidly than that of oceanic areas.

It is evident that under these assumptions inequalities would commence first on the under surface of the crust by additions there, making convexities beneath the continental and concavities beneath the oceanic areas. But by *flotation* these inequalities on the under side next the liquid would be reproduced on the upper side next the atmosphere, and by this means alone continents would grow continually higher, and ocean beds deeper. Now add to these erosion. By cutting down continents and filling up the seas erosion would tend constantly to destroy these inequalities, while flotation would tend as constantly to reproduce them. Thus according to this view the continents rise partly by additions beneath and partly by removal above, and similarly the ocean beds sink partly by increased concavity beneath and partly by additions above. But evidently if unequal thickening should stop, flotation could only *partly* restore the inequalities destroyed by erosion.

Except the abstract above referred to, the paper was never published, and in February, 1865, it was destroyed, along with much else, by Sherman's army. My reason for not publishing more fully was that I soon became dissatisfied with it; for about that time the views of Hopkins and Pratt on the solidity of the earth began to attract attention, and I became convinced that dynamical geology must be reconstructed on a basis of a solid earth. But now that the idea of a sub-crust liquid or semi-liquid layer is becoming prominent (a condition which would not probably interfere with the substantial solidity of the earth in its astronomical relations), it seemed to me important that this long forgotten paper should be brought forward merely as a part of the history of the subject.

Now a few words on the subject of the communications referred to in the beginning of this letter. It seems to me that some of your correspondents have gone too far in regarding unloading by erosion as a cause of elevation. Evidently there must be some other and more fundamental cause, or erosion could not act. Evidently erosion can only partly restore an elevation produced by some other cause. Erosion is primarily an effect of elevation, only in this a in so many other cases the effect may react as a cause, to maintain the elevation. For example, the Colorado plateau region has been raised since Cretaceous times about 20,000 feet, but the maximum general erosion has been only about 12,000 feet. The erosion has been, therefore, the consequence, not the cause, of elevation, for it is impossible that the cause should lie so far behind the effect. I give this one example because it is on so large a scale, but every mountain range furnishes an example of great erosion as an effect of elevation produced by other causes. That loading and unloading the crust is a cause of subsidence and elevation there is little doubt, but that there are other and far more important causes is certain.

Berkeley, Cal., December 3 JOSEPH LECONTE

Red-deer Horns

IN continuation of my remarks on the eating of shed deer-horns by other deer, I have to add that six shed horns in various stages of erosion have been sent to me from Sutherlandshire. They each bear well defined teeth-marks on the gnawed portions, and this leaves little if any doubt that the popular belief that the horns are eaten by deer is founded on fact. The accompanying interesting letter from Mr. James Inglis, which gives the evidence of two experienced stalkers, both most intelligent and reliable men, is further confirmation of a curious though no doubt very natural habit of the deer, which finds in the lime-salts of the horn a necessary element of nutrition. You will observe that Inglis believes the deer use the molars in eating the bone, and this seems probable enough, as they apparently always begin at the points and eat towards the beam and burr, a method of proceeding by which they can bring portions of the horn within the action of the molars. J. FAYRER

December 27, 1883

". . . I send a few red-deer horns that have been partially gnawed by deer in the forest. I asked the stalkers to keep a look out and see if they could find any deer eating horns, and am glad to say that they have been able to put the matter beyond all doubt.

"Donald McRae saw with his glass a stag, in Dunrobin Glen, eating a horn; he went to the place where he saw him eating it, and found it partially eaten. I send it with the others. You will find a ticket on it to distinguish it from the rest.

"Duncan McPherson saw with his glass a hind, last week, eating a horn also; he did not find the horn, but he saw her (the hind), quite plainly, with it in her mouth, gnawing away at it near the point.

"Deer have no incisors in the upper jaw, but they have grinders or molars in both upper and lower jaws, formidable enough to eat any horn, and I have no doubt that it is with their molars that the horns are eaten.

"A shepherd in the parish of Lairg has a cow that eats all the bones she can find, and goes miles for them, and eats them up, shank bones and all; ribs are eaten easily, and seem to give no trouble whatever. "JAMES INGLIS

"December 24, 1883"

On the Absence of Earthworms from the Prairies of the Canadian North-West

NOT by any means the least remarkable of the very notable series of works which Mr. Darwin has given to the world is that which came last from his pen but a short time previous to his lamented death. Dealing, as it does, with effects which, when looked at in the detail, are exceedingly small and insignificant, but, when viewed in the aggregate, are shown to be of surprising importance, the "Vegetable Mould and Earthworms" must certainly rank as a most strikingly interesting work.

It is not my desire to call in question the conclusions at which Mr. Darwin has arrived with regard to the action of earthworms in cultivating the soil, but I wish to point out that in one extensive portion of the earth's surface, to which much attention has of late been directed on account of its agricultural capabilities, earthworms do not exist. I refer to the vast region commonly known as Manitoba and North-West Territories. My friend, Mr. E. E. T. Seton, of Carberry, Manitoba, was the first to point out to me that this enormous country must be regarded as forming an exception to Mr. Darwin's generalisations, on account of the total absence from it of every kind of earthworm, and, having lately returned from a visit to these regions, I can add my testimony to his in this particular, as well as in the matter of the amazing, innate fertility of the soil, which has been the wonder and remark of all travellers for years past, but which, in this case, obviously cannot be attributed to the action of worms, since these do not exist there. In addition to my own observations, I have the testimony of numbers of intelligent settlers, most of whom had been several years in the country, but all of whom unhesitatingly assured me that such a thing as an earthworm was unknown. Further, Mr. Leo Rogers, son of Mr. Thos. Rogers of Manchester, who has spent several years with the engineers of the Canadian Pacific Railway, has informed me that earthworms are unknown between Winnipeg and the Rockies. This being the case, it does not seem reasonable to suppose that they exist anywhere in the huge territory still further to the north, and comprising upwards of 3,000,000 square miles of land, or something like one third of the entire North American continent, and which may therefore be regarded as forming an exception to Mr. Darwin's statement (p. 120), that "Worms are found in all parts of the world, and some of the genera have an enormous range. They inhabit the most isolated islands; they abound in Iceland, and are known to exist in the West Indies, St. Helena, Madagascar, New Caledonia, and Tahiti. In the Antarctic regions worms from Kerguelen Land have been described by Ray Lankester, and I have found them in the Falkland Islands. How they reach such isolated spots is at present quite unknown." In connection with the statement (p. 121) that "Worms throw up plenty of castings in the United States," it may be pointed out that the boundary line (the 49th parallel) is to some extent a natural one, from which the rivers run both north and south. Further, I have been assured by friends, and have also seen with my own eyes, that earthworms abound at Toronto and in other parts of Ontario. This being the case, an interesting inquiry arises as to the cause of the absence of worms from the North-West, and I can only suggest two probable reasons—the great cold of winter and the prevalence of prairie fires in spring and autumn. Personally I favour the latter, though both causes may in part be answerable. If worms abound in Iceland (65° N. lat.), in Kerguelen Land (50° S. lat.), and in Toronto (43·4° N. lat., mean winter temperature 27¼° F.), why should they not also occur at Winnipeg (50° N. lat.)? Certainly the mean winter temperature is very low, being about 8° F., and the mean minimum for eleven years – 40½° F. I made special inquiries as to the depth to which the soil in Manitoba becomes frozen in winter. This is often as much as five or six feet, but only, I believe, in the more exposed places, and certainly as a rule it is thawed again in the spring. I do not think this would render the ground uninhabitable by worms when they are able to exist in Iceland. Mr. Darwin says nothing as to the effect of frost on worms except (p. 26) that "worms are sensitive to a low temperature, as may be inferred from their not coming out of their burrows during a frost"; but he states (p. 110) that they are easily able to descend three or four or even seven or eight feet below the surface. It would be interesting to ascertain whether worms inhabit equally cold portions of the Old World.

But the agency which I believe has caused the absence of earthworms from the North-West is, as already stated, the prairie fires which annually sweep over enormous portions of the country, totally consuming the grass, and converting it into a black ash. This, it might well be imagined, would for months together completely deprive any worms that formerly existed of that variety of decaying vegetable matter that composes their food; and assuming that fires have annually passed over large portions of the prairies for scores of generations (as seems in every way probable), it appears to me only reasonable to suppose that this cause would effectually have exterminated the worms from the country or have prevented them occupying it. It is my belief (as I shall elsewhere state more fully) that the very fertile, fine, black, powdery, and almost soot-like soil from one to three feet thick, even the open, treeless nature of the prairies themselves, and the absence from their surface, so far as my observation goes, of every single species of mollusk, while many species abound in all the ponds, lakes, and streams, are all in a large degree, if not entirely, due to the action of the fire. If this view ultimately turns out to be correct, it will be further seen that the very means which has deprived the soil of the North-West of that natural cultivation which the soils of most other countries enjoy has, at the same time, liberally supplied it with a manure resulting from the charred ashes of the grass which is annually burned. My friend, Mr. T. Rogers, who has taken much interest in the absence of worms from the North-West, and is inclined to attribute it rather to frost than to fire, though he suggests that the "alkali" may possibly have had something to do with it, has already brought the subject before the Literary and Scientific Society of Manchester, where he seems to have met with a good deal of incredulity.

As another evidence of the absence of worms, the numerous, large, Glacial boulders that strew the prairies around Brandon and elsewhere may be cited. These, had worms existed, would doubtless have long ago been lowered beneath the surface, as also the skulls and other bones of buffaloes, which so abound on the prairies, and most of which have evidently lain there a long while. Nevertheless some of these have been buried in the course of time, as one gentleman told me that he had sometimes turned them up from a depth of two or three inches beneath the surface when ploughing. Their burial may have been accomplished by the wind drifting soil over them, or by the working of gophers. Of these peculiar little animals two species are very abundant on the prairies, where they make extensive burrows, which it seems possible may to some extent accomplish the natural cultivation of the soil in the way worms are accustomed to do it elsewhere. Some more suggestive remarks on this point may be found in a paper by Mr. Seton, published in the Report of the Manitoba Department of Agriculture for 1882, and which may be studied with advantage. ROBT. MILLER CHRISTY

Chignal St. James, near Chelmsford, December 20, 1883

Magnetic Dip in South China and Formosa

WHILE engaged on a meteorological mission in China I availed myself of the opportunity to make the following determinations of the magnetic dip. The observations in Hong Kong were made at the public gardens, the Observatory being not yet ready. On October 10 I observed at the British Consulate; on November 3 at the English Presbyterian Missions Compound, Swatow. In Amoy I observed at the residence of the Commissioner I.M. Customs, in Takow (Formosa) at the Custom House, and at the South Cape (Formosa), near the magnificent fortified lighthouse. It is to be feared that the observations on the coast of China are slightly vitiated from local attraction, the rocks consisting of ferruginous granite. Southern Formosa is built up of coral, raised in places to a great height, no doubt through volcanic action. Slight earthquakes are of common occurrence in Formosa, whereas along the coast of China they are rare and of no importance except to the seismologist.

Place	Date	Local M.T. h. m.	Dip. ° ′
Hong Kong ...	1883, Nov. 5 ...	5 9 p.m. ...	32 17
,, ...	,, ,, 9 ...	5 4 ,, ...	32 19
Swatow	,, Oct. 10 ...	5 24 ,, ...	34 23
,, ...	,, Nov. 3 ...	11 25 a.m. ...	34 17
Amoy	,, Oct. 14 ...	3 50 p.m. ...	36 45
,, ...	,, ,, 16 ...	5 10 ,, ...	36 50
Takow	,, ,, 24 ...	2 45 ,, ...	32 54
South Cape ...	,, ,, 27 ...	4 0 ,, ...	31 24
,, ...	,, ,, 28 ...	4 30 ,, ...	31 27·5
,, ...	,, ,, 29 ...	3 20 ,, ...	31 24·5

W. DOBERCK,
Government Astronomer

Hong Kong, Nov. 10

THE ORIGIN OF CORAL REEFS

REGARDING this interesting geological problem, which has recently been discussed in NATURE, we are enabled through the kindness of Mr. Murray, of the *Challenger* Commission, to publish a letter which has been addressed to him by Dr. Guppy from the Pacific. The importance of this communication will be recognised in the confirmation it supplies of the inference that coral reefs start upon a platform of limestone composed of the remains of foraminifera, &c., and are themselves of no great thickness. Dr. Guppy will no doubt continue his researches, and we may hope to obtain from him precise data regarding the average thickness of the coral rock, the lithological difference between it and the underlying limestone, the structure of the limestone, whether any succession of organisms can be detected in it, and whether at any point the underlying volcanic rock can be seen which would afford a measurement of the thickness of the calcareous deposits. The effects of denudation and their relation to height above the sea will no doubt also receive his attention.

"*Shortlands Islands, Solomon Group,*
"*August* 7, 1883

"During the twelve months I have spent in this group of islands—serving as surgeon on board H.M. surveying-ship *Lark*—I have been much interested in and have devoted considerable attention to the raised coral formations in various islands; and as my observations may be of service towards confirming the views which you have advanced with reference to coral islands and reefs, I will state briefly the results of my observations.

"Excluding the large continental islands, I will refer for the sake of brevity to the numerous small islands of this archipelago, those of volcanic, and those of calcareous formations. Confining myself to the islands of calcareous formation, I will pass over the numerous small islands which are entirely composed of coral detritus, sand, and shells, and have been formed by the materials thrown up by the waves at the present sea-level; and will restrict my remarks to a very common type of islands in this group, with gently sloping and rounded profile, having an elevation varying perhaps between 100 and 1100 or 1200 feet, and composed in bulk of *an impure earthy or argillaceous limestone*, usually bedded, and almost always *foraminiferous*, now and then rich in other pelagic organisms, such as *Pteropods*. On this rock *rests the* *coral limestone*, which forms but a comparatively thin crust, and has been altogether removed from most of the higher regions by sub-aërial agencies. However, I have observed the raised coral rock still preserved at considerable heights above the sea, and in two localities at elevations of 900 feet.

"Amongst the sub-group known as the Shortland Islands, I came upon beds of this *impure calcareous rock* (beneath the raised coral rock) *abounding in Pteropods*, mostly *Hyalæa*, and large foraminiferous tests, mingled with shells, some of them of shallow water habit.

"I am, &c., "H. B. GUPPY"

A FORGOTTEN EVOLUTIONIST

A BOOK has lately come into my hands a few words about which may possibly interest some of the readers of NATURE. Its title is "Histoire Naturelle des Fraisiers"; the author was A. N. Duchesne, and it was published at Paris in 1766. It must be, I suspect, an uncommon book, for there is no copy in the library of the Royal Gardens at Kew. And this library, comprising as it does the contributions of many collectors who allowed little to escape them, is remarkably complete; Mr. Daydon Jackson has in fact found in it more than a thousand publications the titles of which are not to be met with in the last edition of Pritzel's well-known "Thesaurus."

The scarceness of a botanical book is not perhaps in itself a matter of any great moment, and I bought the book out of a provincial sale catalogue without expecting it to be particularly interesting, though I knew Duchesne's name as an authority on the cultivated forms of the strawberry. I very soon, however, came to the conclusion on looking over it that it was a very remarkable production indeed, and in a scientific sense at least a century in advance of its time.

Duchesne's book is in fact the record of a purely biological study of a small group of plants. The significance of work of this sort has only been thoroughly recognised since the publication of the "Origin of Species." Just as with C. K. Sprengel, whose book was also written in the last century (1793), the world has had to roll on far into another hundred years before it was ready to do justice to this kind of research. There is a curious incongruousness between the freshness and modernness of the ideas and the faded type and musty paper in which they are embalmed.

Duchesne plunges at once into the business of his book in the first line of the preface with a straightforward simplicity not unworthy of Mr. Darwin. I will attempt a translation of the first paragraph:—

"The wish to see if it were possible to raise from seed a plant which scarcely ever produces any has led me by a happy chance to the production of a new race, which made its appearance at Versailles in 1761. This circumstance induced me to more closely devote myself to the study of strawberries, and led me to another discovery. I found that they are not all truly hermaphrodite; forms exist, in fact, which are sexually differentiated.[1] And I have succeeded in the past year, 1765, in fertilising, by means of one set of plants, individuals of another sort, which are cultivated as a matter of curiosity, and are constantly sterile. One, amongst others, has produced fruits of great beauty; M. le Marquis de Marigny has obtained for me the honour of having this submitted to the king, and it is to be raised in the Versailles Gardens by my method. This unexpected success has still more redoubled my ardour to make further observations."

The race so produced, which Duchesne called *Le Fraisier de Versailles*, or *Fragaria monophylla*, is undoubtedly a very curious plant. All its leaves are permanently unifoliate; *i.e.* instead of bearing three leaflets, as is ordinarily the case with strawberries, the petioles bear but one. Duchesne observes that this is also the case with the first leaves of all seedling strawberries. *Fragaria monophylla* may be therefore regarded as a form which always retains the juvenile, and never arrives at the adult, foliage, and this peculiarity remains constant in subsequent generations. The effect of crossing, as a potent stimulus to variation, could not but have powerfully impressed Duchesne in so striking a case as this, and further observations seemed to have led him to account for the common characters which otherwise diverging forms exhibited as best accounted for by a common ancestral origin. The study of geographically separated species, however, necessarily led him to see that something more than crossing was needed to account for variation in every case. In discussing *Fragaria virginiana*, a native of North America, which is the origin of the race of Scarlets, Duchesne speculates as to its derivation from the wild *F. vesca* of Europe, and attributes the divergences from this type to the effect of North American soil and climate.

His work on Strawberries, where he was dealing mainly with races, led him to speculate with regard to the higher groups of species, genera, and orders. His results seem to me, for the time, so extraordinarily bold, and therefore historically so interesting, that I quote the first portion of the Recapitulation, pp. 219-221, entire, in the original French:—

"J'ai déjà dit, à l'occasion du Fraisier-ananas, qu'il étoit très-difficile de ranger en ligne droite les diverses Races d'une même Espèce, de manière qu'on pût passer de l'une a l'autre par gradations de nuance. Cela est peut-être aussi impossible, que de ranger en ligne droite les Espèces, les Genres, et les Familles; par la raison que chaque Race, comme chaque Espèce, chaque Genre, ou chaque Famille, a des rapports de ressemblance avec plusieurs autres.

"L'ordre Généalogique est donc le seul que la nature indique, le seul qui satisfasse pleinement l'esprit; tout autre est arbitraire et vide d'idées. J'ai eu soin, à chacune des Races de Fraisiers, d'indiquer ce qui m'a paru vraisemblable à cet égard; mais je n'ose me flatter d'avoir toujours rencontré juste. Il faudroit, pour le bien faire, avoir des connaissances certaines et précises du pays natal de chaque Fraisier, ou bien, du tems où il a été élevé de graine, et de quel autre Fraisier provenoit cette graine; j'ai fait voir combien on manquoit encore de lumières sur tout cela.

"C'est par cette raison que je me suis permis de donner mes conjectures; en voici les résultats; la forme d'Arbre généalogique les rendra encore plus sensibles, et en fera mieux saisir l'ensemble."

It is certainly startling to come upon a phylogeny of the most modern type in a book more than a century old.

It was not till after I had gratified myself with a study of Duchesne's remarkable speculations that it flashed across my mind that attention had already recently been called to them; and I found, in fact, that Prof. Alphonse de Candolle, in a short paper put together with the felicitous erudition of which he seems to possess so inexhaustible a store, had already, in May of last year,[1] stated most of the points on which I have dwelt above. And he mentions that, on the occasion of a visit to Mr. Darwin in 1880 he told him of the existence of the book, which he describes, justly enough, as "a very curious work, older than that of Lamarck, but to which no one had ever referred except for points of secondary interest."

I know little about Duchesne himself. De Candolle says that he was a horticulturist and Professor of Natural History, and that his knowledge was as varied as it was

[1] This must be one of the first observations of the tendency of plants with hermaphrodite flowers to pass into the diœcious state. The fact is now well established. (See Darwin's "Forms of Flowers," pp. 278-309.)

[1] "Darwin considéré au point de vue des causes de son succès," &c., *Archives des Sciences*, May, 1882.

sound. No one, nevertheless, ever seems to have paid the smallest attention to his evolutionary theories. Even Silvestre, who pronounced his *éloge* at a public meeting of the Société Royale d'Agriculture in 1827, abstains from the slightest reference to them.

While in his experiments and his mode of drawing conclusions from them Duchesne strongly recalls the method of Mr. Darwin, the parallel cannot be carried further. In so far as he obtained a glimpse at the modern doctrine of evolution it was in the form afterwards formulated by Lamarck. Of the part played by the struggle for existence in the matter I find no trace in his writings. W. T. THISELTON DYER

TEACHING ANIMALS TO CONVERSE

MR. DARWIN'S notes on Instinct, recently published by my friend Mr. Romanes, have again called our attention to the interesting subject of instinct in animals.

Miss Martineau once remarked that, considering how long we have lived in close association with animals, it is astonishing how little we know about them, and especially about their mental condition. This applies with especial force to our domestic animals, and above all of course to dogs.

I believe that it arises very much from the fact that hitherto we have tried to teach animals rather than to learn from them,—to convey our ideas to them, rather than to devise any language, or code of signals, by means of which they might communicate theirs to us. No doubt the former process is interesting and instructive, but it does not carry us very far.

Under these circumstances it has occurred to me whether some such system as that followed with deaf-mutes, especially by Dr. Howe with Laura Bridgman, might not prove very instructive if adapted to the case of dogs.

Accordingly I prepared some pieces of stout cardboard, and printed on each in legible letters a word such as "Food," "Bone," "Out," &c. The head master of one of the deaf and dumb schools kindly agreed to assist me. We each began with a terrier puppy, but neither of us obtained any satisfactory results. My dog indeed was lost before I had had him long. I then began training a black poodle, "Van" by name, kindly given me by my friend Mr. Nickalls. I commenced by giving the dog food in a saucer, over which I laid the card on which was the word "Food," placing also by the side an empty saucer, covered by a plain card.

"Van" soon learnt to distinguish between the two, and the next stage was to teach him to bring me the card; this he now does, and hands it to me quite prettily, and I then give him a bone, or a little food, or take him out, according to the card brought. He still brings sometimes a plain card, in which case I point out his error, and he then takes it back and changes it. This however does not often happen. Yesterday morning, for instance, "Van" brought me the card with "Food" on it, nine times in succession, selecting it from among other plain cards, though I changed the relative position every time.

No one who sees him can doubt that he understands the act of bringing the card with the word "Food" on it as a request for something to eat, and that he distinguishes between it and a plain card. I also believe that he distinguishes for instance between the card with the word "Food" on it and the card with "Out" on it.

This then seems to open up a method, which may be carried much further, for it is obvious that the cards may be multiplied, and the dog thus enabled to communicate freely with us. I have as yet, I know, made only a very small beginning, and hope to carry the experiment much further, but my object in sending this communication is twofold. In the first place I trust that some of the readers of NATURE may be able and willing to suggest extensions and improvements of the idea.

Secondly, my spare time is small and liable to many interruptions; animals also we know differ greatly from one another. Now many of your readers have favourite dogs, and I would express a hope that some of them may be disposed to study them in the manner indicated.

The observations, even though negative, would be interesting; but I confess I hope that some positive results might follow, which would enable us to obtain a more correct insight into the minds of animals than we have yet acquired. JOHN LUBBOCK

High Elms, Down, Kent, December 20, 1883

THE FRENCH DEEP-SEA EXPEDITION OF 1883

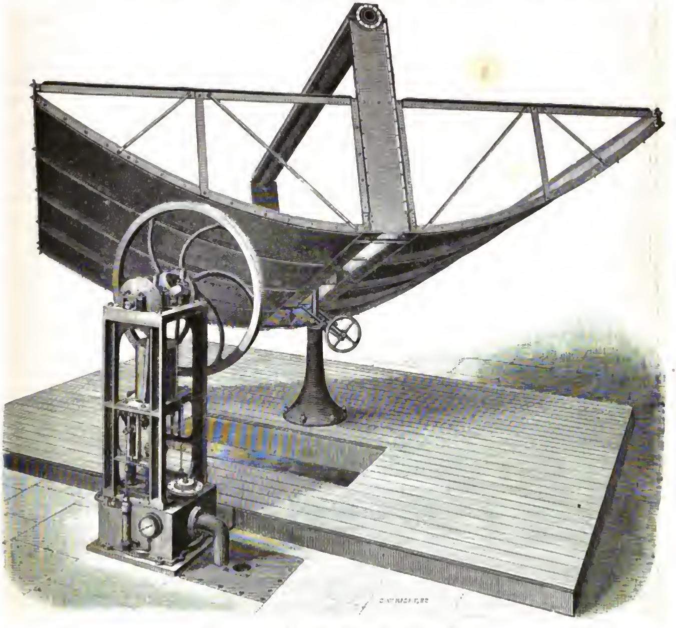
I HAVE just returned from a very short visit to Paris, made for the purpose of inspecting the Mollusca which were procured during last summer's deep-sea expedition in the French Government steamer *Talisman*. The expedition was under the scientific charge of Prof. Alphonse Milne-Edwards. For the opportunity of this inspection I was indebted to the kindness of my friend Dr. Paul Fischer, whose reputation as a conchologist is so well known.

The course of the expedition was along the Atlantic coasts of Spain, Marocco, Sahara, Senegal, Cape Verde Isles, the Canaries, and Azores; and the time occupied was three months. More full and accurate particulars will very shortly be given by Prof. A. Milne-Edwards to the Academy of Sciences, and be published in their *Comptes Rendus*. The collection will be exhibited next month to public view. The greatest depth explored was about 2200 fathoms. The trawl was mostly used. Life was plentiful everywhere. As was the case in the *Porcupine*, *Challenger*, and other expeditions of the same kind, many animals (especially Crustacea) at the greatest depths were highly and brightly coloured, some of them having large eyes, and others being blind or eyeless. There was an abundance of hitherto unknown forms (genera and species) in every department of zoology—fishes, Mollusca, Polyzoa, Crustacea, Annelids, Echinoderms, Polyps, Corals, Foraminifera, and Sponges. Among the Mollusca were some remarkable cases of the wide distribution of species in respect of space as well as of depth. For instance, boreal shells, such as *Fusus islandicus* and *F. berniciensis*, which inhabit northern seas at moderate depths, viz. 50 to 80 fathoms, were found living off the coast of Marocco, and the latter species even below the tropic of Capricorn, at depths of from 450 to 2200 fathoms. *Lima excavata*, considered a peculiarly Norwegian species, was likewise obtained off the Moorish coast, of a very large size; it was recorded by Prof. Seguenza as a Pliocene fossil of Sicily and Calabria, under the name of *Lima gigantea*. In the *Porcupine* Expedition of 1870 fragments were dredged off Cape St. Vincent; and in the *Challenger* Expedition this fine species was obtained from 10 to 175 fathoms off Western Patagonia and Japan. A bivalve (*Scrobicularia longicallus*), which in northern seas inhabits moderate depths, was procured in many places by the *Talisman*, at depths varying from 350 to 1429 fathoms. It occurred living in the deepest dredgings of the *Porcupine* Expedition of 1869, off the coast of Brittany, at a depth of 2435 fathoms. Many Mollusca (*e.g. Pecten vitreus, Limopsis minuta, Dentalium agile, Trochus ottoi, Columbella haliæeti*, and *Scaphander punctostriatus*) seem to inhabit the depths of the North Atlantic in every part, from one side to the other. The smaller shells in the *Talisman* collection have not yet been picked out. The Marquis de Folin will, with his usual care and industry, undertake that part of the work, which will occupy some time; he has requested me to examine and name those species which are known to me. I understand that another deep-sea expedition will be made by our enterprising neighbours next summer, being the fourth in consecutive years.[1]

December 21, 1883 J. GWYN JEFFREYS

THE SUN MOTOR AND THE SUN'S TEMPERATURE

THE annexed illustration (Fig. 1) represents a perspective view of a sun motor constructed by the writer, and put in operation last summer. This mechanical device for utilising the sun's radiant heat is the result of experiments conducted during a series of twenty years; a succession of experimental machines of similar general design, but varying in detail, having been built during that period. The leading feature of the sun motor is that of concentrating the radiant heat by means of a rectangular trough having a curved bottom lined on the inside with polished plates so arranged that they reflect the sun's rays towards a cylindrical heater placed longitudinally above the trough. This heater, it is scarcely necessary to state, contains the acting medium, steam or air, employed to transfer the solar energy to the motor; the transfer being effected by



Ericsson's Sun Motor, erected at New York, 1883.

means of cylinders provided with pistons and valves resembling those of motive engines of the ordinary type. Practical engineers as well as scientists have demonstrated that solar energy cannot be rendered available for producing motive power, in consequence of the feebleness of solar radiation. The great cost of large reflectors and the difficulty of producing accurate curvature on a large scale, besides the great amount of labour called for in preventing the polished surface from becoming tarnished, are objections which have been supposed to render direct solar energy practically useless for producing mechanical power.

The device under consideration overcomes the stated objections by very simple means, as will be seen by the following description:—The bottom of the rectangular trough consists of straight wooden staves, supported by iron ribs of parabolic curvature secured to the sides of the trough. On these staves the reflecting plates, consisting

[1] P.S.—In NATURE of December 20 (p. 172), I overlooked the misprint of India for Sweden.—J. G. J.

of flat window glass silvered on the under side, are fastened. It will be readily understood that the method thus adopted for concentrating the radiant heat does not call for a structure of great accuracy, provided the wooden staves are secured to the iron ribs in such a position that the silvered plates attached to the same reflect the solar rays towards the heater. Fig. 2 represents a transverse section of the latter, part of the bottom of the trough, and sections of the reflecting plates; the direct and reflected solar rays being indicated by vertical and diagonal lines.

Referring to the illustration, it will be seen that the trough, 11 feet long, and 16 feet broad, including a parallel opening in the bottom, 12 inches wide, is sustained by a light truss attached to each end; the heater being supported by vertical plates secured to the truss. The heater is 6¼ inches in diameter, 11 feet long, exposing $130 \times 9{\cdot}8 = 1274$ superficial inches to the action of the reflected solar rays. The reflecting plates, each 3 inches wide and 26 inches long, intercept a sunbeam of $130 \times 180 = 23{,}400$ square inches section.

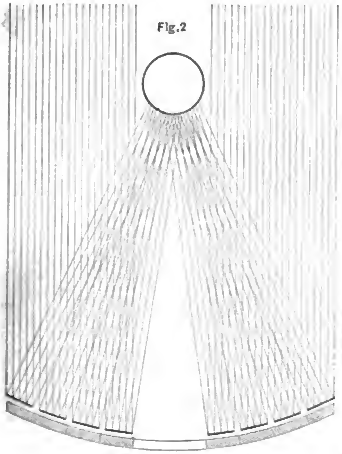


Fig. 2

The trough is supported by a central pivot, round which it revolves. The change of inclination is effected by means of a horizontal axle—concealed by the trough—the entire mass being so accurately balanced that a pull of five pounds applied at the extremity enables a person to change the inclination or cause the whole to revolve. A single revolution of the motive engine develops more power than needed to turn the trough, and regulate its inclination so as to face the sun, during a day's operation.

The motor shown by the illustration is a steam-engine, the working cylinder being 6 inches in diameter, with 8 inches stroke. The piston rod, passing through the bottom of the cylinder, operates a force-pump of 5 inches diameter. By means of an ordinary cross-head secured to the piston-rod below the steam cylinder, and by ordinary connecting rods, motion is imparted to a crank shaft and fly-wheel, applied at the top of the engine frame; the object of this arrangement being that of showing the capability of the engine to work either pumps or mills. It should be noticed that the flexible steam-pipe employed to convey the steam to the engine, as well as the steam chamber attached to the upper end of the heater, have been excluded in the illustration. The average speed of the engine during the trials last summer was 120 turns per minute, the absolute pressure on the working piston being 35 lbs. per square inch. The steam was worked expansively in the ratio of 1 to 3, with a nearly perfect vacuum kept up in the condenser inclosed in the pedestal which supports the engine frame.

In view of the foregoing, experts need not be told that the sun motor can be carried out on a sufficient scale to benefit very materially the sun-burnt regions of our planet.

With reference to solar temperature, the power developed by the sun motor establishes relations between diffusion and energy of solar radiation which show that Newton's estimate of solar temperature must be accepted. The following demonstration, based on the foregoing particulars, will be readily comprehended.

The area of a sphere whose radius is equal to the earth's mean distance from the sun being to the area of the latter as $214{\cdot}5^2 : 1$, while the reflector of the solar motor intercepts a sunbeam of 23,400 square inches section, it follows that the reflector will receive the heat developed by $\frac{23400}{214{\cdot}5^2} = 0{\cdot}508$ square inch of the solar surface. Hence, as the heater of the motor contains 1274 square inches, we establish the fact that the reflected solar rays acting on the same are *diffused* in the ratio of $1274 : 0{\cdot}508 = 2507 : 1$. Practice has now shown that, notwithstanding this extreme diffusion, the radiant energy transmitted to the reflector by the sun is capable of imparting a temperature to the heater of 520° Fahr. above that of the atmosphere. The practical demonstration thus furnished by the sun motor enables us to determine with sufficient exactness the minimum temperature of the solar surface. It also enables us to prove that the calculations made by certain French scientists indicating that solar temperature does not exceed the temperatures produced in the laboratory are wholly erroneous. Had Pouillet known that solar radiation, after suffering a *two-thousand-five-hundred-and seven-fold* diffusion, retains a radiant energy of 520° Fahr., he would not have asserted that the temperature of the solar surface is 1760° C. Accepting Newton's law that "the temperature is as the density of the rays," the temperature imparted to the heater of the sun motor proves that the temperature of the solar surface cannot be less than $520° \times 2507 = 1{,}303{,}640°$ Fahr. Let us bear in mind that, while attempts have been made to establish a much lower temperature than Newton's estimate, no demonstration whatever has yet been produced tending to *prove* that the said law is unsound. On the contrary, the most careful investigations show that the temperature produced by radiant heat emanating from incandescent spherical bodies diminishes inversely as the *diffusion* of the heat rays. Again, the writer has proved by his vacuum-actinometer, inclosed in a vessel maintained at a constant temperature during the observations, that for equal zenith distance the intensity of solar radiation at midsummer is 5°·88 Fahr. less than during the winter solstice. This diminution of the sun's radiant heat in aphelion, it will be found, corresponds within 0°·40 of the temperature which Newton's law demands. It is proposed to discuss this branch of the subject more fully on a future occasion.

The operation of the sun motor, it will be well to add, furnishes another proof in support of Newton's assumption that the energy increases as the *density* of the rays. The foregoing explanation concerning the reflection of the rays (see Fig. 2), shows that no augmentation of temperature takes place during their transmission from the reflector to the heater. Yet we find that an increase of the number of reflecting plates increases proportionably the power of the motor. Considering that the parallelism of the rays absolutely prevents augmentation of temperature during the transmission, it will be asked: What causes the observed increase of mechanical power? Obviously, the energy produced by the increased *density* of the rays acting on the heater. The truth of the Newtonian doctrine, that the energy increases as the density of the rays, has thus been verified by a practical test which cannot be questioned. It is scarcely necessary to observe that our computation of temperature—1,303,640° Fahr.—does not show maximum solar intensity, the following points, besides atmospheric absorption, not having been considered:—(1) The diminution of energy attending the passage of the heat rays through the substance of the reflecting plates; (2) the diminution consequent on the great amount of heat radiated by the blackened surface of the heater; (3) the diminution of temperature in the heater caused by convection. J. ERICSSON

A CHRISTMAS VISIT TO BEN NEVIS OBSERVATORY

ALTHOUGH I have no tale of perilous adventure or hair-breadth escape to tell the readers of NATURE, yet I think that they will be interested to hear of the progress that is being made in the first British attempt at the cultivation of high-level meteorology. This interest will be all the greater that the hearty encouragement and support that the Ben Nevis experiment has received from all parts of the United Kingdom has given it the character of a national undertaking.

As most of the readers of NATURE doubtless know, the observatory is at present in the experimental stage. A good road to the top with bridges and waterways has been made, and a part of the building erected sufficient to shelter the observers. It was judged wise to build as little as possible, until experience should have taught us the peculiar difficulties to be contended with in the somewhat novel circumstances presented by the summit of Ben Nevis in winter time. For, although several high level meteorological observatories, and indeed many other human habitations, already exist at much greater heights above the sea, yet there is probably no spot at present inhabited all the year round that presents climatic vicissitudes so remarkable. When winter is over, the directors will have a full report, with practical suggestions from the superintendent, Mr Omond, to guide them in their further operations. Still it was thought well that some of the governing body should see with their own eyes the state of the observatory, and the work of the observers during the cold season. Accordingly two of them (Mr. John Murray and myself) made a visit of inspection on December 26th, of which I propose to give a few particulars.

Accompanied by Mr. Maclean, the contractor for the road and observatory buildings, we started from Fort William about 9.30 on Wednesday morning. At first the sky was dark and gloomy, and it was thought that Ben Nevis was to give a specimen of his worst weather. It was not cold however; in fact it was oppressively warm during the first thousand feet of the ascent from the farm of Achantie where the new road begins. This, coupled with the fact that the pony which one of the party rode up the first 2500 feet of the hill somewhat forced the pace, made it a little uncomfortable for the two pedestrians. The newly made road, loosened by the frost, and sodden by the rain and melting snow, was in places very heavy. Up as far as the little lake (Loch an Meall aut Suidhe), however, the roadway had suffered no substantial damage, except that the fall of a large stone had carried away a small piece of the margin; and all the bridges and waterways were found in excellent condition. This is very satisfactory, for the snow has already been down to Fort William; and recently a very rapid thaw has carried it so completely away, that on the 26th very little was met with under 3000 feet. The test has thus been tolerably severe and yet up to 2600 feet or so the road on the 26th was in far better condition than it was on the day of the opening ceremony. About the altitude just mentioned, a part of the road had been badly ploughed up by a spate of water from the melting snow; higher up still, the damage seemed to be less, but it was not so easy to judge, as the roadway was there gradually lost in the overlying snow.

As the party rose in height, the temperature of the air and the ardour of the pony alike fell, and then the walkers were left to the full enjoyment of their climb. During the latter part of the first 3000 feet, the mist had been so thick that the pony and its rider could scarcely be discerned a few yards off; but several hundred feet higher, after the road had been finally lost sight of in the snow, and all the party were on foot, we suddenly emerged about noon from the gloom of the mist into the brightest of daylight. Overhead the sky was blue, a fresh light breeze was blowing, and the reflected sunlight was shining in silvery masses on the undulating surface of the frozen snow. We soon reached Buchan's Well, the position of which had been marked by a wooden pole; but the well itself was completely hidden by a deep snow-drift, which filled the hollow in which it lies. From this spot to the top, the ascent was made almost straight over the snow. At times it was steep and slippery, but the surface was so hard that we rarely sank over the ankles. Two of us were rough shod, one having a few cricketer's spikes screwed to the soles of his boots, the other a pair of *steigeisen* (climbing irons), the use of which he had learned several years ago during some excursions in the Tyrolese Alps. Mr. Maclean, who had not taken these precautions, fell once or twice, but fortunately without being hurt in any way. When near the last slope we descried Mr. Omond hacking away most assiduously with an ice-axe to prepare a way for us, a needless precaution as far as the rough-shod members of the party were concerned.

The view from the plateau on the summit was magnificent. All round there floated a billowy ocean of white mist, from which rose masses of the same, piled up in places like mountain ranges, and through which rose here and there black mountain peaks (prominent among these Schiehallion). Away towards Fort William was stretched a black curtain of mist in striking contrast with the snow-whiteness of the upper layer. Down in Glen Nevis a similar mass was seen, rolled and twisted by the air-currents into the most fantastic shapes. So grand was the spectacle that one of our party insisted that we had before us the model from which Dante had drawn his vision of the entrance to hell.

The summit reached, the directors naturally looked around for the building, whose site they had chosen some five months before, and upon whose construction they had expended so much anxious thought. There was, however, nothing to be seen but two small dark-looking stumps rising a little over the surrounding snow-flat, and alongside of these a little mound of snow. The stumps turned out to be the chimney and ventilator on the roof of the observatory, and the mound was a portico built by the observers with blocks of frozen snow to protect a snow staircase which had been carried down the side of the house to the doorway. After descending under the translucent canopy and stumbling for a little in the unfamiliar darkness of the passage, we entered the main room of the observatory, which for the present serves as sitting-room, kitchen, and office combined. Here we found the table laid for our lunch; and very soon we were comforting ourselves with hot coffee, cabin biscuits, and excellent Danish butter from the stores of the establishment. The whole ascent had occupied a little over three hours and a half.

The little room in which we sat contained the American stove which heats the whole observatory, and on which the snow melting and all the cooking is done by John Duncan, the second assistant observer and housemaid. On one of the walls is the combined sideboard and crockery and instrument cupboard; against another stands a small bench with a vice; and on a third is the telegraph instrument, Mr. Omond's desk and book-case, and the drawers in which are kept the records of the observatory. Out of the sitting-room open the three bedrooms for the observers, which resemble very closely the cabins on board a ship; indeed the whole establishment has an intensely nautical air about it, and the visitor steadies himself instinctively now and then, and wonders that the roll never comes.

The rest of the building is occupied with a coal and oil store, and a storeroom in which are kept the cabin biscuits, dried potatoes, tinned soups, meat, and vegetables, lime juice, and medicine chest; which Mr. Omond calculates will support the three observers till June.

The afternoon and evening we spent in watching the observers at work, in dining (which we did very comfortably off the Christmas cheer, viz. roast turkey and plum pudding, provided for the inhabitants of Ben Nevis by a thoughtful friend), and in eager discussion of plans for the present and future work of the Observatory. The routine of the observatory at present consists in hourly observations of the barometer, protected thermometers, dry and wet bulb and maximum and minimum, wind-direction and pressure, rain, snow, sleet or hail, mist, fog or haze, clouds lower and upper, amount, species, and direction, sunshine recorder, miscellaneous, thunder, lightning, haloes, auroræ, meteors, &c., nature and precise time of occurrence of. The self-registering barograph and thermograph now added to the collection of instruments are working very well, and will be invaluable for the record of sudden changes. The protected thermometers and the thermograph are attached to a ladder fixed in the snow. As the level of the snow rises and falls, they are moved from step to step, so as to keep them as nearly as possible to the regulation distance of four feet from the surface. A measurement from the top of the ladder to the surface gives the depth of the snow, which at present varies from six to ten feet at different parts of the summit of the mountain.

Any detailed account of the winter climate of Ben Nevis would be premature and out of place in this notice; but Mr. Buchan has kindly furnished me with an analysis of the meteorological phenomena on Christmas and the following day which were in several respects remarkable.

At 1 A.M. of Christmas day, temperature was 37°o from which it steadily fell to 31°·5 at 11 A.M., the air all the time being quite saturated and loaded with dark, gloomy mist, with a barometer steadily rising. The wind was moderate from north-west till 3 A.M., when it changed to west-south-west. About noon the mist pall cleared away and the sun shone out with great splendour. From this hour to midnight, the following most remarkable observations were made (see table).

Except a few cirrus clouds which appeared about one, three, four, and ten o'clock, the sky was cloudless throughout, and during the evening the stars sparkled with unwonted brightness in the dark blue sky.

These remarkable atmospheric conditions were strictly confined to the higher region of Ben Nevis. Fog or cloud covered the lower hills and filled the valleys all the afternoon; it rose sometimes as high as the "plateau of storms," but was mostly below 3000 feet on Ben Nevis, and during the time no other hill showed itself through the sea of cloud. The sunset of the 25th, as well as the sunrise of the 26th, was very beautiful. On the 26th pressure remained high and steady, wind south-westerly, sky generally clear, and temperature and humidity equally

	Barom.	Therm.		Humidity.	
	Inches.	Dry.	Wet.	Calculated.	Air Hygrometer.
Noon	25·822	33°·0	31°·9	88	—
1 P.M.	·834	36°·9	33°·4	70	86
2 ,,	·824	37°·6	33°·1	66	76
3 ,,	·823	40°·9	31°·8	45	64
4 ,,	·819	37°·7	30°·8	50	71
5 ,,	·818	39°·8	31°·8	47	60
6 ,,	·817	40°·0	32°·8	50	56
7 ,,	·811	39°·3	32°·2	51	57
8 ,,	·813	38°·4	32°·1	53	64
9 ,,	·812	32°·8	31°·7	87	77
10 ,,	·813	38°·8	34°·7	69	63
11 ,,	·804	37°·0	36°·1	92	65
Midnight	·809	38°·9	38°·5	97	62

remarkable as on the preceding day. Indeed at 2 P.M. the relative humidity, which was lower than could be calculated from Glaisher's Tables, was only 34. At 3 P.M. temperature had fallen 6°·9, humidity risen to 96°, and a light fog prevailed for the next four hours, the wind having shifted from south-west to west-north-west. About 7 P.M. the sky again cleared, temperature steady, rose from 28°·0 to 36°·0 at midnight, and a humidity as low as 67 was observed. The great significance of these observations on Ben Nevis will be more apparent when compared with the anticyclone which overspread so large a part of north-western Europe at the time, to which, being situated on its west side, we owed the mild weather of Christmas, 1883.

In addition to the hourly observations, the observers have had for some time back to conduct a constant warfare with the rapidly-accumulating snow. Every now and then all hands had to be turned out to clear the doors and windows of the observatory; and it sometimes happened that, when they went out for this purpose, the snow drifted in so rapidly that it was almost impossible to shut the door again. The device of the snow staircase got over the difficulty to a large extent as regards the door, and it is proposed to build tubes with short lengths of rectangular wooden framework, passing from the windows up to the surface of the snow. At the upper end of these will be placed, at night or during heavy snowfalls, light canvas doors, which can be afterwards removed and additional lengths of framework added according to necessity. The chimney will be lengthened in a similar way by means of iron tubes, which have been sent up for the purpose. In this way the difficulties of the present winter will be met. For the future it is proposed to get over the difficulty of the accumulating snow by building an observing tower at some little distance from the living-rooms. In this tower there will be several stories with doors to the four cardinal points of the compass, so that the observers may use for exit and entrance that story which is nearest the snow level, and that door which happens to be on the lee-side of the tower. In the ground-floor of this tower it is proposed to place a seismometer and self-registering magnetic instruments. On the roof will be placed an anemometer for measuring the direction and strength of the wind. It is proposed so to arrange this instrument that its indications can be read inside the tower. This appears to be essential, for during the storm on the 12th ult. it was found impossible to go outside the observatory, so that wind observations are wanting in the daily sheet on that very interesting occasion. The observing-tower will be connected with the rest of the buildings by a covered way of some length fitted with doors to cut off the hot air; and in all probability the accommodation of the observatory will be increased by the addition of an office, or experimenting room, and one or more small bedrooms for the use of inspectors or others on temporary business, and for the convenience of scientific men who may wish to make a visit to the observatory for the purposes of scientific research.

For reasons sufficiently explained, the staff has scarcely had time as yet to go beyond the mere routine of observations above mentioned; but none of the valuable suggestions which Mr. Omond and the directors have received have been lost sight of. A beginning has already been made in the collection of meteoric dust; in fact Mr. Murray carried down with him a portion of the residue obtained by melting considerable quantities of surface snow. This is now being examined, and we shall doubtless hear by and by whether it is all of purely local, or partly of volcanic or cosmic origin.

It is intended, as soon as proper arrangements can be made, and the concurrence of the Post Office authorities obtained, to commence a series of simultaneous observations on earth currents along the cable from the summit of Ben Nevis to Fort William, and along a telegraph line from Fort William to some other station not far above sea-level. By means of this horizontal and vertical exploration we hope to obtain some interesting data (either positive or negative) regarding the origin of the variations of terrestrial magnetism, auroræ, &c. The cable will also be turned to account for observations on atmospheric electricity. These plans are mentioned partly to show that the directors are fully alive to the manifold uses to be made of their stronghold upon Ben Nevis, partly to incite scientific men generally to favour us with their suggestions for the full utilisation of the observatory, not only for meteorology, but for physical science in general.

It would take too long to dwell at length on all the interesting casual observations recorded in Mr. Omond's log, a detailed account of which will probably be given hereafter by Mr. Omond himself. It may be interesting, however, to allude to the frequently occurring phenomenon which he calls "Glories." The shadow of the head or hands of the observer is frequently seen on the clouds in the valley to the north-east surrounded by a halo of colour. The phenomenon appears to be akin to, or identical with, the mist phantom so well known under the name of the "Brocken Spectre." The occurrence of this phenomenon is by no means so rare in this country as many suppose. The writer of this notice saw it to perfection three years ago in Skye. A party of four or five of us were standing on Sgur-na-Panachtich, one of the Cuchullin peaks; we were looking down on the dark rock basin of Coruisk, in which was floating a cloud of mist. The sun was low behind us; and, projected on the mist, we saw what appeared to be gigantic dark shadows of ourselves completely outlined with a glory of rainbow colours. Each could see his own spectre best, but also those of his neighbours more or less distinctly. The figures imitated every motion we made, and, when we whirled our alpenstocks over our heads, the antics of the phantoms were most weird and awe-inspiring.

We spent the night of the 26th at the Observatory. During the first watch, that is, up to about one o'clock in the morning, we sat up, and went out with the observer when he made his hourly observations. The air felt quite mild, although the temperature was about the freezing point; the sky was perfectly clear, and the stars shone brilliantly. Mr. Omond brought out his telescope, and we lay down on the snow and examined Jupiter and his satellites, filled our eyes with the beauties of the Pleiades, and exhausted our little stocks of astronomical knowledge by naming such constellations as we happened to know.

The staff had insisted on providing each of us with a bed; we thus had good opportunity of testing their sleeping accommodation, which turned out to be excellent. Next morning we rose to see the sun rise, and were richly rewarded. About eight o'clock a ribbon of bright crimson appeared behind Schiehallion, which deloped a gorgeous succession of tints ending in copper colour and brick red, under the gradually rising sun; to right and left appeared the peculiar green colours so marked in the recent remarkable sunsets, to which the Ben Nevis sunrise showed a great resemblance. The greater part of the horizon was clear, and we had a view of the surrounding mountains seldom, if ever, equalled in summer time for beauty of colour. Ben More, the range of Glencoe, the Perthshire Hills, the whole length of the Caledonian Canal, the Cuchullin Hills, could all be seen with perfect distinctness. The white snow on the black-blue hilltops, and the bright red of the withered heather and bracken lower down, afforded contrasts of colour to be seen at no other season. Some of the hillsides shone in the sunlight like bronze. Others glowed like the richest velvet, and the valleys were filled with the subtle blue haze that gives such a charm to the scenery of the west of Scotland.

We naturally congratulated Mr. Omond on the weather he enjoyed on Ben Nevis; but it appeared that the treat was as great for him as for us. Since he began his seclusion on November 11, there had been just three fine days —the day on which he went up, Christmas day, and the day following, all the rest of the time the most he had seen was an occasional glimpse of a snow-covered mountain-peak through a hole in the mist. Our good fortune had been great; and, although it might have suited the main purpose of our visit better to have been detained by mist and sleet, or to have seen the observatory in the process of being buried in a snow-drift, we resigned ourselves with a very good grace to what the Fates had sent us.

After sharing the regulation breakfast of tinned mutton and coffee, we went out once more to see the observers at work. We then had an opportunity of seeing the precautions which they find it necessary to take in tempestuous weather when they have occasion to go near the edge of the narrow plateau on which they live. For sanitary reasons it is necessary to carry all the refuse of the observatory to a considerable distance, where it is thrown over a cliff. In winter, when this cliff is covered with a treacherous cornice of slippery snow, and the wind blows so hard that the head of a meat tin thrown to windward is often carried right back to leeward of the mountain, the footing at the edge is anything but secure. On such occasions two of the observers go abreast with the pail of rubbish between them, and each is roped to one who goes behind with an ice-axe to steady him in case of accident.

By 11 o'clock the barometer had begun to fall, and the humidity of the air had greatly increased. Mr. Omond therefore warned us that, unless we were prepared to incur the risk of detention, we had better depart. Accordingly we packed up our trophies, consisting of the residue above mentioned, pregnant with the potentiality of cosmic and volcanic dust, a bundle of Mr. Omond's daily sheets, and a little shrew that had been killed on the previous evening, the first of a colony of these animals who, with several weasels, had taken up their abode in the outer dry stone wall of the observatory. As might be expected, animal life is very scarce in winter on the top of Ben Nevis. No deer or ptarmigan had been seen, only the tracks of foxes, which abound in certain parts of the hill. The only living things we had seen in the snow-covered part of the hill were large numbers of a dipterous fly, which we found every now and then crawling on the surface of the snow.

Having bidden farewell to Mr. Omond and his companions, and wished them good luck and a continuance of their present good health and spirits during the rest of the winter, we commenced our descent at 11.30. The bottom was reached, after several halts to enjoy the magnificent view, in about the same time as it had taken us to ascend.

In such weather as we had the ascent of Ben Nevis is decidedly more pleasant and less fatiguing than in summer. It is well, however, to warn the readers of NATURE that our case was exceptional, and that under adverse circumstances such an enterprise is likely to be both unpleasant and dangerous. G. CHRYSTAL

THE REMARKABLE SUNSETS

INFORMATION with regard to these beautiful phenomena and their cause is rapidly being collected, and at the same time the opinions of those who have given most attention to them are being stated, both here and on the Continent. Among the latter we may refer to a memoir presented by Prof. Forel to the Société Vaudoise des Sciences Naturelles, on the 19th of December. At the beginning of the displays in Switzerland, M. Forel ascribed them to those causes which produce the ordinary after-glow so beautifully visible in mountainous countries, and at first he considered that the meteorological conditions were such as to favour this view. Further inquiry, however, he now states has made this hypothesis absolutely untenable. One of his arguments is that the glows which first appeared in November and then decreased to 3rd December, regained a maximum on the 24th and 25th. Now from the 22nd to 26th December, Switzerland was the centre of a maximum of atmospheric pressure, the barometer being higher there than in any of the surrounding countries. Exactly the opposite held in November, and this confirms him in the idea that meteorological factors alone do not suffice to explain the glows. He also describes the dates and tracts of the chromatic phenomena observed, and considers that their origination in Krakatoa is a simple and sufficient explanation. *La Nature* for the 29th ult. contains an interesting communication from M. Van Sandick, an Engineer des Ponts et Chaussées, at Pedang, who was an eye witness of the later stage of the eruption. He was on board the *Governor-General Loudin*, and was close to Krakatoa on August 26th. His communication is accompanied by a very detailed map, showing the changes which have supervened not only in the Straits themselves, but also on the neighbouring coasts of Java and Sumatra, but we shall return to this important letter.

The new observatory on the summit of Ben Nevis has been utilised for the collection of snow, with a view of determining whether or not it contains any dust particles. This has been forwarded to Mr. John Murray of the *Challenger* Commission by Mr. Omond the superintendent of the observatory. We may hope to hear soon whether the results are positive or negative on this special point of inquiry. We have to call attention to the important letter of Mr. Macpherson published below. We learn from the *Weekly British Colonist*, published at Victoria, British Columbia, that the sunsets made their appearance there on November 27th. Long after sunset the light in the sky became more fervent in colour, till at last the waters in the harbour and straits borrowed the splendid crimson. Darting and rapidly moving blood-red rays of light were seen shooting far into the sky, suggesting an aurora. A letter from St. Raphael, on the shores of the bay of San Francisco, dated December 4th, refers to the magnificent sunrises and sunsets. The date of their commencement is not stated. From Kiakhta, on the Mongolian frontier, we learn that the glows there began on December 11th, and terminated on the 25th.

The glows were seen some time before November 6th at Kalim Pong, twenty miles north-west of Darjeeling.

We have received the following further communications on this subject:—

THE body of evidence now brought in from all parts of the world must, I think, by this time have convinced Mr. Piazzi Smyth that the late sunrises and sunsets do need some explanation, more particular than he was willing to give them. With your leave I should like to point out from my own observations and those of others that, "given a clear sky" and the other conditions put by Mr. Smyth, the sunrises and sunsets of other days, however bright and beautiful, have *not* given any such effects as were witnessed, to take an instance, here on Sunday night, December 16th. I shall speak chiefly of the sunsets.

(1.) *These sunsets differ from others, first in their time and their place or quarter.* Sunset proper is, I suppose, the few minutes between the first dipping and the last disappearance of the sun's disk below the true horizen; the pageant or phenomena we call sunset, however, includes a great deal that goes on before and after this. The remarkable and specific features of the late sunsets have not been before or at sunset proper; they have been after-glows, and have lasted long, very long, after. To take instances from your number of the 13th ult., Mr. F. A. R. Russell notices that on November 28th, the sun having set at 3.55, one after-glow lasted till 5.10, and was then succeeded by another "reaching high above the horizon." The day before he mentions the after-glow as lasting to 5.20. On the 29th a "foreglow" is reported as seen in London from 5.30 to 7.30, that is more than two hours before sunrise, which was at 7.43. On December 1st, sunset being at 3.53, Mr. Russell observed an after-glow till 5.35; on December 4th the first dawn at 6.5, the sun rising at 7.50; the next day dawn at the same time, sunrise 7.51; that evening, sunset being at 3.50, he observed not a glow only but "spokes of rays from the glowing bank" at 4.45, thatis to say, sunbeams, visible in the shape of sunbeams, 55 minutes after sunset. Mr. Johnston-Lavis speaks of the after-glow at Naples as *at a maximum* an hour after sunset Here at Stonyhurst on December 16th, the sun having set at 3.49, the glow was observed till 5.50. Now winter dawns and after-glows do not last from an hour to two hours, and still less so day after day, as these have done. The recent sunrises and sunsets then differ from others in duration.

They differ also in the quarter of the heavens where they are seen. The after-glows are not low lingering slips of light skirting the horizon, but high up in the sky, sometimes in the zenith.

I have further remarked that the deepest of the after-glow is in the south, whereas the sun below the horizon is then northing. I see that other observers take notice of the same.

(2) *They differ in their periodic action or behaviour.* The flushes of crimson and other colours after ordinary sunsets are irregular, not the same nor at the same time for two days together; for they depend upon the accidental shapes and sizes and densities of the cloud-banks or vapour-banks the sun is entering or freeing himself from, which vary and can never be alike from day to day. But these glows or flushes are noticed to be periodic before sunrise and after sunset. Mr. Russell furnishes exact estimates of the intervals of time, which he finds to be the same day after day.

(3) *They differ in the nature of the glow, which is both intense and lustreless*, and that both in the sky and on the earth. The glow is intense, this is what strikes every one; it has prolonged the daylight, and optically changed the season; it bathes the whole sky, it is mistaken for the reflection of a great fire; at the sundown itself and southwards from that on December 4, I took a note of it as more like inflamed flesh than the lucid reds of ordinary sunsets. On the same evening the fields facing west glowed as if overlaid with yellow wax.

But it is also lustreless. A bright sunset lines the clouds so that their brims look like gold, brass, bronze, or steel. It fetches out those dazzling flecks and spangles which people call fish-scales. It gives to a mackerel or dappled cloudrack the appearance of quilted crimson silk, or a ploughed field glazed with crimson ice. These effects may have been seen in the late sunsets, but they are not the specific after-glow; that is, without gloss or lustre.

The two things together, that is intensity of light and want of lustre, give to objects on the earth the peculiar illumination which may be seen in studios and other well-like rooms, and which itself affects the practice of painters and may be seen in their works, notably Rembrandt's, disguising or feebly showing the outlines and distinctions of things, but fetching out white surfaces and coloured stuffs with a rich and inward and seemingly self-luminous glow.

(4) *They differ in the regularity of their colouring.* Four colours in particular have been noticeable in these after-glows, and in a fixed order of time and place—orange, lowest and nearest the sundown; above this, and broader, green; above this, broader still, a variable red, ending in being crimson; above this a faint lilac. The lilac disappears; the green deepens, spreads, and encroaches on the orange; and the red deepens, spreads, and encroaches on the green, till at last one red, varying downwards from crimson to scarlet or orange fills the west and south. The four colours I have named are mentioned in Lieut. G. N. Bittleston's letter from Umballa: "The sun goes down as usual and it gets nearly dark, and then a bright red and yellow and green and purple blaze comes in the sky and makes it lighter again." I suppose the yellow here spoken of to be an orange yellow, and the purple to be what I have above called lilac.

Ordinary sunsets have not this order; this, so to say, fixed and limited palette. The green in particular, is low down when it appears. There is often a trace of olive between the sundown and the higher blue sky, but it never develops, that I remember, into a fresh green.

(5) *They differ in the colours themselves, which are impure and not of the spectrum.* The first orange and the last crimson flush are perhaps pure, or nearly so, but the two most remarkable glows, the green and the red, are not. The green is between an apple-green or pea-green (which are pure greens) and an olive (which is a tertiary colour): it is vivid and beautiful, but not pure. The red is very impure, and not evenly laid on. On the 4th it appeared brown, like a strong light behind tortoiseshell, or Derbyshire alabaster. It has been well compared to the colour of incandescent iron. Sometimes it appears like a mixture of chalk with sand and muddy earths. The pigments for it would be ochre and Indian red.

Now the yellows, oranges, crimsons, purples, and greens of bright sunsets are beautifully pure. Tertiary colours may of course also be found in certain cases and places.

(6) *They differ in the texture of the coloured surfaces*, which are neither distinct cloud of recognised make nor yet translucent mediums. Mr. Russell's observations should here be read. I have further noticed streamers, fine ribbing or mackerelling, and other more curious textures, the colour varying with the texture.

In ordinary sunsets the yellows and greens and the lower reds look like glass, or coloured liquids, as pure as the blue. Other colours, or these in other parts, are distinct flushes or illuminations of cloud or landscape.

I subjoin an account of the sunset of the 16th, which was here very remarkable, from my own observations and those of one of the observatory staff.

A bright glow had been round the sun all day and became more remarkable towards sunset. It then had a silvery or steely look, with soft radiating streamers and little colour; its shape was mainly elliptical, the slightly longer axis being vertical; the size about 20° from the sun each way. There was a pale gold colour, brightening and fading by turns for ten minutes as the sun went down. After the sunset the horizon was, by 4.10, lined a long way by a glowing tawny light, not very pure in colour and distinctly textured in hummocks, bodies like a shoal of dolphins, or in what are called gadroons, or as the Japanese conventionally represent waves. The glowing vapour above this was as yet colourless; then this took a beautiful olive or celadon green, not so vivid as the previous day's, and delicately fluted: the green belt was broader than the orange, and pressed down on and contracted it. Above the green in turn appeared a red glow, broader and burlier in make; it was softly brindled, and in the ribs or bars the colour was rosier, in the channels where the blue of the sky shone through it was a mallow colour. Above this was a vague lilac. The red was first noticed 45° above the horizon, and spokes or beams could be seen in it, compared by one beholder to a man's open hand. By 4.45 the red had driven out the green, and, fusing with the remains of the orange, reached the horizon. By that time the east, which had a rose tinge, became of a duller red, compared to sand: according to my observation, the ground of the sky in the east was green or else tawny, and the crimson only in the clouds. A great sheet of heavy dark cloud, with a reefed or puckered make, drew off the west in the course of the pageant: the edge of this and the smaller pellets of clond that filed across the bright field of the sundown caught a livid green. At 5 the red in the west was fainter, at 5.20 it became notably rosier and livelier; but it was never of a pure rose. A faint dusky blush was left as late as 5.30, or later. While these changes were going on in the sky, the landscape of Ribblesdale glowed with a frowning brown.

The two following observations seem to have to do with the same phenomena and their causes. For some weeks past on fine bright days, when the sun has been behind a big cloud and has sent up (perspectively speaking) the dark crown or paling of beams of shadow in such cases commonly to be seen, I have remarked, upon the ground of the sky, sometimes an amber, sometimes a soft rose colour, instead of the usual darkening of the blue. Also on moonlight nights, and particularly on December 14, a sort of brown or muddy cast, never before witnessed, has been seen by more than one observer, in the sky. GERARD HOPKINS

Stonyhurst College, December 21, 1883

THE remarkable phenomena after sunset which, according to NATURE, were seen in the second half of November in England, Italy, at the Cape, and a little earlier in many parts of Asia, could be observed almost all over Austria and Germany. I saw them myself in an especially distinct appearance here on November 22 and 29. Soon after sunset on November 22 (at 4.30 p.m.), a crimson glow was seen in the direction of south-west, and while everybody was supposing that some large printworks lying in that direction were on fire, the glow was getting more intense, and at 5 p.m. the whole of the western sky assumed a bluish purple hue which rose up to the zenith while the sun was sinking lower, so that the glow could be attributed only to an atmospheric phenomenon. About an hour after sunset the colour of the sky was almost violet, with which the phenomenon disappeared.

According to German papers, a phenomenon of this kind and intensity was never before observed in Central Europe. Dr. Assmann, director of the Meteorological Observatory, Madgeburg, attempts to explain these phenomena by the reflection of sunlight from the upper strata of our atmosphere, highly saturated with aqueous vapour, owing to its comparatively high temperature. The phenomenon could not be attributed to electrical causes, as at that time not the slightest magnetic disturbance could be observed at the Prague Observatory. In the spectrum of this light uncommonly strong "rain bands" were seen. As the sun was about 18¾° below the horizon when the phenomena began (before sunrise) or ceased (after sunset), the reflection was calculated to have taken place at a height of about fifty English miles.

Does it not strike you that the glow was observed at earlier periods the more we advance towards the east—the source of the late Java eruptions? B. BRAUNER

Bohemian University, Prague, December 18, 1883

THE late splendid sunsets which have so vividly attracted the attention of men of science and of the general public were so remarkable and of so long a duration in the clear atmosphere of the Castilian tableland, where sunsets are usually dull, that they have not failed to impress observers with the notion that they were due to other causes than those of common atmospheric refraction and reflection.

When the phenomena had already lasted four or five days, I read Mr. Symons' letter, published in the *Times* of the 1st inst., and I thought that possibly evidence might be obtained towards the confirmation of this theory if the sediment of fresh-fallen snow was thoroughly investigated; for if the dust of Krakatoa was really reflecting in the higher regions of the atmosphere the sun's rays, some of it must necessarily be descending towards the earth.

Luckily on the 7th of this month, and when the phenomenon was at its height, and had already lasted for about eight days, there was a fall of snow at Madrid, of which I naturally profited, submitting it to a thorough investigation, the results of which, I think, will throw some light on so remarkable a phenomenon.

The snow analysed was obtained from what had fallen on some zinc plates before the exposed windows to the north of my house, which is situated at the extreme north end of the town, where there are no buildings facing it, and also from what my friend Dr. Francisco Quisoga gathered from the windows of his house, situated about a mile to the south-east of mine; and in both the same substances were found.

The snow yielded about a litre of water, which, when the sediment had collected, was decanted, and the solid part dried at a temperature below that of boiling water. The dry powder was then tested for magnetism and it was found to be extremely magnetic. It was then incinerated on platinum foil to a bright red heat so as to destroy organic substances, and the remaining dust was then submitted to microscopical investigation. The greater part of it is made up of what probably is the natural dust of the atmosphere of Madrid; of particles of mica, generally brown, and similar to that of the Guadarrama range, and in various states of decomposition, splinters of quartz and felspar, the greater part of it orthoclase, some small fragments of tourmaline, magnetic iron, and fragments of diatoms. Besides these mineral substances, which may probably be traced to the rocks forming the vicinity of the capital, some others were found for the presence of which it is difficult to account. The most remarkable are small particles of a foliated mineral of a yellowish colour, perceptibly dichroic, and which between crossed Nichols is extinguished when the cleavage traces are parallel to the principal section of the polarising Nichol; the interference colours being of bright blue, and red, and yellow colours. Treated by boiling hydrochloric acid for twenty minutes, not a trace of action was perceived. These characters are all referable to a rhombic pyroxene, and judging from its dichroism this substance may be taken for a hypersthene, which has besides a most striking resemblance to volcanic hypersthene. In addition to this mineral, small particles are found which appear to be referable to common pyroxene of a yellowish colour, of active action in polarised light, and the extinction not taking place parallel to what seem to be the edges of the prism. Besides these minerals some corpuscles are found of hardly any action on polarised light, and sometimes full of globular concretions and other kinds of microliths, which, if seen in products of a volcanic region, I would not hesitate in considering of volcanic origin.

These are the principal substances which an investigation of the sediment of the snow which fell in Madrid on the 7th inst. have revealed, and though I am far from asserting that what appears to be foreign to the atmosphere of this part of the world is referable to the dust of Krakatoa, if further analyses in other parts of the world should show these same substances floating in the atmosphere, there would be powerful reasons for inferring that the gorgeous sunsets of the past months have been brought about in consequence of that stupendous display of the volcanic forces of our globe.

It is already a remarkable coincidence that hypersthene should have been found both by MM. Daubrée and Renard in their respective analyses of the ashes collected in the vicinity of Krakatoa. JOSEPH MACPHERSON

Madrid, December 22, 1883

COMPLYING with the request contained in your "Notes" of December 13 (p. 157), I would say that the appearances, already fully described by so many of your correspondents, commenced here on December 1. On that day I made an entry in my note-book as follows:—"Perfectly calm at sunset, with a light haze of a rose tint rolling away from overhead towards the west-south-west horizon. The colours of the sky were a very pale green, red, gold, and pink; and, as the light faded away, the south-west was one mass of deep rich red. The crescent moon (a little over eighteen days old) in the refractor was of a pale green colour, and the bright limb seemed to extend to an extraordinary distance round the dark body. Barometer falling."

Again: "December 2.—Sky clouded over by 1 p.m. Sunset, as seen between breaks in the clouds, was again of a deep rich red. Barometer steady."

"December 3.—Rainy and very dull. Barometer steady."

"December 4.—Sunset, as seen through the clouds along the horizon, was again of a deep red colour, gradually shading off into a pale rose tint towards the zenith. The moon, Fomalhaut, and Vega seemed to float in a pale rose sea; whilst thin fleecy clouds as they drifted across the moon's face were of a beautiful pale green. This appearance—as did that on the 1st—lasted for about an hour and a quarter after sunset; the rest of the sky being covered with clouds, some faintly reflecting the various tints. Barometer falling."

I should not omit to mention that the sunrises were also, more or less, of similar character. Since the 4th we have had very bad weather; gales from both north and south, heavy rains, and snow. Yet the sky, when occasionally glimpsed at sunset, seems to bear traces of the same appearances. W. E. J.

Constantinople, December 21, 1883

IN addition to the remarkable sunsets which have led to such a large amount of correspondence in NATURE and elsewhere, there is another and possibly a related phenomenon to which my attention has been directed during the last few weeks. From country friends I learn that the nights, in the absence of the moon, and even when cloudy, have been remarkably light for the time of year. I cannot profess to have witnessed this phenomenon myself, living as I do in the midst of London, where the perpetual glare of gas renders any satisfactory estimate of the atmospheric luminosity quite hopeless. It would be interesting, however, to learn whether other observers more favourably located have noticed this effect. It occurred to me that the phenomenon might perhaps be connected with the volcanic dust theory of the sunsets, being, in fact, a result of the slight phosphorescence of this dust. Whether the latter exhibits any degree of phosphorescence could be readily determined by those who are fortunate enough to possess a specimen, by means of Becquerel's phosphoroscope.

R. MELDOLA

21, John Street, Bedford Row, W.C., Dec. 31, 1883

IN corroboration of what Messrs. Beyerinck and Van Dam noticed at Wageningen in connection with the late storm, I write to tell you that on the morning of December 12, after the heavy rain which accompanied the gale had ceased, the windows of my house, which is isolated and exposed, were covered with a grayish sediment, just as your correspondents describe it. It will be interesting, now that attention has been drawn to the fact, to know if the phenomenon, the result no doubt of dust brought down by the rain, has been observed elsewhere.

F. M. BURTON

Highfield, Gainsborough, December 24, 1883

I SUBMIT to you two slides of dust from windows, deposited during the storm of December 12. When the contained salt crystals are dissolved by adding distilled water, the appearance much resembles that recorded in NATURE of December 20. The material, scraped from windows cleaned just before the storm, where the original drop-marks are still unaltered, was put on the cleaned slides, and a drop of distilled water added. Should my surmise be confirmed, and any of your readers desire to have specimen slides, I would forward a limited number on receipt of sixpence each to cover postage and trouble. Descriptions I have received from America, either in letters or newspaper cuttings, show an identical sequence of appearances. At Poughkeepsie, on the Hudson, the fire engines were called out on the morning of November 27, and "this spectacle has been witnessed every clear evening for several days past, generally between a quarter past five and six o'clock." A letter from Dorset, Vermont, November 29, describes "a very unusual exhibition in the skies for the past three or four evenings. It has been clear, and the colouring intense, from flame to a delicate pink, and the clouds off at a distance would look light green. . . . It gave an impression of an intense fire the other side of the West Mountains, and colouring the entire sky."

J. EDMUND CLARK

York, December 22, 1883

THE accompanying extract may be of service to you. Sapporo is in the northernmost island of Japan (Yeso), in lat. 43° N., and long. (*circa*) 141° E. As the telegraph ramifies through all parts of Japan, it is improbable that any considerable local eruption would have taken place to account for the phenomenon without news of it having also reached the *Official Gazette*.

ROBERT BEADON

11, Lee Park, Lee, Kent, December 14, 1883

Extract from *Japan Weekly Mail* (published in Yokohama) of October 20, 1883. (The *Official Gazette* is the Government gazette published in Japanese.)—"The *Official Gazette* states that, since the 13th inst., a constant haze has pervaded the atmosphere of Sapporo, and that the sun and moon are of a blood red colour. Clouds of ashes fall continuously. The phenomenon is ascribed to some volcanic eruption."

NOTES

PROF. OWEN has received the honour of K.C.B. as an acknowledgment of his eminent services for sixty years to science and the public interests.

PROF. W. H. MACKINTOSH has been elected to the Professorship of Comparative Anatomy in Trinity College, Dublin, vice Prof. Macalister, F.R.S., who resigned on his appointment to the Anatomy Chair at Cambridge.

BY the death of the well-known mathematician, the Rev. W. Roberts, M.A., the Rev. Richard Townsend, M.A., F.R.S., becomes a Senior Fellow of Trinity College, Dublin, thereby vacating the Professorship of Natural Philosophy held by him since 1870.

THE vacancy in the Professorship of Geology and Mineralogy in the University of Dublin has been filled by the election of Prof. Sollas, of University College, Bristol. This appointment will give great satisfaction, and will afford Mr. Sollas large opportunities for palæontological research; the large collections of fossil plants and vertebrates in the museum in Dublin remaining to this day almost unknown.

THE Swedish Government intend to establish a botanico-physiological station in the north of Sweden for the study of the flora and the diseases of the crops in that part of the country.

THE Finnish Government have ordered a steamer to be specially built in Sweden for the scientific researches about to be prosecuted in the Baltic.

M. HOUZEAU, who was only recently appointed director of the Brussels Observatory, has resigned his post, and it is reported that M. de Konkolly of Gzalla Observatory, Hungary, will succeed him.

PROF. MAURICE LEVY has been nominated member of the Paris Academy of Sciences in the Section of Mechanics.

THE Prince of Wales, as President of the Society of Arts, has transmitted to Lady Siemens the resolution passed after the death of Sir William Siemens, by the Council of that Society, and in doing so has expressed his own appreciation of Sir William Siemens's labours.

SCIENCE had quite a field-day in Perth on December 20, when the Natural History Society of the Fair City formally opened its museum. Prof. J. Geikie of Edinburgh, who was for some time president of the Society, opened the proceeding with an address in which he pointed out what such a local museum should be. Other speakers followed, and from the 20th to the 23rd was an almost continuous *conversazione*, in which exhibitions, demonstrations, and lectures were given. The electric light played a prominent part, and the objects brought together for the instruction and enjoyment of the many visitors represented all departments of science. The enterprise of the Perthshire Society is exceptional, and they have reason to be proud of their museum, reading, lecture, and other rooms, all of which, we have no doubt, will be put to excellent practical uses.

THE meteorological observations taken during October, 1883, at St. Ignatius' College, Malta, by the Rev. James Scoles, S.J., have been received. For the month the means were—pressure, 30·283 inches; temperature, 67°·98; daily range, 10°·2; elastic force of vapour, 0·498 inch, and humidity, 76; rainfall, 2·67 inches, and days of rain, 12; velocity of wind per hour, 8¼ miles; sky, a third covered with cloud; temperature of sea, 72°·0, with a monthly range of 4°·0; and thunderstorms and other electrical phenomena on the 4th, 10th, 11th, 12th, 13th, 15th, 26th, and 30th. Atmospheric pressure was thus fully a fourth of an inch below the mean, temperature 3°·4 lower than usual, and rainfall about half an inch less. This Society has peculiar facilities for prosecuting meteorological and other researches through its widely scattered seminaries and colleges, and we have the greatest pleasure in noting the increasing readiness with which its services are given to science.

MR. H. H. JOHNSTON will give a discourse on "Kilimanjaro, the snow-clad Mountain of Equatorial Africa," at the Royal Institution, on Friday evening, January 25. Prof. Bonney's discourse on "The Building of the Alps," announced for that evening will be given on April 4.

HERR STEINEGER has been so fortunate as to secure eleven crania and numerous bones of the extinct sea-cow, *Rhytina stelleri*, which have been forwarded to the Smithsonian Institution at Washington.

A SPLENDID meteor was seen at Frankfort-on-the-Maine on December 8 at 6.45 a.m. It moved from west to east, and illuminated the whole neighbourhood.

A *Times* correspondent writes from Iceland that reports of a volcanic eruption in the interior were current last year, and were founded on peculiar appearances of the sky, and especially on the observation from some of the remote inland farms of columns of smoke or vapour rising in the far distance. Nothing definite has, however, been ascertained as to these phenomena. An unusually large number of scientific men, geologists, botanists, and philologists, chiefly German and Swedish, have this year visited Iceland and investigated its structure, flora, and language; and at present Prof. Sophus Tromholt, well known in scientific circles by his researches as to the aurora borealis, is pursuing these investigations here, and intends to remain all the winter, as, from the clearness of the atmosphere and the frequency and brilliancy of the aurora, Iceland is exceedingly well suited for his observations.

THE extensive collections of American Coleoptera made by the late Dr. J. L. LeConte, containing an immense number of original types, become the property of the Museum of Comparative Zoology of Cambridge, Mass.

THE French Société des Électriciens has completed its arrangements, and has been divided into six sections:—Theoretical electricity, M. Marie Davy president; Dynamo-electrical machinery, transmission of force to a distance, distribution of energy, M. Tresca president; Electric lighting, M. Du Moncel president; Telegraphy and telephony, M. Blavier president; Electro-chemistry and electrotherapy, M. Jamin president.

WHEN Arago was director of the Observatory of Paris, the dotation of this establishment was less than 4000*l*. a year. This sum was greatly increased when Leverrier was appointed by Napoleon III., and before his death it had reached 10,000*l*. Now the sum allotted is about 16,000*l*., although the meteorological department has been set apart as a special service.

THE Italian Geographical Society awards its great gold medal to Count Pietro Antonelli, in consideration of the important results of his last journey to Shoa.

FROM advanced sheets of the *Proceedings of the Anthropological Society of Washington*, Col. F. A. Seely of the United States Patent Office, we learn from *Science*, publishes a pamphlet entitled "An Inquiry into the Origin of Invention." The author is accustomed, day by day, as new claims for patents come before him, to eliminate the successive steps in the classes of machinery until he reaches the fundamental idea. This is the plan pursued in tracing backward the whole subject of invention to its sources in the mind of primitive man. The subject is illustrated, first, by the story of the steam-engine, and then by the examination of the bow and arrow and other implements of the lower races. The author rejects Prof Gaudry's Dryopithecus, and affirms, "Obviously, archæology can find no trace of a remoter age than that of stone; but I mistrust that the thoughtful anthropologist will accept the evidence of earlier ages, one of which, taking one of its perishable materials as the type of all, we may call the age of wood. Still farther back must lie an age, as indefinite in duration as any, when man existed in his rudest condition, without arts of any kind, except such as he employed in common with lower animals; and this is the true primitive period."

WE have received the report for the years 1880 and 1881 of the administration of the artistic and scientific collections in the Royal Museums of Dresden. The Zoological and Anthropological Museum was visited by 61,129 persons in 1880, and by 65,455 in 1881. An index to Reichenbach's ornithological works has been prepared by the director, Dr. A. B. Meyer, who has also issued an important work on the picture-writings of the Eastern Archipelago and Pacific Islands. The staff of this museum now consists of the Director, Th. Kirsch, curator, L. Römer and J. C. G. Wilhelm, first and second conservators, C. A. Kippe, preparer of specimens, a scientific assistant, and two attendants. The zoological and anthropological collections were enriched in the years 1880 and 1881 by 2242 specimens of the higher animals, and 17,753 of insects, by 237 anthropological and 1351 ethnographic objects, including 61 crania and 56 photographs and drawings of human types from various quarters. The library attached to this department was increased by 332 works, including donations from the British Museum, Smithsonian, and other sources. The systematic catalogue of the fishes was completed in three volumes, with alphabetical index of the 294 genera, 726 species, and 2901 specimens contained in the collection. The nests, to the number of 800, were also rearranged and catalogued, and progress was made with the catalogues of the birds (from No. 1688 to 2948) and insects (Hymenoptera concluded, Diptera thoroughly revised, of Coleoptera three families arranged and catalogued).

MESSRS. BAILLIÈRE AND CO. of Paris have issued the first number of a new scientific weekly, *Science et Nature*, profusely illustrated.

M. ÉD. MAILLY has brought out, in two volumes, a "Histoire de l'Académie Impérial et Royal de Bruxelles," from which so much good work has emanated. The history abounds in interest. F. Hayez of Brussels is the publisher.

SPAIN does seem to be progressing in the right direction. We have the second volume of Mr. F. Gillman's very useful and carefully compiled "Enciclopedia-Popular Illustrada" (Madrid), with a large atlas of plates. Also the first number of *La Industria Ibérica*, a weekly paper devoted to the industry and science of the whole peninsula, well printed, and, to judge from the first number, judiciously edited.

MESSRS. CHARLES GRIFFIN AND CO. announce the following scientific publications as forthcoming:—"A Manual of Geology," by Robert Etheridge, F.R.S., and Prof. H. G. Seeley, F.R.S.; "A Manual of Chemistry," by Prof. Dupré, F.R.S., and Dr. H. Wilson Hake; "A Manual of Botany: the Morphology, Physiology, and Classification of Plants, for the Use of Students," by Prof. W. R. M'Nab; "A Pocket-book of Electrical Rules and Tables, for the Use of Electricians and Engineers," by John Munro, C.E., and Andrew Jamieson, C.E., F.R.S.E.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Miss P. Crabtree; a Campbell's Monkey (*Cercopithecus campbelli*) from West Africa, presented by Mr. Walter van Weede; an Alligator (*Alligator mississippiensis*) from the Mississippi, presented by Mr. Thick; a Ring-tailed Coati (*Nasua rufa*) from South America, deposited.

PHYSICAL NOTES

M. E. REYNIER has described, in *l'Electricien*, a research made by him on the maxima and minima of electromotive force of certain batteries in which polarisation takes place. These he calls "single-electrolyte" batteries, instead of "single-fluid" batteries, following a suggestion of the late M. Niaudet. The difference consists in the relative size of the electrodes. For example, in the case of a zinc-copper cell containing a single electrolytic fluid, the maximum cell is made with a kathode of sheet-copper folded and curved, presenting 300 times as much surface as the thin copper rod which serves as anode, whilst in the minimum cell the pr portion is reversed, so that the polarisation at the surface of the copper attains at once its maximum value. The value of the E.M.F. of the cells when filled with dilute sulphuric acid, and having the zinc amalgamated, was 1·072 volts maximum, and 0·272 volts minimum. Many other electrolytes were examined by M. Reynier. The electromotive force was measured upon a galvanometer of high resistance.

M. REYNIER has suggested a modification of his maximum cell to serve as a standard of electromotive force—namely, a cell having a very large copper electrode, and a very small amalgamated zinc electrode, immersed in a solution of sea salt. According to M. Reynier, this battery has an E.M.F. of 0·82 volts, and maintains this value within 1 per cent. even when the circuit was loosed for two hours through a resistance of 820 ohms. M. Reynier prefers this combination to one containing sulphate of zinc in solution, because of the liability of the latter salt to contain free acid.

M. HENRI BECQUEREL has been pursuing his researches upon the infra-red rays of the spectrum. For the investigation of this region there are four methods, the first of them involving the use of a line-thermopile and a rock-salt prism; the second, Abney's photographic method; the third, Langley's method, with bolometer and a reflecting diffraction grating; the fourth, that of Becquerel, depending upon the discovery that the infra-red rays have the effect of extinguishing the glow of a phosphorescent body exposed previously to ultra-violet rays. M. Becquerel finds that water, for example, gives in the region to which this method is applicable three well marked absorption-bands, having wave-lengths respectively of 930, 1080, and 1230.

THE newest result of Becquerel's researches is worth more than passing mention. He finds that there exist in this wholly invisible region of the spectrum bright-line spectra—equally invisible, of course—just as in the visible parts of the spectrum, observable in the radiations of hot vapours. Thus, incandescent sodium vapour prints upon the previously "insolated" phosphorescent substance two well-marked lines (wave-lengths 819 and 1098), corresponding to two bright lines hitherto unknown. The extent of the region which is capable of being explored by this novel process is from wave-length 760 to 1300, or exceeding in extent that of the whole of the visible and ultra-violet rays.

AN interesting experiment is described in the *Zeitschrift des elektrotechnischen Vereins*, in Vienna, by Prof. von Waltenhofen, made by means of Noe's thermo-electric generators. If a current from a voltaic battery has been sent for a few moments through one of these generators, it is capable of yielding a discharge like a secondary battery. This effect is so far a mere repetition of a well-known experiment of Peltier, and is due to the change of temperature at the junction, called the Peltier effect. But von Waltenhofen observes that the effects are different according to the sense of the charging current. In one case, with increasing charging currents the discharge currents also increased, and were always in the opposite sense to that of the charging current. But when the charging current was reversed, it was found that with increasing charging currents the discharge currents at first increase, then attain a maximum, then decrease to zero, then actually recommence in the converse sense, namely, in the same sense as that of the charging current. Prof. von Waltenhofen is disposed to attribute this anamalous result to the lack of symmetry in the disposition of the alternate solderings of the generators, and to their alternately unequal resistance causing alternately unequal developments of heat due to resistance.

IN proof of the law of proportion between the thickness of a square vibrating plate and its pitch, Dr. Elsas gives the following neat experiment. Let three plates be cut from the same sheet of material, of the same size and form. Cement two of these together so as to produce a plate of double thickness Then, on exciting the single plate and the double plate by communicating to them respectively the vibrations of two tuning forks whose pitches are as 1 : 2, the plates will be excited in identical manners, as will be seen by dusting sand upon them, the clang-figures being identical.

LORD RAYLEIGH has reprinted for private circulation in pamphlet form several of his most valuable optical papers, including those on the manufacture, reproduction by photography, and theory, of diffraction-gratings, and those on colour-mixtures.

LORD RAYLEIGH has also reprinted some of his papers on electricity and on absolute pitch, from NATURE and from the Reports of the British Association, in a convenient pamphlet form.

THE question whether condensation of steam is a cause of electrification has been examined afresh by S. Kalischer in the Physical Laboratory at Berlin. According to the views of Faraday, this is a cause of electrification, and upon the alleged phenomenon Prof. Spring has founded a theory of the origin of thunderstorms. Landerer thought he had heard sounds in the telephone due to condensation of moisture on the line wires. Kalischer has in vain repeated the experiment. He has also examined, by means of the quadrant electrometer, whether any such electrification could be observed from the deposit of moisture upon the surface of a vessel containing ice or some artificial cooling mixture. The whole of the results were negative.

AMONGST the many recent suggestions for primary batteries is one due to MM. Lalande and Chaperon, in which oxide of copper is used as a depolarising agent. The oxide, in powder, is placed in or on a sheet of copper or iron. The positive element is zinc, and the exciting liquid caustic potash. A zincate of potash is formed by the solution of the zinc. The cell is absolutely inactive when the circuit is open. When closed, the current is remarkably constant. According to Hospitalier, the electromotive force is 0·98 volt. It must of course be closed from the air, to prevent absorption of carbonic acid by the potash. The reduced copper is reoxidised by simple exposure to the air.

IN a series of studies on the copper voltameter, published in the *Repertorium der Physik* by Dr. H. Hammerl, the following conclusions are formulated :—1. The material condition of the surface of the electrode, that is to say, whether it is covered with a bright copper film or not, has no influence on the amount of the deposit. 2. The changes of concentration of the copper solution, brought about in the voltameter by the current itself, cannot be sufficiently prevented by stirring. 3. Heating the fluid to boiling causes the deposit to come down almost completely in the state of cuprous oxide: it is partially oxidised even at temperatures between 40° and 60° C. 4. The greatest permissible strength of current, for which the deposit may be safely assumed to be a measure of the current, is about 7 amperes per square decimetre of the cathode surface.

THE EVIDENCE FOR EVOLUTION IN THE HISTORY OF THE EXTINCT MAMMALIA[1]

THE subject to which I wish to call your attention this morning requires neither preface nor apology, as it is one with the discussion of which you are perfectly familiar. My object in bringing it before the general session of the Association was in view of the fact that you were all familiar with it in a general way, and that it probably interests the members of sections which do not pursue the special branch to which it refers, as well as those which do; also, since it has been brought before us in various public addresses for many years during the meetings of this Association, I thought it might be well to be introduced at this meeting of this Association, in order that we might not omit to have all the sides of this interesting question presented.

The interests which are involved in it are large: they are chiefly, however, of a mental and metaphysical character; they do not refer so much to industrial and practical interests, nor do they involve questions of applied science. They involve, however, questions of opinion, questions of belief, questions which affect human happiness, I venture to say, even more than questions of applied science; certainly, which affect the happiness of the higher grades of men and women more than food or clothing, because they relate to the states of our mind, explaining as they do the reasons of our relations to our fellow-beings and to all things by which we are surrounded, and the general system of the forces by which we are surrounded. So it has always appeared to me: hence I have selected the department of biology, and have taken a great interest in this aspect of it.

[1] A lecture by Prof. E. D. Cope of Philadelphia, given in genera session before the American Association for Advancement of Science at Minneapolis, August 20, 1883. Stenographically reported for *Science*.

The doctrine of evolution, as taught by the biologists of to-day, has several stages as grounds or parts of its presentation. First, the foundation principle is this: That the species of animals and of plants, the species of organic beings, as well as the various natural divisions into which these organic beings fall, have not always been as we see them to-day, but they have been produced by a process of change which has progressed from age to age through the influence of natural laws; that, therefore, the species which now exist are the descendants of other species which have existed heretofore, by the ordinary processes of reproduction; and that all the various structures of organic beings which make them what they are, and which compel them to act as they now act, are the result of gradual or sudden modifications and changes during the periods of geologic time. That is the first phase or aspect which meets the naturalist or biologist.

Another phase of the question relates to the origin itself of that life which is supposed to inhabit or possess organic beings. There is an hypothesis of evolution which derives this life from no-life, which derives vitality from non-vitality. That is another branch of the subject, to which I cannot devote much attention to-day. There is still another department of the subject, which relates to the origin of mind, and which derives the mental organisation of the higher animals, especially of man, from pre-existent types of mental organisation. This gives us a genealogy of mind, a history of the production or creation of mind, as it is now presented in its more complex aspects as a function of the human brain. This aspect of the subject is, of course, interesting, and upon that I can touch with more confidence than upon the question of the origin of life.

Coming now to the question of the origin of structures, we have by this time accumulated a vast number of facts which have been collated by laborious and faithful workers, in many countries and during many years; so that we can speak with a good deal of confidence on this subject also. As to the phenomena which meet the student of zoology and botany at every turn, I would merely repeat what every one knows—and I beg pardon of my biological friends for telling them a few well-known truths, for there may be those present who are not in the Biological Section—that the phenomena which meet the student of biology come under two leading classes: the one is the remarkable fidelity of species in reproducing their like. "Like produces like," is the old theorem, and is true in a great many cases; just as coins are struck from the die, just as castings are turned out from a common mould. It is one of the most wonderful phenomena of nature, that such complex organisms, consisting of so many parts, should be repeated from age to age, and from generation to generation, with such surprising fidelity and precision. This fact is the first that strikes the student of these sciences. The general impression of the ordinary person would be that these things must continue unchanged. When I began to study zoology and botany, I was remarkably surprised to find there was a science of which I had no conception, and that was this remarkable reproduction of types one after another in succession. After a man has had this idea thoroughly assimilated by his honest and conscientious studies, he will be again struck with another class of facts. He will find, not unfrequently, that this doctrine does not apply. He will find a series of facts which show that many individuals fail to coincide with their fellows precisely, the most remarkable variations and the most remarkable half-way attitudes and double-sided aspects occurring; and he will come to the conclusion, sooner or later, that like does not produce like with the same precision and fidelity with which he had supposed it did. So that we have these two classes of facts,—the one relating to, and expressing, the law of heredity; the other, which expresses the law of metamorphosis. I should not like to say which class of facts is the most numerously presented to the student. In the present fauna we find many groups of species and varieties before us; but how many species we have, how many genera we have, and families, we cannot definitely state. The more precise and exact a person is in his definition and in his analysis, the more definite his science becomes, and the more precise and scientific his work. It is a case of analysis and forms. What the scales are to the chemist and the physicist, the rule and measure are to the biologist. It is a question of dimension, it is a question of length and breadth and thickness, a question of curves, a question of crooked shapes or simple shapes,—rarely simple shapes, mostly crooked, generally bilateral. It requires that one should have a mechanical eye, and should have also something of an artistic eye to appreciate these forms, to measure them, and to be able to compare and weigh them.

Now, when we come to arrange our shapes and our measurements, we find, as I said before, a certain number of identities, and a certain number of variations. This question of variation is so common and so remarkable, that it becomes perfectly evident to the specialist in each department that like does not at all times produce like. It is perfectly clear, and I will venture the assertion that nearly all the biologists in this room will bear me witness, that variability is practically unlimited in its range, unlimited in the number of its examples, unlimited in the degree to which it extends. That is to say, the species vary by failing to retain certain characteristics, and generic and other characters are found to be absent or present in accordance with some law to be discussed further on.

I believe that this is the simplest mode of stating and explaining the law of variation: that some forms acquire something which their parents do not possess; and that those which acquire something additional have to pass through more numerous stages than those which have not acquired so much had themselves passed through.

Of course we are met with the opposite side of the case,—this law of heredity. We are told that the facts there are not accounted for in that way; that we cannot pass from one class of facts to the other class of facts; what we find in one class is not applicable to the other. Here is a question of rational processes, of ordinary reason. If the rules of chemistry are true in America, I imagine they are true in Australia and Africa, although I have not been there to see. If the law of gravitation is effective here, I do not need to go to Australia or New Zealand to ascertain whether it is true there. So, if we find in a group of animals a law sufficient to account for their creation, it is not necessary to know that others of their relatives have gone through a similar process. I am willing to allow the ordinary practical law of induction, the practical law of inference, to carry me over these gaps, over these interruptions. And I state the case in that way, because this is just where some people differ from me, and that is just where I say the simple question of rationality comes in. I cannot believe that nature's laws are so dissimilar, so irregular, so inexact, that those which we can see and understand in one place are not true in another; and that the question of geological likelihood is similar to the question of geographical likelihood. If a given process is true in one of the geological periods it is true in another; if it is true in one part of the world it is true in another; because I find interruptions in the series here, it does not follow that there need be interruptions clear through from age to age. The assumption is on the side of that man who asserts that transitions have not taken place between forms which are now distinct.

We are told that we find no sort of evidence of that transition in past geological periods; we are assured that such changes have not taken place; we are even assured that no such sign of such transition from one species to another has ever been observed,—a most astonishing assertion to make *to* a biologist, or *by* a biologist; and such persons have even the temerity to cite special cases, as between the wolf and the dog. Many of our domestic dogs are nothing but wolves, which have been modified by the hand of man to a very slight extent indeed. Many dogs, in fact nearly all dogs, are descendants of wild species of various countries, and are but slightly modified.

To take the question of the definition of species. Supposing we have several species well defined, say four or five. In the process of investigation we obtain a larger number of individual, many of which betray characters which invalidate the definitions. It becomes necessary to unite the four or five species into one. And so then, because our system requires that we shall have accurate definitions (the whole basis of the system is definitions—you know the very comprehension of the subject requires definitions), we throw them all together, because we cannot define all the various special forms as we did before, until we have but one species. And the critic of the view of evolution tells us, "I told you so! There is but one species, after all. There is no such thing as connection between species; you never will find it." Now, how many discoveries of this kind will be necessary to convince the world that there are connections between species? How long are we to go on finding connecting links, and putting them together, as we have to do for the sake of the definition, and then be told that we have nevertheless no intermediate forms between species? The matter is too plain for further comment. We throw them together simply because our definitions require it. If we knew all the known individuals which have lived, we should have no species, we should have no genera. That is all there is of it. It is simply a question of a universal accretion of material and the collection of information. I do not believe that the well-defined groups will be found to run together, as we call it, in any one geological period, certainly in no one recent period. We recognise, however, that they diverge to a wonderful extent; one group has diverged at one period, and another one has become diversified in a different period; and so each one has its history, some beginning farther back than others, some reaching far back beyond the very beginning of the time when fossils could be preserved. I call attention to this view because it is a very easy matter for us to use words for the purpose of confusing the mind; for, next to the power of language to express clear ideas, is its power of expressing no ideas at all. As we all know, we can *say* many things which we cannot *think*. It is a very easy thing to say twice two is equal to six, but it is impossible to think it.

I would cite what I mean by variations of species in one of its phases: I would just mention a genus of snakes, Ophibolus, which is found in the United States. If we take the species of this snake genus as found in the Northern States, we have a good many species well defined. If we go to the Gulf States and examine our material, we see we have certain other species well defined, and they are very nicely defined and distinguished. If now we go to the Pacific coast, to Arizona and New Mexico, we shall find another set of species well defined indeed. If we take all these different types of our specimens of different localities together, our species, as the Germans say, all tumble together; definitions disappear, and we have to recognise, out of the preliminary list of thirteen or fourteen, only four or five. That is simply a case of the kind of fact with which every biologist is perfectly familiar.

When we come to the history of the extinct forms of life, it is perfectly true then that we cannot observe the process of descent in actual operation, because, forsooth, fossils are necessarily dead. We cannot perceive any activities because fossils have ceased to act. But if this doctrine be true we should get the series, if there be such a thing; and we do, as a matter of fact, find longer or shorter series of structures, series of organisms proceeding from one thing into another form, which are exactly as they ought to be, if this process of development by descent had taken place.

I am careful to say this, because it is literally true, as we all must admit, that the system must fall into some kind of order or other. You could not collect bottles, you could not collect old shoes, but you could make some kind of a serial order of them. There are no doubt characters, by which such and such shoes could be distinguished from other shoes, these bottles from other bottles; but it is also true that we have, in recent forms of life in zoology and botany, irrefragable proofs of the metamorphoses, and transformations, and changes of the species, in accordance with the doctrine which we commenced with.

We now come to the second chapter of our subject. With the assumption, as I take it, already satisfactorily proven, of species having changed over into others—in considering this matter of geological succession or biological succession, I bring you face to face with the nature and mode of the change, and hence we may get a glance, perhaps, at its laws.

I have on the board a sketch or table which represents the changes which took place in certain of the mammalia. I give you a summary of the kind of thing which we fi d in one of the branches of palæontology. I have here two figures, one representing a restoration, and the other an actual picture, of two extinct species that belong to the early Eocene period. One represents the ancestor of the horse line, Hyracotherium, which has four toes on his anterior feet, and three behind; and the other, a type of animal, Phenacodus, which antedated all the horse series, the elephant series, the hog, the rhinoceros, and all of the other series of hoofed animals. Each presents us with the primitive position in which they first come to our knowledge in the history of geological time.

I have also arranged here a series of some leading forms of the three principal epochs of the Mesozoic times, and six of the leading ones of the Tertiary time. I have added some dates to show you the time when the faunæ which are entombed in those beds were discovered in the course of our studies; and you will easily see how unsafe it is to say that any given type of life has never existed, and assert that such and such a form is unknown; and it is still more unsafe, I think, to assert that any given form of life properly defined, or that a specific intermediate form of life, will not be found. I think it is much safer to assert that such and such intermediate forms will be found. I have frequently had the pleasure of realising anticipations of this kind. I have asserted that certain types would be found, and they have been found. You will see that I attend to the matter of time closely, because there have been a great many things discovered in the last ten or fifteen years in this department. In these forms I give the date of the discovery of the fauna in which they are embraced.

Formation	No. of toes	Feet	Astragalus	Carpus and Tarsus	Ulno-radius	Superior Molars	Zygapophyses	Brain
Miocene ... Upper ... (Loup Fork) ...	1–1 2–2 3–3 4–4 (5–5)	Digitigrade (Plantigrade)	Grooved (Flat)	Interlocking (Opposite)	Faceted	4-tubercles, crested and cemented	Doubly involute Singly do.	Hemispheres larger, convoluted
Middle ... (John Day)	2–2 3–3 4–4	Digitigrade	Grooved	Interlocking	Faceted Smooth	4-tubercles, and crested	Singly involute Doubly do.	Hemispheres larger, convoluted
Lower ... (White River)	3–3 4–3 4–4	Digitigrade Plantigrade	Grooved	Interlocking	Smooth Faceted	4-tubercles, and crested	? Singly involute	Hemispheres small; and larger
Eocene ... Upper ... (Bridger)	3–3 4–3 4–5 5–5	(Digitigrade) Plantigrade	Grooved (Flat)	Opposite Interlocking	Smooth	4-tubercles 3-tubercles, and crested	Singly involute Plane	Hemispheres small
Middle ... (Wasatch)	4–3 4–5 5–5	Plantigrade (Digitigrade)	Flat (Grooved)	Opposite Interlocking	Smooth	4-tubercles 3-tubercles, a few crested	Plane Singly involute	Hemispheres small; mesencephalon sometimes exposed
Lower ... (Puerco)	5–5	Plantigrade	Flat	Opposite	Smooth	3-tubercles (4-tubercles), none crested	Plane	Mesencephalon exposed; hemisphere small and smoother

Here we have the White River fauna discovered in 1856; then we skip a considerable period of time, and the next one was in 1869, when the Cretaceous series was found. Six or seven Cretaceous faunæ have been found. Thus we have the Bridger fauna in 1870, the Wasatch fauna in 1874. Next we have, in 1877, the Equus beds and the fauna which they embrace, which also was found in 1878. The Permian fauna, which is one of the last, is 1879; and the last, the Puerco, which gives the oldest and ancestral types of the modern forms of mammalia, was only found in 1881. When I first commenced the study of this subject, about 1860, there were perhaps 250 species known.

There are now something near 2000, and we are augmenting them all the time. I have found many myself: if they were distributed through the days of the year I think in some years I should have had several every day. But the accessions to knowledge which are constantly being made make it unsafe to indulge in any prophecies that, because such and such things have not been found, therefore such and such things cannot be; for we find such and such things really have been and really are discovered.

The successive changes that we have in the mammalia have taken place in the feet, teeth, and brain, and the vertebral column. The parts which present us the greatest numbers of variations are those in which many parts are concerned, as in the limbs and feet. In the Lower Eocene (Puerco) the toes were 5-5. In the Loup Fork fauna some possess toes but 1-1. Prior to this period no such reduction was known, though in the Loup Fork fauna a very few species were 5-5. Through this entire series we have transitions steady and constant, from 5-5, to 4-5, to 4-4, to 4-3, to 3-3, to 2-2, to 1-1. In the Puerco period there was not a single mammal of any kind which had a good ankle-joint, which had an ankle-joint constructed as ankle-joints ought to be, with tongue and groove. The model ankle joint is a tongue-and-groove arrangement. In this period they were all perfectly flat. As time passes on, we get them more and more grooved, until in the Loup Fork fauna and the White River fauna they are all grooved. In the sole of the foot, in the Puerco fauna, they are all flat; but in the Loup Fork fauna the sole of the foot is in the air, and the toes only are applied to the ground, with the exception of the line of monkeys, in which the feet have not become erect on the toes, and the elephant, in which the feet are nearly flat also, and the line of bears, where they are also flat. As regards the ungulation between the small bones of the palm and of the sole there is not a single instance in which the bones of the toes are locked in the Lower Eocene, as they are in the later and latest Tertiary.

When we come to the limbs, the species of the Puerco fauna have short legs. They have gradually lengthened out, and in the late periods they are nearly all relatively long.

(To be continued.)

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Dec. 13, 1883.—"On the Figure of Equilibrium of a Planet of Heterogeneous Density," by G. H. Darwin, F.R.S., Plumian Professor of Astronomy in the University of Cambridge.

If a rotating planet be formed of compressible fluid, the strata of equal pressure are of equal density, and the ellipticity of the strata increases from the centre outwards. Since it is supposed that the earth consolidated into its present form from a fluid or semi-fluid condition, the determination of the arrangement of internal density and of the law of ellipticity in such a planet is often called the problem of the figure of the earth. When the law of compressibility of the fluid is known, the laws of density and ellipticity are determinate, but the differential equations involved are of such complexity that only one solution of the problem is well known, viz. that associated with the names of Legendre and Laplace.[1]

In this solution the modulus of compressibility varies as the square of the density, but the assumption of this law appears to have been dictated more by the necessity of solving a certain differential equation than by physical considerations.

The comparison of the solution of the problem with the observed facts with regard to the earth may be made in several ways. The constant which determines the rate of the earth's precessional motion gives us information with regard to the arrangement of density in the interior, and the ellipticity of the surface is determined by geodesy and by the amount of a certain inequality in the moon's motion. Now, in order that the solution of the problem of the earth's figure may be satisfactory, the same arrangement of internal density must give the observed amounts both to the precessional constant and to the ellipticity of the surface.

Laplace's solution is highly satisfactory in this respect; and at the same time it makes the mean density of the whole earth about twice as great as the density of the surface stratum. The density of rock is about 2·8, and that of the whole earth is about 5·6.

In this state of our knowledge another solution of this celebrated problem possesses some interest, even if its results are not quite so satisfactory as those of Laplace's theory.

In the present paper such a solution is offered. The law of compressibility of the fluid is such, that the modulus varies as a power of the density, which power may range from negative infinity to $\frac{1}{2}$. When the power is zero, we have constant compressibility; and when the power is unity, we have the same law of compressibility as in a gas.

The solution is expressible in a far simpler algebraic form than that of Laplace, and it differs from his solution in placing a far larger proportion of the mass of the planet in the central regions.

It is remarkable that this solution affords for the case of the earth a correspondence between the precessional constant and the surface ellipticity equally good with that of Laplace. To obtain this correspondence we have to assume the compressibility of the fluid to be nearly constant.

The density of the surface layer appears however to be 3·7, and this is considerably greater than that of ordinary rocks. This result tells adversely to the acceptability of the proposed solution, but the discrepancy is not so serious as might appear at first sight. It appears from pendulum experiments on the Himalayan plateau and on the Andes, that there is a considerable deficiency of density underneath those great ranges. This would favour the view that our continents are a mere intumescence of the surface layers. In this case there must be a somewhat abrupt change in the law of density at only a few miles below the surface. The theory of the earth's figure can take no account of a sudden change of density on passing into a swollen superficial layer, and the value of the surface density to be used is that which is to be found immediately below the swollen part.

The author therefore points out that whilst the solution now offered cannot be held to be quite as satisfactory as that of Laplace, yet its inferiority is not of a kind to render altogether unacceptable the contention that it may be somewhere near the truth.

[1] The late M. Roche seems to have also solved the problem in 1848, and his paper is published in the *Memoirs of the Academy of Montpellier.*

Linnean Society, December 20, 1883.—Alfred W. Bennett, M.A., in the chair.—Messrs. N. Cantley, W. Dobson, F. G. Smart, and Rev. R. Thom were elected Fellows of the Society.—Mr. S. O. Ridley exhibited and made remarks on a series of 177 vertical sections of sponges collected in the neighbourhood of Point de Galle, Ceylon, by Dr. W. C. Ondaatje, F.L.S., and transmitted to England by him in letters. They are in most instances sufficient for the identification of the genera and some species.—Mr. F. Maule Campbell showed the web of a spider (*Tegenaria guyonii*) which had been spun in the centre of a pasteboard cylinder, the peculiarity being the manner in which the solid part of the web was medially swung, whereas in this species of spider it is more usually on the sides of objects.—A paper was read by Mr. F. O. Bower on the structure of the stem of *Rhynchopetalum montanum.* The plant is a native of Abyssinia, growing in districts 11,000 to 13,000 feet above the level of the sea. It differs from its ally Lobelias in being perennial. Internally it is succulent when young, but afterwards the surface becomes scarred as the leaves drop off, and exteriorly is hardened by a thick corky deposit. *Rhynchopetalum*, the author shows in detail, has certain peculiarities in the arrangement of the tissue of its leaf bundles, since the cortical system does not consist of branches of bundles of the leaf trace, but are cauline bundles, in this respect differing widely from such forms as *Lathyrus casuarina*, many *Begonias*, &c. *Rhynchopetalum*, moreover, has the cortical bundles running obliquely, and forming a regular four-sided meshed network related to the leaf bases and bundles of leaf trace. In these respects it approaches *Cycas*, in which latter the bundles of the accessory cortical system are not so regular and are almost vertically arranged. Some Cycads and *Rhynchopetalum* also agree in the exterior appearance of their stem, so that palæontologists might be deceived in their judgment if two well-preserved specimens were examined by them.—A communication was read on the auditory ossicles of *Rhytina stelleri* by Alban Doran. This was based on skeletons obtained by the *Vega* expedition, and shown at the late International Fisheries Exhibition by the Swedish Government. The author arrives at the conclusion that the malleus of *Rhytina* is larger than in *Manatus*, and therefore it is the largest and bulkiest malleus to be found in the whole section of the animal kingdom where such a bone exists, that in the characters of its body it resembles *Manatus* rather than *Halicore*, and that in the manubrium it differs from the other Sirenia, and is far more generalised. The incus is of the *Manatus* type, and so is the stapes, which is also the largest and bulkiest stapes to be found in any animal.—A paper on the organs of secretion in the Hypericaceæ, by Mr. J. R. Green, was read. He concludes (1) that the view advocated by Link, Martinet, and De Bary, of the lysigenous origin of the reservoirs of ethereal oil in these plants is the correct one; (2) that there exists in many parts of the plants a series of ducts or passages differing only slightly from these reservoirs, the differences being that they are not globular and isolated, but are generally connected more or less intimately with each other, and that their secretion is not a clear ethereal oil, but a viscid or resinous liquid, the points of agreement being those connected with their development and function; (3) that at least in some species there is also a series of schizogenous ducts confined to certain portions of the phloem; (4) that the dark glands which have been described are in intimate relationship with the fibrovascular system; (5) that the formation of resin and kindred secretions in these plants is confined to the parts where metabolism is active, and where there is a primary meristem. That all such parts give evidence of such formation with the exception of the roots.—A paper on the glands of *Coprosma baueriana*, by Mr. Walter Gardiner, was read. These glands are externally well developed and very typical. The so-called stipular body is placed immediately behind each leaf, and in the young condition the stipule arches over the leaf, and the glands with which it is provided secrete copiously a mucilaginous fluid, which bathes and surrounds the young leaf structure. As to the development of the glands, they arise as protrusions of the stipule parenchyma, which are covered by an epidermis. Each epidermal cell then rapidly grows out at right angles to the protuberance. In *Coprosma* the glands are situated on the sides of the stipules, but it more usually occurs in other genera that they are distributed over the inner face of the base of the stipular organ.—The last paper taken was on the development of starch grains in the laticiferous cells of the Euphorbiaceæ, by M. C. Potter. It is pointed out that while the discovery of the existence of starch-forming corpuscles had been made by Kruger, yet he had failed to interpret their function, which Mr. Potter's researches now fully prove in the case of the Euphorbiaceæ, where the development of rod or spindle-shaped grains of starch lying within cell protoplasm has been clearly demonstrated.

Chemical Society, Dec. 6, 1883.—Dr. Perkin, president, in the chair.—The following gentlemen were elected Fellows:—F. A. Blair, T. J. Barr, C. J. Baker, L. Briant, R. G. Durrant, Ramchundra Datta, L. L. Garbutt, A. E. Harris, T. Hart, W. Irwin, S. Johnson, R. Jackson, H. C. Lee, W. H. Martin, C. E. Potter, B. M. K. Rogers, C. W. Stephens, P. H. Wright, H. A. Wetzel, and W. G. Whittam.—The following papers were read:—On the constitution of the fulminates, by E. Divers and M. Kawakita. When moist mercury fulminate is treated with much strong hydrochloric acid, hydroxyammonium chloride and hydrocyanic acid are formed; if the fulminate be dry, no prussic acid is formed. The carbon is completely converted into formic acid. No oxalic acid is produced.—Theory of the constitution of the fulminates, by E. Divers.—On Liebig's production of fulminating silver without the use of nitric acid, by E. Divers and M. Kawakita. When nitrous acid is passed into an alcoholic solution of nitrate of silver, crystals separate; these are not, as Liebig stated, fulminating silver, but nitrate of silver.—Note on the constitution of the fulminates, by H. E. Armstrong.—Experimental investigation on the value of iron sulphate as a manure for certain crops, by A. B. Griffiths. The author obtained from an experimental plot of land manured with ferrous sulphate fifty-six bushels of beans; a similar plot in its normal state gave thirty-five bushels. The ash of the plants also contained more iron and phosphoric acid in the first case.

Physical Society, December 8.—Prof. G. Carey Foster, in the chair.—New members:—Major McGregor, R.E., Mr. James Walker, M.A., Mr. W. B. Gregory, B.A.—Prof. Silvanus P. Thompson, D.Sc., read a paper on the static induction telephone as an instrument of research. The author had employed Dolbear's telephone in investigating the action of influence machines such as those of Holtz and Wimshurst or Toepler. This was done by holding the end of a wire (connected to one terminal of the telephone) near the electrified parts of the machine, for example the "carriers" in the Toepler apparatus. The carriers induced a change in the telephone, whose other terminal was to earth, as they passed, and the pitch of the note heard in the telephone increased with the speed at which the machine was driven. Useful results were obtained leading to modifications of some machines. The same telephone was also applied to the measurement of capacities of condensers arranged like the resistances of a Wheatstone balance, and the telephone taking the place of a galvanometer. For the "divided coil" of the balance Prof. Thompson substituted a double condenser, or rather two condensers, so joined that the earth-plates were separate, while the other plates were in one. This device was made from two glass tubes with tinfoil round their outsides and a brass tube sliding into both interiors in such a way that the relative capacities of the two condensers thus combined could be altered by sliding the tube between them. A modification of this plan was suggested by Mr. Starling, the author's assistant, which was analogous to Prof. Foster's arrangement of the Wheatstone balance, that is to say, six condensers were used, the two extra ones being included between the battery connections and the sliding tube. The battery was in this case an induction coil having no condenser, as a discontinuous current is necessary to give sounds. The author also showed that the Dolbear telephone could be used instead of the quadrant electrometer in such experiments as those of Mr. J. E. H. Gordon on specific inductive capacity. The author also showed how he had applied it to explore the equipotential surfaces round conductors charged statically by an induction current. With two wires from the terminals of a telephone silence is produced when both ends are on the same equipotential surfaces; and sounds when they are not.—Prof. Thompson then read a note on a new insulating stem. This consisted of a glass tube with one end blown into a flat foot, which was planted on the bottom of a glass bottle and cemented there by a little wax paraffin. The upper and open end of the tube served to hold the stems of brass plates, or other electrified bodies. Paraffin oil or strong sulphuric acid could be used in the bottom of the bottle. A cap of rubber or percha made to slide up the stem served as a dust cover.—Prof. Thompson next made a communication on the first law of electrostatics, and illustrated his remarks with experiments showing how a series of floating magnet poles of like name repelling one another tend to produce equal distribution of the poles. Prof. Thompson, arguing from the second law of electrostatics (inverse squares), sought to explain the first law in a rational manner, on the hypothesis of self-repelling molecules, which tend to uniform distribution. When there is a surplus in one part and a deficit in another, the molecules are urged towards each other, *i.e.* attract. This was shown by putting a surplus of floating magnets at one part of the basin. By the movements of these magnets when confined by barriers, and with surplus and deficit purposely made, the author imitated the effects of a Leyden jar, induction, a battery current, &c., the motions and arrangement of the poles illustrating the hypothetical behaviour of electricity. The author was led by the hypothesis to infer that either the ether is electricity, or that the ether is electrified, and the former seemed the simpler conclusion.—Dr. Monkman showed some experiments illustrating the attraction and repulsion of bodies in motion. The attraction of a light balanced body to a vibrating tuning-fork was shown; also the attraction between two disks of paper revolving parallel and in the same direction. The author showed that two smoke-rings travelling abreast in the same direction attracted each other, and that two paper rings revolving in the same direction close together attract, while if revolving in opposite directions they repel.—Mr. Walter Baily exhibited his new integrating anemometer in action by means of a small electric motor, which took the place of the Robinson cups. The apparatus sums up, or integrates, the wind velocities on the lines of the four cardinal points. An electric counter is attached.

PARIS

Academy of Sciences, December 17, 1883.—M. Blanchard, president, in the chair.—Preliminary report on the expedition of the *Talisman* to the Atlantic Ocean, by M. Alph. Milne-Edwards.—On the preparation and manner of employing artificially developed virus attenuated by heat, intended to be used in prophylactic inoculations against charbon, by M. A. Chauveau.—On the remarkable sunsets observed during the months of November and December, 1883, by M. P. de Gasparin. The author considers that these luminous effects cannot be due to falling stars, and must be referred to the solar light acting on an atmosphere charged with particles of matter whose nature has not yet been determined.—On the determination of elastic forces, by M. Fontaneau.—On the processes adopted by M. Mandon and M. Aman-Vigié in the treatment of vines affected by phylloxera, by M. F. Henneguy. The process of Dr. Mandon, which consists in saturating the sap with a solution of phenic acid, appears to have little or no effect on the parasite. That by M. Aman-Vigié, an injection of a mixture of vapours of sulphur and sulphuric acid into the ground, has been tried on too limited a scale to warrant any definite judgment as to its efficacy, but the experiments already made do not appear to have proved very beneficial, because the vapours of sulphuric acid do not penetrate to a sufficient depth into the ground, and evaporate too rapidly.—Observations of the Pons-Brooks comet made at the Paris Observatory with the bent equatorial, by M. Périgaud.—Observations of the planet 235 Carolina and of the Pons-Brooks comet made at the Paris Observatory (west equatoreal in the garden), by MM. Henry.—On the multipliers of linear differential equations, by M. Halphen.—On a point in the theory of elliptical functions, by M. Lipschitz.—On a theorem of M. Liouville in mathematical analysis, by M. Stieltjes. In continuation of his previous paper, the author here shows how the theory of elliptical functions leads to the theorem of M. Liouville.—On algebraic equations, by M. H. Poincaré.—Demonstration of the fundamental properties of the system of geodesic polar coordinates, by M. G. Ossian-Bonnet.—On a method of generating the ovals of Descartes proposed by Chasles in his "Aperçu Historique," by M. Maurice d'Ocagne.—On the measurement of the specific heats and variations of temperature of two bodies in contact, by M. Morisot.—On a practicable method available for the photometric comparison of the usual sources diversely coloured, by M. J. Macé de Lépinay.—On the influence of colour on the sensitiveness of the eye to different degrees of luminosity, by M. Aug. Charpentier.—Researches on the permanence of the solidification of superfused sulphur (continued), by M. D. Gernez.—Second note on chromic selenite; preparation of biselenite, by M. Ch. Taquet. The author has obtained a biselenite of chromium by the action of nitric acid on neutral selenite. It is almost insoluble in water, but soluble in acids, and decomposable by heat.—Note on the action of bromium on pilocarpine ($C_{22}H_{16}Az_2O_4$), by M. Chaasting.—On emetics of mucic and saccharic acids, by M. D. Klein.—Third note to serve as a contribution to the history of the formation of coal; genus *Arthropitus*, Gœppert, by M. B. Renault.—On the artificial reproduction of schistosity and slate layers, by M. Ed. Jannettaz.—Experiment relative to the mode of formation of bauxite and gypsum, by M. Stan. Meunier.—On the glaucous amphibolic schists of the island of Groix, by M. Barrois.—On an anorthite rock discovered at Saint Clément, Canton of Saint-Anthème (Puy-de-Dôme), by M. F. Gonnard.—On the fall of cosmic dust, by M. E. Yonng.—On the coincidence of the recent phenomenal after-glows with the passage of the cosmic meteors, by M. Chapel.

December 24, 1883.—M. Blanchard, president, in the chair.—The President announced the painful loss sustained by the Academy in the person of M. Yvon Villarceau, member of the Section for Geography and Navigation, who died after a short illness on December 23. Funeral orations on the deceased savant were pronounced by Col. Perrier in the name of the Academy, by M. Faye in the name of the Bureau of Longitudes, and by M. Tisserand in the name of the Paris Observatory.—Separation of gallium (continued): separation from terbium, ytterbium, and the earth provisionally called y_a by M. de Marignac, from scandium and fluor, by M. Lecoq de Boisbaudran.—Observations of the comet Pons-Brooks, made at the Observatory of Algiers by MM. Trépied and Rambaud.—Observations of the same comet made at the Lyons Observatory (Brunner equatorial of 0·160 metre), by M. Gonnessiat.—On a special development of the perturbing function

$$\frac{1}{\Delta^i} = \frac{1}{(r^2 - 2rr'\cos v + r'^2)^{\frac{i}{2}}},$$

by M. O. Backlund.—On the purely trigonometrical series connected with M. Linstedt's new solution of the problem of three bodies, by M. H. Poincaré.—On the generation of geometrical surfaces, by MM. J. S. and M. N. Vanecek.—On the gauging of galvanometers, by M. E. Ducretet.—Researches on the permanency of the solidification of superfused sulphur (continued); production of a new crystallised variety of sulphur, by M. D. Gernez.—On the decomposition undergone in the presence of water by the acid phosphates of the alkaline earthy bases, by M. A. Joly.—Determination of the neutralising heat for the fluorhydric acid of the alkaline and alkaline-earthy bases, by M. Guntz.—On the kreatines and kreatinines, fourth note, by M. E. Duvillier.—Action of ammoniacal gas on the nitrate of methyl, by MM. E. Duvillier and H. Malbot.—Researches on the compound oxygenised ammonias, by M. Reboul.—On some haloid derivatives of ethane, by M. L. Henry.—On the pathologic anatomy of the phlegmon, and especially on the seat of the bacteria in this affection, by M. Cornil.—On the species of Arctic mollusks found by the *Talisman* Expedition at great depths in the intertropical waters of the Atlantic Ocean, by M. P. Fischer.—On the morphology of the plumicole Sarcoptides, by MM. E. L. Trouessart and P. Mégnin.—On a rapid and economical method of treating vines affected by Peronospora, by M. Senderens.—On a parasitic Nematode of the common onion, by M. Joannes Chatin.—On the cultivation of beetroot and some other plants in solutions of organic substances in decomposition, by M. V. Jodin.—On the relations of the Serpentine rocks to saline substances, especially in the Pyrenees, by M. Dieulafait.—On a chlorosilicate of lime, by M. Le Chatelier.—Experimental researches on the velocity of aqueous or atmospheric currents capable of holding in suspense mineral particles, by M. J. Thoulet.—Note on the sunset glows recently reported to the Academy, by M. E. Marchand.—Observation of the after-glows witnessed at Valence on the evening of December 2, by M. P. du Boys.—Remarks on the sunsets observed at Rambouillet on the evenings of December 15 and 18, by M. A. Laugier.—Letter on the sunsets observed at Christiania towards the end of November, by M. Fearnley, director of the Christiania Observatory.

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THURSDAY, JANUARY 10, 1884

AMERICAN GEOLOGY

Twelfth Annual Report of the United States Geological and Geographical Survey of the Territories. In Two Parts, with Atlas of Maps, &c. By F. V. Hayden, U.S. Geologist. 8vo. (Washington: 1883.)

THERE is a singular fascination in American geology. Its features are as a whole so massive and colossal, their infinite detail so subordinated to breadth of effect, their presentation of the great elements of geological structure so grand, yet so simple and so clearly legible, that they may serve as types for elucidating the rest of the world. The progress of sound geology would assuredly have been more rapid had the science made its start in the Far West of America, rather than among the crumpled and broken rocks of Western Europe. Truths that have been gained on this side of the Atlantic by the laborious gathering together of a broken chain of evidence would have proclaimed themselves from thousands of plateaux, cañons, and mountain ranges, in language too plain to be mistaken. No doubt much has been gained by the mere toilsomeness of the search after the truth. A possession is more valued when it has been hard to obtain, and the qualities which its capture has called forth and strengthened could probably be educated in no other way. Nevertheless, no European geologist can visit these western regions without realizing more or less distinctly what an amount of time has been wasted here over questions about which there should never have been any discussion at all. This impression is renewed by every new geological memoir which brings to us fresh revelations of the scenery and structure of the Western Territories. It is especially deepened by a perusal of the volumes of which a brief notice will here be given.

It may be in the recollection of readers of NATURE that after some inquiry and discussion it was discovered by the Congress of the United States that various independent Surveys, under different Government departments, had been engaged among the Western Territories, and, having no connexion with each other, had, to some extent, duplicated the mapping of the same ground; and that at last in the summer of 1879 a law was passed whereby these various geological and topographical Surveys were abolished, and a new single organization was created under the name of the "Geological Survey of the United States." One of the Surveys thus abolished was known as "the U. S. Geological and Geographical Survey of the Territories," under Dr. F. V. Hayden as Geologist in charge. The publications of this Survey comprised a voluminous series of annual Reports and Bulletins, quarto volumes of elaborate and well illustrated Memoirs, and Geological Maps and Sections. Many thousands of square miles of country had been examined by the staff, and had been mapped and described in such a way as to lay out the broad features of wild regions for the first time, not only for the assistance of the geologist or geological surveyor who might afterwards care to fill in the details and improve the mapping, but for the guidance of future settlers in the far west, and of the Central authorities who have charge of the public lands. When, at the bidding of Congress, Dr. Hayden's Survey organization ceased to exist and his staff dispersed in search of other occupations, the work done in the year 1878 had not been published, while several important works were in progress. A small appropriation was granted to enable him to bring out his last Report and to complete other office-work of the Survey. This grant was exhausted in the summer of 1882, leaving five quarto volumes still unpublished though far advanced towards completion. These have been handed over to the Director of the Geological Survey, to be finished and published under his auspices. The final Annual Report, however, being the twelfth of the series, has at last been issued, the delay in its appearance having arisen from the scattering of the staff and their employment in other avocations, but partly perhaps (though he makes no mention of it) to the prolonged indisposition under which Dr. Hayden has been labouring ever since his retirement from official life.

Dr. Hayden's Report for 1878 is a most fitting termination to the series which it closes. It consists of two massive octavo volumes with an atlas of Maps and Panoramas, and is profusely illustrated with plates. It is of course impossible to give any adequate notice of this elaborate work within the limits permissible in these pages. But a mere outline of its contents may afford some idea of the nature and importance of this latest contribution to American Geology.

The first volume opens with a Prefatory Letter from Dr. Hayden himself, stating briefly the arrangement of the work under his supervision during the last year of its progress. One of his parties was charged with the primary triangulation of the entire area to be surveyed, and made satisfactory progress, among the Wind River and adjacent ranges westwards to Henry's Lake, where its operations were unfortunately cut short by Indians who, crossing its trail, carried off all its animals and a portion of its outfit. Not far to the north lay the Yellowstone Park—an area perpetually exempted from settlement by special Act of Congress. That wild tract, surrounded by rugged mountains, formed a natural retreat for bands of hostile Indians when pursued by troops. Only the year before, the Nez Percés, retreating from General Howard, broke into the region, killing and plundering as they went. No wonder the surveyors should excuse any shortcomings in their work by pleading "that peculiar mental condition consequent on the uncertain and exaggerated rumours relative to the movements of the hostile Bannacks by whom the country was said to be overrun, but of whose presence we saw no more than the traces of some days' old trails." Next year, the writer of these lines, having previously heard similar wild rumours, passed over some of the same ground, but actually encountered an armed party, and will always remember the "peculiar mental condition," which the dust-cloud of the approaching red-skins awakened.

A second division of the staff made a detailed survey of the Yellowstone Park, obtaining materials for a Map of it on the scale of one inch to a mile. Mr. W. H. Holmes, attached to this party, had excellent opportunity for wielding that facile pencil to which geological science is so much indebted. Dr. A. C. Peale and Mr. Musbach made a detailed study of the thermal springs for which the region is now so famous.

A third division surveyed the previously little known but magnificent snowy range of the Wind River Mountains, in which three true glaciers were observed—the first known to occur east of the Coast Range of the Pacific border.

The Report of these various surveys and of palæontological and natural history researches connected with previous explorations is divided into two parts. Taking the second part first, we have a stout volume of some 500 pages with 80 plates, besides figures, maps, and sections entirely devoted to the Yellowstone Park. A good deal has been written on the wonders of this region, chiefly in previous Reports of Dr. Hayden's Surveys, and sometimes in considerable detail, as, in Professor Comstock's Report, accompanying Captain Jones' Reconnaissance published in 1875. But no such minutely circumstantial narrative has ever appeared as that now issued.

An exceedingly erroneous general impression is conveyed by the word "Park" which has been applied to this region and which has received the sanction of an Act of Congress. The tract comprises an area of upwards of 3500 square miles, most of it being forest covered and of a rugged mountainous character. Some of the peaks rise to between 10,000 and 11,000 feet above the sea. Between the lower ridges, open glades of park-like woodlands make one half forget for a while the great altitude and remoteness of the region, till the true character of the place is recalled by some pine-trunk deeply scored by a passing bear or by a herd of "antelopes" or an occasional "elk" scampering across the sunshine into the gloom and silence of the surrounding forest. Through this region, the Yellowstone River and its tributaries, draining a series of lakes, flows northward till it enters a profound cañon in which, at times unseen and unheard, it chafes the feet of volcanic precipices until, emerging amid a series of glacier moraines, it passes out of the "Park" into the Territory of Montana.

The Monograph of this deeply interesting region now published by Dr. Hayden is composed of three unequal sections. The first of these, by Mr. W. H. Holmes, treats of the general geology. It is no disparagement to the author to say that the most valuable part of his Report is to be found in his admirable sketches. He adds some interesting particulars, indeed, to what was already known of the geology of the district. For example he has worked out in greater detail the structure of Cinnabar Mountain which forms so striking a feature in the ascent of the Yellowstone above the second cañon, likewise the geology of the remarkable volcanic plateau of which one sees a section from the camping ground at the Mammoth Hot Springs. The beautiful unconformability under the sheet of rhyolite which forms so impressive a feature in that landscape stands out with admirable clearness in Mr. Holmes' drawings. Evidence is supplied of the diminution of the Yellowstone Lake. A reference, tantalizingly brief, to the interesting glacial problems of the district concludes this short Report. The author was too well and busily employed with his pencil to find time for much independent geological observation. But it is matter for hearty congratulation that before he was moved away into the vaster domain of the Grand Cañons of the Colorado, where he has since done such service to the United States Geological Survey, he was enabled to spend long enough time in the Yellowstone region to produce the series of pictoral illustrations which enrich Dr. Hayden's final Report. His trained eye and power of rapid and accurate sketching greatly contributed to the perfection of the map of the Park.

The second and by much the longest section of the book is devoted to the Hot Springs of the Yellowstone Park, and is from the pen of Dr. A. C. Peale, who spent about two months in the district making detailed observations of the geysers and other thermal waters. He describes more than 2000 springs and seventy-one geysers, and illustrates his descriptions with so numerous a series of plates that every minute detail and variety of form in the geysers and sinter accumulations is vividly brought under the eye. Dr. Hayden justly remarks that this preliminary work ought never again to be necessary. Short of an actual inspection of the geysers and basins themselves, nothing could give a clearer idea than these plates do of the extraordinary forms assumed by the deposits from the thermal waters. The strange coralloid and sponge-like aggregations are excellently depicted in lithographs which have obviously been reproduced from photographs. Dr. Peale's Monograph consists of three parts, the first devoted to a description of the geysers and thermal springs; the second to an account of the principal geyser regions of the world for purposes of comparison; the third to thermo-hydrology, in which he discusses the general characters of thermal waters, their chemistry and deposits, and the theories of geyser action. The premature disbanding of the Survey prevented the completion of this essay on the scale originally intended. But Dr. Peale may be congratulated on having made a most useful addition to the literature of the subject. Not the least of its merits is the copious bibliography which is given in an Appendix.

The third section of the volume, by that able cartographer Mr. H. Gannet, deals with the topography, and gives an interesting *résumé* of the various reconnaissances and surveys which have resulted in the present detailed map of the Yellowstone Park.

The other volume, forming Part I. of the Report for 1878 is divided into two sections. One of these, relating to geology and palæontology, contains a series of Reports by Dr. C. A. White on the invertebrate palæontology of the Western States and Territories from the Carboniferous to the Tertiary rocks, and is accompanied by forty-two Plates of Fossils. Some sections have a special interest, in particular that in which the author discusses the fossils of the much disputed Laramie group, and sustains his previously expressed opinion that this group should be regarded as transitional between the Cretaceous and Eocene formations of the West. The abrupt cessation of the Survey, by depriving Dr. White of an opportunity of completing some of his work by further collection, has materially crippled him in the preparation of these further contributions to a subject which he has already done so much to elucidate.

Mr. Orestes St. John supplies a report on the Wind River District Basin, and Mr. Scudder reprints with additions and alterations the report on the Tertiary Lake-basin of Florissant, Colorado, which has already appeared in the Bulletin of the Survey, and which made known the extraordinary abundance of insect remains preserved in the lacustrine deposits of that locality.

The second section of the volume is devoted to Zoology, and consists of two Reports—one of them an invaluable monograph by Mr. A. S. Packard, jun., on Phyllopod Crustacea, recent and fossil, illustrated with thirty-nine plates and a coloured map showing the zoological provinces of North America. This memoir will be welcomed by all who take interest in the investigation of genealogies and of the history of distribution in the animal kingdom. Dr. R. W. Shufeldt concludes the volume with an essay on the osteology of various American Birds, likewise copiously illustrated with woodcuts and with lithograph plates.

From this outline it will be seen how well Dr. Hayden has sustained to the last the character of the Survey under his charge. During his tenure of office he proved himself to be endowed with rare powers of organization and administration and to possess wide views of the scope of a survey which, like his, was to break ground for the first time in new and unknown territories. He might have been simply an explorer, anxious to find out the sources of rivers, the positions of passes, the heights of peaks, and the trend of mountain-ranges. He might have been a mere geologist, desirous of adding some thousand miles of new area to formations already known or of discovering formations such as have no precise parallel elsewhere. He might have been only a topographer, caring chiefly for the accuracy of his triangulations and levellings. He might have been a botanist or zoologist, eager to add new species to the known flora and fauna of the earth's surface. In one sense Dr. Hayden was none of these; in another sense he combined the fun tions of them all. In later years his executive duties appear to have left him little opportunity for carrying on original research himself. But he had sympathy with all the pursuits just named, and had the faculty of choosing good men for prosecuting them. He had force of character enough to succeed in battling his way and getting his appropriations from Congress, and he had the perseverance to press forward his operations, keeping his fellow-labourers together and publishing with their aid a series of volumes of which the United States may well be proud.

The consolidation of the various Surveys under one organization was an inevitable and entirely justifiable step on the part of Congress, and the United States Geological Survey could not be under more energetic and skilful direction than that of its present estimable chief, Major Powell, with the cooperation of such leaders in geological enterprise as Mr. Gilbert, Captain Dutton, and their colleagues. Nevertheless, it may be permitted to a geologist on this side of the Atlantic, who looks disinterestedly but not unsympathetically upon the progress of events on the other side, to express his regret that it should not have been possible to find a place where scope might have been afforded for the talents of one who had done such good service to geology as Dr. F. V. Hayden.

ARCH. GEIKIE

OUR BOOK SHELF

Attraction et Gravitation d'après Newton. Par Mme. Clémence Royer. Extracted from the Review "*Philosophie positive.*" Pp. 23. (Paris, 1883.)

IT is very surprising to find what is, in most other respects, a really well-written and able dissertation on the question of *action at a distance* marred at the very outset by an almost inexplicable blunder.

Madame Royer has evidently read much, and lays down with great clearness the distinction between Newton's Theory of *Gravitation* as a mode of grouping together under one simple law the whole phenomena of physical astronomy, and the assumption handed down from old Greece, of a mutual *attraction* exerted upon one another by any two portions of matter. She shows that Newton everywhere expresses himself in the most explicit terms against the notion of distance-action. But she also points out the curious distinction between Newton in the *Principia*, the pure mathematician and physicist, who constructs no hypotheses and declares that the mode in which gravitation is produced is one which he has not been able to discover from the phenomena themselves; and Newton in his *Optics*, the bold speculator, who discusses the possible characteristics and properties of the medium by which gravitation may be produced.

This is, on the whole, so well done that we are positively amazed to find the all-important property of matter, *Inertia*, absolutely and entirely ignored. From a psychological point of view, the following remarks, by such a writer as Madame Royer shows herself to be, are of the very highest interest and curiosity:—

"Qu'est ce en effet que la notion de *masse*, si ce n'est celle d'un corps déjà considéré comme pesant? Un corps sans pesanteur serait-il une masse? en aurait-il les propriétés mécaniques? Une masse, supposée absolument isolée dans l'espace, aurait-elle un poids? Evidemment non, puisque le poids ne naît que des rapports de grandeur et de distance des masses. Dire que le poids ou la masse est proportionnel à la quantité de matière ou de substance, c'est affirmer une chose que nous ne savons pas, que nous ne pouvons absolument savoir d'aucune manière. Tout ce que nous savons c'est que, considérant des corps déjà pesants, en vertu de leurs relations de quantité et de distance, leur pesanteur croît en raison de ces quantités et en raison inverse de ces distances, sans que leurs quantités, comme matière, soient altérées, de façon que des masses doubles ont une tendance deux fois plus forte à tomber l'une vers l'autre, ce qui fait qu'elles s'approchent en réalité avec la même vitesse (*sic*), et que si leur distance devient moitié moindre, elles s'approchent quatre fois plus vite l'une de l'autre.

"Mais comme l'unique moyen que nous ayons de mesurer la grandeur de ces masses est de les peser, nous restons dans l'impossibilité absolue de dire si des masses de même poids, en même relation de distance avec d'autres masses pesantes, contiennent, oui ou non, la même quantité de matière."

Evidently Madame Royer, in reading the *Principia*, has failed to notice, not only the definition of *Vis insita* but also, those important pendulum experiments by which Newton satisfied himself of the exact proportionality of weights to masses, in any one place. Here we see, in no doubtful manner, the evil effects of an education in which athletics have no part. No one, man or woman, who has had experience of Indian clubs or of dumb-bells, could for a moment doubt that we have another mode of distinguishing mass, besides weighing.

Electrotechnisches Jahrbuch von der Electrotechnischen Gesellschaft in Frankfurt am Main. (1883.)

ALL over Germany are springing up electrotechnical societies, in emulation of those in Berlin and Vienna, fulfilling a kindred part to that played in Great Britain by the much older Society of Telegraph Engineers and Electricians. The volume published by the Frankfort Society—the first of its *Proceedings*—contains several papers of interest. Amongst these may be noticed two by Dr. Th. Stein of Frankfort, on the measurement of small intervals of time by the photographic electric method; and on certain modern electro-chirurgical apparatus, especially modifications of the influence machine of Holtz. In the first of these papers Dr. Stein describes an apparatus for photographing the pulsations of the heart, &c., as conveyed by a Marey's tambour to an apparatus which at the same time causes a record from an automatic tuning-fork interrupter to be imprinted side by side on the photographic plate. In Dr. Stein's second paper, he describes the use of a small Deprez electromotor to drive a small fan, by which warm, dry air is caused to circulate round a Holtz machine, which by this means is always ready for action. In some historical notes by Herr Holthof, dealing with the early stages of telegraphy, there comes out the interesting point that, so early as 1854, an important improvement had been made in the suggestion of Bourseul for an electric telephone. An anonymous writer, signing himself "L." in the pages of "Didaskalia," gave in that year, under the title of "Elektrische Telephonie," an account of Bourseul's crude notion, and added something not to be found in Bourseul's suggestion, namely, the use of an electromagnet in the receiver to actuate the disk of thin metal to which the listener was to apply his ear; the description of the instrument—which, it seems, never reached anything beyond an anonymous suggestion—reads like a description of a Bell telephone, of which it is a remarkable foreshadowing. It is remarkable that Reis, who was at that time resident in Frankfort, should, when using an electromagnet in his subsequently invented telephone, have stopped short of the use of a disk in his receiver in place of the bar armature he employed. It is pretty clear he did not know of "L.'s" suggestion. The remainder of the papers in the "Year-book" deal chiefly with telegraphic and fire-alarm apparatus. The Frankfort Society is to be congratulated on the value of the papers communicated to it during its short existence.

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.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

What are the Saccopharyngoid Fishes?

In December of last year M. Vaillant communicated to the French Academy of Sciences a notice of a remarkable deep sea fish, to which he gave the name *Eurypharynx pelecanoides*. He was in great doubt as to the relations of this form, but concluded that "of all fishes it is to *Malacosteus niger*," placed in the family Scopelidæ by zoologists, that he was most inclined to approximate the new type. Five specimens of a nearly related form, to which Mr. J. A. Ryder and myself have given the name *Gastrostomus bairdii*, were obtained by the United States Fish Commission steamer *Albatross*, in the summer and autumn of the present year. The largest of these specimens is nearly two feet long, and an anatomical investigation reveals some very remarkable peculiarities of structure, which have caused Mr. Ryder and myself to differentiate the two forms, Gastrostomus and Eurypharnyx, in a distinct order of fishes to which we have given the name Lyomeri.

The Lyomeri are fishes with five branchial arches (none modified as branchiostegal or pharyngeal) far behind the skull; an imperfectly ossified cranium, deficient especially in nasal and vomerine elements, articulating with the first vertebra by a basi-occipital condyle alone; with only two cephalic arches, both freely movable, (1) an anterior dentigerous one, the palatine, and (2) the suspensorial, consisting of the hyomandibular and quadrate bones; without opercular elements; without maxillary bones, or distinct posterior bony elements to the mandible, with the scapular arch imperfect (limited to a single cartilaginous plate) and remote from the skull; and with separately ossified but imperfect vertebræ. Whether other than the two genera mentioned, Eurypharynx and Gastrostomus, belong to this order is not entirely certain, but there is little doubt, in the opinion of Mr. Ryder and myself, that the family Saccopharyngidæ also belongs to the order, and it is for the purpose of calling attention to this doubtful and still little known type, that in behalf of Mr. Ryder and myself I address the present communication. No satisfactory information has been given as to the Saccopharyngidæ, except by Dr. Mitchill in 1824, and by Dr. Harwood in the *Philosophical Transactions* for 1827. The plate published in the volume cited represents the head of Ophiognathus with the mouth closed as well as open, and the differences in the relation of the posterior angles of the mouth to the axis indicate that Ophiognathus (as well as Saccopharynx) has a movable suspensorium, and would therefore exhibit the Lyomerous peculiarity of structure. It appears from Dr. Günther's "Catalogue of the Fishes in the British Museum" (vol. viii. p. 22), that in 1870 there were two specimens of a Saccopharyngoid fish—probably the *Ophiognathus ampullaceus*—in the British collection. (It is possible that the so-called young mentioned in the Catalogue may be a Eurypharyngoid.) The question whether that species belongs to the Lyomeri can therefore be readily settled negatively or affirmatively. Assuming that the family Saccopharyngidæ belongs to the order, the two families would apparently be distinguishable as follows:—

The Eurypharyngidæ are Lyomeri with the branchio-anal portion much shorter than the rostro-branchial; with the tail very elongated and moderately attenuated backwards; the head flat above and with a transverse rostral margin, at the outer angles of which the eyes are exposed; with the palatine jaws excessively elongated backwards and the upper parallel, and closing against each other as far as the articulation of the two suspensorial bones; with minute teeth on both jaws; the dorsal and anal fins well developed, and continued nearly to the end of the tail, and with minute narrow pectoral fins.

The Saccopharyngidæ appear to be Lyomeri with the branchio-anal portion much longer than the rostro-branchial; the tail excessively elongated and attenuated; the cranium unknown; the eyes antero-lateral; with the palatine bones moderately extended backwards (in comparison with the Eurypharyngidæ), and apparently not closable against each other; with enlarged teeth in one or both jaws; with the dorsal and anal fins feebly developed, and with pectorals small but bread. Saccopharynx is considered by Dr. Günther to consist of "deep-sea congers," but evidently it is not at all related to the congers or any other allied fishes.

I can assure English naturalists that no type of fishes will more fully reward investigation than the Saccopharyngidæ, and it is to be hoped that some master of applied anatomy, like Profs. Huxley or Lankester, may deem an examination of the specimens in the British Museum worthy of their attention. A few of the many remarkable peculiarities of organisation of the type have been described in an article "On the Anatomy and Relations of the Eurypharyngidæ," by Theodore Gill and John A. Ryder, in the *Proceedings* of the United States National Museum for 1883 (pp. 262-273), and a full monograph will appear later. May we hope for information respecting Saccopharynx in time to correlate it with that on Gastrostomus? THEO. GILL

Cosmos Club, Washington, December 18, 1883

The Mildness of the Season

As the flowering of plants at this time of the year is perhaps the best indication of the mildness of the season, I send you a list of the plants from which I and a friend gathered one or more flowers on the 24th and 26th inst. I have given the list of each day's gathering separately. Those on the 24th were gathered between this city and Hinton Charterhouse, once noted for its Carthusian monastery. Those of the 26th were gathered between Bath and Bradford-on-Avon, a very old town which contains the remains of a Saxon church and one of the finest tithe barns in England. VIATOR

Bath, December 27, 1883

List of Plants from which Flowers were gathered on December 24

Draba verna (Spring Whitlow Grass)
Primula acaulis (Primrose)
Veronica officinalis (Com. Speedwell)
Bellis perennis (Daisy)
Centaurea scabiosa (Greater Knapweed)
Ulex europæus (Com. Furze)
Achillea millefolium (Com. Yarrow)
Crepis virens (Smooth Hawk's Beard)
Lamium album (White Deadnettle)
Fragaria vesca (Wood Strawberry)

Gathered on December 26

Ranunculus repens (Creeping Crowfoot)
Cheiranthus chieri (Com. Wallflower)

Cerastium semidecandrum (Little Mouse-Ear Chickweed)
,, *triviale* (Lesser do.)
Arenaria tenuifolia (Fine leaved Sandwort)
Pimpinella saxifraga (Com. Burnet Saxifrage)
Pastinaca sativa (Wild Parsnip)
Torillis anthriscus (Upright Hedge Parsley)
Senecio vulgaris (Com. Groundsel)
,, *sylvaticus* (Mountain do.)
Crepis virens (Smooth Hawk's Beard)
Hypochæris radicata (Long-rooted Cat's Ear)
Taraxacum dens-leonis (Dandelion)
Veronica hederifolia (Ivy-leaved Speedwell)
,, *polita* (Gray Procumbent do.)
,, *agrestis* (Green do. do.)
Lamium purpureum (Red Deadnettle)
,, *album* (White do.)
Rumex crispus (Curled Dock)

River Thames—Abnormal High Tides

In a letter in Nature of November 2, 1882 (p. 6), I gave a review of exceptional tides from 1860, and attempted to trace the causes thereof; it appeared that from 1860 to 1868 inclusive the computed maximum rise above "Trinity Standard" of high water for spring tides was 6 inches, and the actual range excess was 3 feet 6 inches above that standard.

From 1869 to 1882 the greatest computed elevation at high water was 2 feet 1 inch, and the maximum rise 5 feet above "Trinity" at Westminster, viz. on January 18, 1881, and again on October 28, 1882, the same height was attained—in each case resultant on a great north-east gale. On November 14, 1882, the afternoon tide marked 2 feet 5 inches above "Trinity," or 2 feet 4 inches above computed height—resultant again on a north-north-east gale. Since then, during the last thirteen months, there have been no very exceptional tides until last springs.

The following abstract table gives the more salient results for the present year:—

High Waters referred to "Trinity"

1883		Computed ′ ″	Observed ′ ″	Difference ′ ″	Wind
Jan.	22 p.m.	0 7 below	1 0 above	1 7	E.N.E.
,,	24 ,,	0 2 above	1 6 below	1 8	S.
Feb.	9 ,,	1 6 ,,	1 6 above	Equal	W.N.W.
,,	12 ,,	1 1 ,,	2 6 ,,	1 5	S.S.W. to S.[2]
,,	13 ,,	0 1 ,,	2 0 ,,	1 11	W.S.W.[1]
Mar.	12 a.m.	2 0 ,,	3 8 ,,	1 8	N.N.W.
April	21 p.m.	0 6 below	1 0 ,,	1 6	E.N.E.
June	8 ,,	0 5 above	1 6 ,,	1 1	E.N.E.
Sept.	3 ,,	0 6 ,,	0 6 below	1 0	W.S.W.[2]
,,	5 ,,	0 2 ,,	1 6 above	1 4	N.N.W.
Oct.	2 ,,	0 2 ,,	1 6 ,,	1 4	N.
,,	4 ,,	0 1 ,,	2 0 ,,	1 11	N.N.W.[2]
,,	16 ,,	1 2 ,,	"Trinity"	1 2	W.S.W.[2]
Nov.	5 ,,	1 1 below	"Trinity"	1 1	W.N.W.
,,	6 ,,	1 9 ,,	0 6 below	1 3	W.[2]
,,	19 ,,	0 1 ,,	1 6 above	1 7	W.
,,	29 ,,	0 8 ,,	0 8 ,,	1 4	S.S.E.
,,	30 ,,	0 5 ,,	1 0 ,,	1 5	W.
Dec.	1 ,,	0 3 ,,	1 9 ,,	2 0	N.N.W.
,,	12 midnight	0 5 ,,	3 6 ,,	3 11	W.N.W.[2]
,,	16 a.m.	1 1 above	3 8 ,,	2 7	N.[1]

[1] A gale. [2] A great gale.

It will be observed that in the majority of cases northerly winds accompany or have preceded the exceptionally high tides; also how a great westerly gale blowing down the river depresses the range of tide. The most remarkable result is that attendant on the great gale of the 12th inst. during last springs, for although high water level was less by 18 inches than in January, 1881, and October, 1882, it was exceptional for its great rise over the computed elevation, being no less than 3 feet 11 inches above the height denoted in the Admiralty tide tables with the reservation before named in my former letter, that the computed heights are for London Bridge. The high water of October 28, 1882, was 3 feet 4 inches above computed height; but the very remarkable tide of January 18, 1881, was actually 5 feet above the estimated range, which was only level with "Trinity Standard." The afternoon tide of Sunday, the 16th inst., was also, it will be seen, very much increased by the northerly gale then prevailing.

J. B. Redman

6, Queen Anne's Gate, S.W., December 19, 1883

Deafness in White Cats

Referring to the note in your issue of December 13 (p. 164), by Mr. Lawson Tait, on "Deafness in White Cats," I should like to state, if my remarks may not be out of date, that my father kept a breed of deaf white cats over several years; and on making an inquiry regarding these cats of my brother, who now lives in Reading, but who at that time was resident with my father on a farm in North Hampshire, he informs me that the deaf cats were all white with blue eyes, with one single exception, and that one refers to an aged mother who was named "Deaf," on account of her infirmity, and who had eyes of different colours, the one being "red," or pink, as seen in white rabbits, and the other blue. So remarkable was the appearance of this cat that the eyes often attracted the attention of visitors, and my brother has more than once related to me a circumstance which I should not mention here, save that it so thoroughly bears on this question as one of fact. On one occasion a neighbour, remarking on the ocular peculiarities of this cat, elicited from my father the jocular reply that "she had one eye for the rats, and another for the mice." My brother further states that these deaf cats were all females, and that the breed was preserved on account of its furnishing "good mousers." I apprehend that this characteristic may in some measure be attributed to the character of the eyes enabling the animals to see better in obscure light. Males were not preserved, because they became rovers and destroyed the game. When any of the offspring were pied, or otherwise coloured, they were not deaf. Bearing on this, and evidently referable to my brother's early associations, he once observed, in his walks round Reading, a white cat with blue eyes sitting at a cottage door, and on inquiring he found that the animal was deaf; but he made no observation as to whether it was male or female.

Joseph Stevens

Oxford Road, Reading, December 24, 1883

Teaching Animals to Converse

I have read with interest Sir John Lubbock's communication (p. 216), but I would like to know whether any precautions were taken to find out whether "Van" selected the right card by his sense of sight or by scent? This could have been easily done by changing the card for a facsimile which had not been previously scented. A more thorough test would be to employ a set of cards with "Food" written on one side of each and some other word on the other, then putting the cards in cases with an opening exposing one word only. The cards could then be put in a row and be kept in the same relative position, the changes for the experiments being made by turning the cards in their cases. Would it not be simpler to commence with drawings on the cards instead of words. For instance, a saucer or biscuit for "Food," a bone for "Bone," a hat for "Out," &c.?

Hanover, January 5 J. S. B.

On the Absence of Earthworms from the Prairies of the Canadian North-West

An incidental allusion is made by Mr. Christy in Nature of the 3rd inst. (p. 213) to Darwin's statement that earthworms "abound in Iceland." In 1881 I spent several weeks in that island, and had occasion many times to search for worms as a bait for trout and char around Thingvalla, Ori, the Sog River, &c., and could not obtain them except near the farmhouses—which are at great distances from each other—and absent altogether from the interior of Iceland, which is uninhabited and a desert.

Richard M. Barrington

Fassaroe, Bray, Co. Wicklow, January 4

Merrifield's "Treatise on Navigation"

I beg to thank your reviewer of my book for the suggestions he has made in Nature of December 20 (p. 169), and should like to point out to him that he must have overlooked some remarks contained therein, when he says:—

"We regret that Mr. Merrifield has omitted from the chapter on Traverse Sailing the warning given by Raper, that, especially in high latitudes, the difference of longitude should be found on each course," &c., by Mercator's sailing.

Will you kindly allow me to remark that I mention this twice in my book? First, on pp. 88, 89 I say, "Middle-latitude sailing should not be used in (*a*) high latitudes; (*b*) when the difference of latitude is great ; and (c) when the two places under consideration are on different sides of the Equator. In these cases Mercator's sailing should be used." And again, on p. 104, when speaking of a ship's journal (which I considered the right place to introduce it), I give this caution :—

"As longitude by inspection depends on the middle latitude, the cases in which it should not be used as explained under middle-latitude sailing should be attended to : and if the latitude be high, or the distance made good be great on a small course, then correct longitude can only be obtained by finding the position of the ship by Mercator's sailing on every change of course."

JOHN MERRIFIELD

Navigation School, Plymouth, December 22, 1883

[I WAS, of course, aware of the existence of the paragraphs mentioned by Mr. Merrifield, but they do not seem to meet the point raised, viz. that no notice was taken in the chapter on Traverse-Sailing of the necessity of finding the difference of longitude on each course in high latitudes, although the subject is incidentally referred to at p. 104. There will doubtless always be differences of opinion between the writer and reviewer of a book, but it seems to me that, in teaching, the theory should be unassailable. Whether in practice it is necessary to apply all the corrections required should be left to the judgment of the practitioner. Mr. Merrifield has reversed this order, having omitted certain rules from the instructions on Traverse Sailing, but mentioned them casually in a paragraph preceding the copy of the log.—THE REVIEWER.]

AN AMERICAN ROTHAMSTED

HALF a century has elapsed since Sir John Lawes commenced at Rothamsted Park, in Hertfordshire, the unique series of experiments the results of which have produced so salutary an effect on agricultural practice. The inquiries were at the outset restricted to determining the influences of various kinds of manures, and these led to the institution, in the year 1843, of systematic field experiments which are still in progress. Wheat and barley have been grown on the same land for forty-one consecutive years, oats for twelve years, turnips for thirty years, potatoes for nine years, meadow herbage for twenty-eight years, while beans, clover, sugar-beets, and mangel-wurzel have likewise been grown more or less continuously, and all under the varied influences of the different manurial agents. The influence of soils and manures on the composition of crops, the relations of botanical characteristics to the soil and to manures, the physical and chemical properties of the soils themselves, the transpiration of water by plants, the question as to whether plants assimilate free nitrogen, the composition of rain and drainage waters,—these are some of the chief problems which have been the subjects of research. Not less noteworthy are the experiments which have been made with animals, such as the determination of the relation of quantity and kind of food consumed to increase in live weight, the proportion and relative development of the different organs of farm animals, the composition of the animals in different conditions as to age and fatness, the composition of the solid and liquid excreta in relation to that of the food consumed, and the composition of the ash of animals in different conditions and variously fed.

Valuable and highly appreciated as are the many published results of the Rothamsted researches, yet their significance could not fail to be greatly enhanced were it possible to compare them with similar experiments carried on elsewhere. But the efficient equipment of an agricultural experiment station like that at Rothamsted is a very costly affair, and, unless State aid can be relied upon, it can hardly be undertaken save through the munificence of private individuals. The splendid example set by the founder of the Rothamsted station in this country has stimulated an American gentleman to establish in the State of New York an experimental farm which is already well on the way towards becoming another Rothamsted. The credit of this enterprise is due to Mr. Lawson Valentine, who thereby realises "a long-cherished plan for doing something towards the progress of American agriculture," and at the same time providing a pleasant country home conveniently near his place of business in New York City.

Houghton Farm, Orange County, is within two hours' railway journey of New York City, and occupies an area of 600 acres. In the summer of 1879 the proprietor secured the services of Dr. Manly Miles as director of the projected experiments, and after a period of eighteen months, during which the fields were laid out and drained, the experiments were begun. Since the summer of 1881 the experimental work has been carried on as a distinct department, quite separate from that of the farm proper on the one hand, and from that of the residential portion of the estate on the other. Thus the present plans as to Houghton Farm are, in the words of the proprietor, the following :—1. That the farming operations be carried on in accordance with the best known methods, and under the best possible organisation and management, with a view to educating and enlightening others by furnishing valuable examples and results in practical agriculture. 2. That there be a scientific department devoted to agricultural investigation and experiment, and that such department be of the highest order, so as to command the respect, interest, and co operation of the leading scientific minds of this and other countries. 3. That Houghton Farm be a comfortable, healthful, and attractive home for the family of its proprietor, and afford large hospitality for friends and guests.

Two distinct though closely related and parallel lines of investigation are recognised. Firstly, the purely scientific work of the laboratory to gain a knowledge of the elements of animal and vegetable nutrition, and of their relations under known definite conditions. Secondly, accurate and well planned experiments in the feeding of animals and in the growth of crops to answer the various practical questions that arise in the management of the farm, and to determine the agricultural value of the facts and theories that are presented as the result of purely scientific investigations. Experiments under this second head demand, on the part of those who conduct them, an extended knowledge of practical farming, as well as the trained skill and ability for original investigations that are required in researches in pure science.

As the system of growing the same kind of crop on the same land for a continuous series of years, in the manner followed at Rothamsted, appears to be the only one that can be relied upon to give consistent and trustworthy results, this method has been adopted at Houghton Farm. But besides wheat, barley, and oats, the staple American cereal, Indian corn, forms the subject of a special series of experiments. Indian corn is successfully cultivated over a very wide area; it much exceeds in aggregate value any other crop grown in the United States ; it is of great importance as a cleaning crop; and the large amount of cattle food of good quality it is capable of yielding, together with the value of the manure produced per acre when it is fed on the farm, all point to this crop as the one a series of systematic experiments upon the cultivation of which will yield results of greater practical interest to American farmers than will experiments with any other field crop.

The first report on the experiments with Indian corn has already been published, with considerable elaboration of detail. Some interesting results have been established, particularly those on the influence of drainage, on the employment of barnyard manure, and on the character and quality of the grain.

Prof. D. P. Penhallow, the botanist and chemist at the station, has issued no less than four reports last year and this. These deal respectively with the meteorology of the district in which the farm is situated, based on observations extending over a period of six consecutive months; with soil temperatures, a series of observations embracing a similar period; with the normal condition of vegetable structure with reference to cell contents; and with "peach yellows," a disease attacking peach trees. To do justice to any one of these memoirs would really require a separate notice, but the mere mention of them will serve to indicate some of the channels into which the energies of this new centre of research are being directed. In connection with the meteorological work, however, it is worth noting that daily bulletins were issued, the predictions being made for twenty-four hours from noon to noon. The whole number of predictions made was 210, of which only 1·9 per cent. proved incorrect, so that the bulletins came to be depended upon and served a most important purpose for the time during which they were issued. All the reports are printed in an attractive form, and special pains appear to have been bestowed upon the diagrams and coloured plates.

To the names that have already been mentioned it is necessary to add that of Mr. Henry E. Alvord, who has undertaken the duties of general manager. Mr. Alvord's name is already familiar to agriculturists on this side of the Atlantic, particularly in connection with American dairy farming, and his association with Houghton Farm is another guarantee, if one were needed, of the thoroughly business-like manner in which the new experiment station is to be conducted.

From this brief sketch it will be seen that there exist at Houghton Farm potentialities whose development can hardly fail to exercise considerable influence on the agricultural practice of the future. Those who have studied the Rothamsted results will be glad to compare with them the results deduced from the Houghton Farm experiments, and each station will be benefited by comparing notes with its friendly rival, while the valuable work which English agriculturists associate with the names of Lawes, Gilbert, Pugh, Masters, and Warington will, it is to be hoped, find a parallel in the discoveries we shall confidently look for from the transatlantic station. Intentionally planned, in many details, upon the same lines as Rothamsted, there is one point in which the new station specially resembles its English prototype, and it is contained in the words, "Visitors are always welcome at Houghton Farm."

W. Fream

EDELMANN'S ELECTROMETER

AMONGST the many forms of electrometer that derive their origin from the quadrant electrometer of Sir William Thomson is that of Edelmann, which is very extensively used in the physical laboratories of the Continent. Dr. Edelmann, whose name it bears, is not only proprietor of workshops in Munich, which are rapidly winning renown for the excellence of the instruments which they turn out, but also holds the post of *privat-docent* in the Polytechnicum of Munich.

In the parent instrument of Sir W. Thomson, and in most of the modifications of that instrument which go by the names of Branly, Kirchoff, Mascart, &c, the quadrants are literally four quadrants cut from one plane circle; and in most of these instruments the *needle* is of the flat dumb-bell or lemniscate form which Sir W. Thomson himself gave to it. Dr. Edelmann has, however, taken a departure in quite another line, his instrument being very appropriately named the "cylinder-quadrant" electrometer. The three accompanying figures show the essential parts of the instrument. The quadrants, marked G in Fig. 1, and *a*, *b*, *c*, *d* in Fig. 2, are formed by taking a metal tube, furnished with flanges above and below, and slitting it into four parts by four equidistant cuts parallel to the axis of the tube; the four pieces being then set in their proper places by being screwed to two rings, R and S, of ebonite. This arrangement has some advantages over those of the ordinary quadrant electrometers. In these, when the quadrants consist of four pieces of flat brass borne each on an insulating pillar, it is difficult to set them so that they shall be all exactly in one plane; and when, as in some of the more delicate instruments, the quadrants are made of a hollow box slit into four parts, there is found the further difficulty of arranging the quadrants so that the needle can be taken out and replaced. These difficulties are, to a large extent, obviated in Dr. Edelmann's form of instrument; for the inner surface of the cylinder, which constitutes the four quadrants, can be turned perfectly true after the quadrants have been screwed to the ebonite rings; and there is no difficulty at all in lowering the needle into the cylindrical cavity within the quadrants, or in lifting it out. The needle itself is of the form shown in Figs. 2 and 3, and

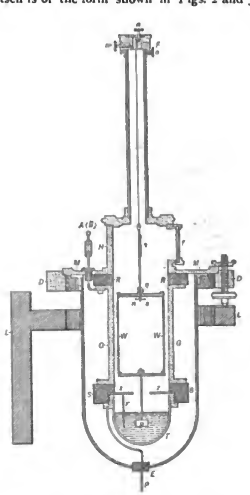

Fig. 1.

consists of two portions of metal (W W) cut from a cylinder, united above and below, and hung by a single fibre of small torsion from an adjustable head, F, above. A mirror, *s*, is attached above the needle, and a platinum vane, P, below it dips into a vessel, T, containing sulphuric acid. To give directive force to the "needle" a small magnetic needle, *n s*, is attached to it. This device was indeed used in some of Sir W. Thomson's early instruments, though subsequently abandoned in favour of the bifilar suspension usually adopted. It is of course understood that the opposite pairs of quadrants are, as usual, connected together. Electrodes, A, B, pass through the metal plate, M, which covers the instrument, and are connected with the quadrants as shown in Fig. 1. An outer jar of glass surrounds the instrument and is fixed to the under side of the plate M by a bayonet point. The plate M itself is very substantial, and is provided with three levelling screws which rest in V-grooves in a strong ring-shaped support of cast zinc, L L, which is screwed to the laboratory wall like a bracket.

It will be seen that Dr. Edelmann has discarded the Leyden jar, replenisher, and gauge, which play so important a part in Sir W. Thomson's electrometers. Instead of these a Zamboni pile, or a battery of 200 small well insulated voltaic elements, is used. These are made of test-tubes filled with common water, and having small zinc-copper pairs placed from cell to cell. It is difficult to believe that either of these dispositions is an improvement on the replenisher-jar-gauge arrangement, though either may be somewhat cheaper. Nor is it likely that the presence of the ebonite rings R and S will add, in the

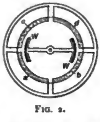

Fig. 2.

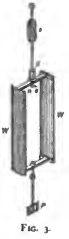

Fig. 3.

long run, to the satisfactory working of the instrument; for, as is well known, this substance when exposed to light decomposes at the surface, and becomes covered with a conducting-film of acid. The insulation of the quadrants ought not to be risked by such a doubtful device. It ought to be mentioned that a cylindrical arrangement of quadrants had been previously employed by Silow in an instrument for investigating the dielectric capacity of liquids: but to Dr. Edelmann is due the credit of having applied this arrangement for the construction of these electrometers, which in consequence of their many good points are becoming so popular for laboratory work both in Germany and elsewhere.

GLEANINGS FROM THE REPORTS CONCERNING THE ERUPTION OF KRAKATOA

I DO not propose to give here an abstract of all the reports which I have gathered, but I only wish to state some important data which might be useful to those who wish to become acquainted with the full particulars concerning the eruption. Therefore I have mentioned the authorities from which I have taken the following statements, in order that the reader who wishes for more circumstantial reports may find them easily.

I regret to say that I have not been able to find any reports from Tjiringin and the lighthouse-keepers of Java's First Point and Vlakke Hoek. In the beginning of October an engineer of the mine-service was sent to Krakatoa to examine the island, and he is expected now to bring in a scientific report about the eruption; it is to be hoped he has insisted that everything referring to the catastrophe should be circumstantially recorded.

1. *Data referring to the time anterior to the Eruption.*—In a report which was published in the *Java Courant* (the paper of the Dutch Government), which was brought from Batavia by the mail of August 25, it was said: "There are now two craters on Krakatoa, 3 km. distant from each other, which are continually working. The western crater is at the foot of Mount Perbuatan (working since May 20); the eastern crater working since a more recent date (which is unknown to me) at the foot of Mount Dannan. The outlines of the top of Mount Perbuatan are changed; the outlines of the beach are also altered by some increase of land along the shore. The trees which covered the island are burnt for the greater part."

As to what occurred before and during the eruption of August 26 and 27 I particularly took the data:—

(1) From the report of the *Berbice*, Capt. Logan, from New York (*Nieuws van den Dag*, October 11): August 26 at 2 p.m. she was off Vlakke Hoek, 20 miles to the south; she got sight of the light of Java's First Point August 28 at 12 p.m. Since August 26 at 4 p.m. she had only little sail; 28, at 4 a.m., maintopsail was set; afterwards at noon she set full sail and made for First Point. Therefore she was during the eruption near a line which joins Java Head and the point where she was August 26 at 2 p.m.

(2) From the report of the *Charles Bal* (NATURE, Dec. 6, p. 140): She passed Prince's Island August 26, at 9 a.m.; Krakatoa seen at 4.15 p.m., north half east, 10 miles distant. At 11 p.m. the island became more visible, west-north-west, 11 miles distant; August 27 at 6 a.m. she set sail, passed lighthouse Fourth Point at 8 o'clock, Anjer at 8 30; passed Button Island at 10.15.

(3) From the report of eye-witnesses, who were at Anjer during the catastrophe (*Nieuws van den Dag*, October 11 and 14).

(4) From a report written by a passenger (an engineer) of the *Gouverneur Loudon* (Dutch Indian steamer, 761 reg. tons, 190 h.p.) (*Nieuw. Rotterdam. Court.*, October 23, by Mr. van Sandick): She was off Anjer August 26 at 3 p.m.; went to Telok Betong, where she arrived at 7 p.m.; remained there till next morning at 7 o'clock. After a wave had destroyed Telok Betong she made for Anjer, but before she had left the bay darkness came on, and she was compelled to lie there till August 28 in the morning.

(5) From the report of eye-witnesses at Telok Betong (*Nieuws van den Dag*, November 3 and 13).

Moreover, I took a few particulars from the reports of Katimbang (*Nieuws van den Dag*, October 16) (Lampongs, at the foot of the Radjah Bassa), Binuangan (*Nieuw. Rotterdam. Court.*, October 23) (at the bottom of the Semangka Bay), and Pulu Merak (*Nieuws van den Dag*, October 10).

Though *e.g.* on the Island Bali strong detonations were heard in the morning of August 26, the reports of Telok Betong and Anjer say: Fine weather, no extraordinary detonations in the afternoon. *Berbice* reports: Sky dark at 2 o'clock, threatening at 4 o'clock; at 6 p.m. thunder and lightning. On board the *Charles Bal* at 4 15 an eruption at the east of Krakatoa was observed; the masses which were driven forth to the east had the appearance of a furious squall. Anjer reported: At 6 o'clock quite dark; at Telok Betong at 6 p.m. slight rain of ashes; at the same time *Berbice* experienced ashes pouring down at once; it was quite dark. Fall of ashes and darkness continued the whole evening. About this time the commotion of the sea began also. At Anjer, between 6 and 7 p.m., several vessels were carried by the wave to and fro in the harbour (canal), but the sea did not flow over. From Merak is reported, August 26, at 7 p.m. or 7.30 p.m.: Heavy detonations, violent shocks (but no earthquake). Waves swept away the Chinese camp; caused much damage. In the night (I could not find out at what o'clock) fiery phenomena were seen in the direction of Krakatoa, shocks of earthquake, waves. The Controleur, who was at Katimbang, related: "August 26, 7 p.m., several prows thrown on the beach, waves, but the sea did not flow over, nor did the waves grow higher."

The *Loudon* came to anchor off Telok Betong at 7 p.m. Rough sea, boats could not communicate. They observed that there was something wrong, but could not make out what it was. The Dutch bark *Marie*, which was there also (there are two vessels of the same name, *Marie* and *Maria*, in the list, the one, *Marie*, of 570, the other, *Maria*, of 790 tons) reported: At 7.30 currents observed in different directions, some small vessels lost their anchors, ten persons saved from being drowned. From Telok Betong is reported: By 6.30 sea quite calm, level of the sea 1 metre lower than pier, a moment afterwards 1 metre above it; people who were at the end of the pier, about 1000 metres distant from the shore, had to walk back through the water, which was done without accidents. Meanwhile the *Charles Bal* was in a fearful situation since 5 o'clock. She reports:—"At 5 p.m. sky darkening, detonations stronger, pumice-stones pouring down, rather big pieces, had to cover skylights. At 6 p.m. big pieces ceased, small pieces, ashes, &c., continued. Terrible night. After 7 p.m., at Anjer, heavy detonations were heard, the ground was groaning, thunderstorm; by 9.30 calm, slight rain of ashes. After this the sea was very calm. After midnight some waves were observed, which were not violent. Lloyd's agent at Batavia wrote under date of October 16 (*Scotsman*, November 24):—"But we know now that the village of Sirah, six miles below Anjer, was partially submerged at 1 o'clock on Sunday night, August 26. This I had from the head man himself, who at the time reported it at once. . . . At Anjer, however, nothing was felt and no alarm was experienced." At Katimbang a noise was heard of a far-off wave at 10 o'clock, and the Europeans and natives went to a higher place. During the night the waves were heard causing an awful devastation. At Telok Betong, by 10 o'clock, several vessels were thrown on the beach (among which the steamer *Berouw*, draft 1·75 m., 4 guns, 30 h.p., 4 Europeans, 24 natives), houses swept away, people drowned, &c.; towards midnight calm.

From this it seems to me that no extraordinary detonations were heard nor any phenomena seen which could have startled the inhabitants, who, however, had been accustomed for three months to the noise of Krakatoa.

Meanwhile the outburst continued. The *Berbice* reported:—At midnight ashes increased, pieces of pumice-stones, thunder and lightning increased, fireballs fell on deck and were scattered about, fearful roaring, copper at the helm got hot; helmsman, captain, and several sailors were struck by electric discharges; sail over the hatches to prevent fire, helm tied, crew sent below, captain and master kept guard; 27th, at 2 a.m., all hands to shovel ashes into the sea (were about 3 feet thick lying on deck). In a still worse situation was the *Charles Bal*. Lightning continued; saw a light at 11 p.m., supposed it to be the light of the Fourth Point (Anjer lighthouse); lay by; Krakatoa visible in west-north-west, 11 miles distant; wind strong south-west, chains of fire appearing to descend and ascend between the sky and the island, while on the south-west end there seemed to be a continued roll of balls of white fire; the wind, though strong, was hot and choking, sulphurous, with a smell as of burning cinders, some of the pieces falling on us being like iron cinders, and the lead from a bottom of 30 fathoms came up quite warm. From midnight to 4 a.m. (27th) wind strong, but very unsteady between south-south-west and west-south-west, impenetrable darkness continuing, the roaring of Krakatoa less continuous, but more explosive in sound, the sky one second intense blackness, and the next a blaze of fire; masthead and yardarms studded with corposants, and a peculiarly pinkish flame coming from the clouds, which seemed to touch the mastheads and yardarms."

On the morning of August 27, by 6 o'clock, as is reported from Binuangan (Semangka Bay), the sunken cliffs were visible; a little while afterwards a wave came and returned, but another followed, which did much damage; soon (?) after this it became quite dark, mud and ashes poured down; several waves followed till late in the evening; darkness continued till next morning. From Anjer is reported that it was about 6 o'clock when the first wave came. One of the persons who were saved said: "I went out about 5.15. After having talked with several persons, I saw the wave, still far off, rapidly making way towards us. I ran away, was followed by the wave, fell down quite exhausted, but happily on a hill, where the water could not reach me. Before my eyes all the houses along the beach were destroyed." Another person reported:—"I was early at the beach (early, after Indian habit, might be at 5 o'clock). When I returned home I heard a cry, 'The flood comes.' On looking round I saw a high wave which I could not escape; I was lifted from the ground, but caught hold of a tree. Then I perceived several waves, which followed the first; the place where Anjer had been before was covered by a turbulent sea, from which some trees and roofs of houses were still peeping out. After the wave had flowed off, I left the tree, and found myself in the midst of the devastation. The Chinese camp was not yet destroyed." A third person, who was still in bed at 6 o'clock, was lifted up by the wave and carried to a hill. All agree that after 9 a.m. it became dark, and a pouring down of mud and ashes commenced (darkness till next morning), &c. From Merak it is reported that in the morning all European officers were in their houses; when the first wave came they were not afraid, and would not yet go to the hills. The *Berbice* reported: "Till 8 o'clock it was, as before, quite dark, afterwards worse." The *Charles Bal*: "August 27, 6 a.m., being able to make out the Java shore, set sail. Passing Fourth Point Lighthouse at 8, hoisted our signal letters, but got no answer. Passed Anjer at 8.30, name still hoisted, close enough in to make out the houses, but could see no movement of any kind; in fact through the whole straits we have not seen a single moving thing of any kind on sea or land."

I must confess I am here at a loss. It is possible that the *Charles Bal* passed Anjer after the first wave had annihilated most of the living beings and before the following waves had finished the destruction of buildings, though it would be strange if at the lighthouse all the people had been killed before the building was destroyed. Moreover, it seems strange to me that the captain should not have seen the devastation nor remarked the tidal waves When they came on, the ship was very near them, and even if we suppose that the waves had been shot like a projectile from Krakatoa on to Anjer, it would be astonishing that such a considerable mass of water should not at all have been perceived, or not described if it had been. We learn from Anjer (and from Telok Betong) that it was seen from the beach like a black wall, and it must have had a considerable height, for it covered all the houses and trees which were near the beach; now an ordinary house might at least be ten or twelve metres high, and the shaft of a cocoanut tree has also a considerable length. *Loudon* reports: August 27, in the morning fine weather, at 7 a.m. an immense wave came on; the *Loudon*, under steam, turned her head to it, was lifted up, but kept well; now the wave rushed on to the beach, and before the eyes of the passengers and crew of the *Loudon*, houses disappeared; the *Berouw* (which had been thrown on the beach on the evening of the 26th) was lifted up and carried a few kilometres into the land. The place where Telok Betong had been before was changed into a violent sea (except the buildings on the hills). Three other waves followed at short intervals. Since it was supposed that the cable had been destroyed, the steamer intended to go to Anjer to report the catastrophe. Before she could get out of the Lampong Bay it darkened. The mate of the *Marie* reports: August 27, in the morning the sea was calmer, but queer weather, sky threatening, prepared the third anchor. At once we saw an immense wave at the horizon making rapidly its way on to us; we spiked up the hatches, and after having done it the first wave struck the vessel, and threw it on the beach; after the wave had flowed off, the *Marie* was literally on dry sand; one could have walked around the vessel. Part of the crew left the ship. From the barracks at Telok Betong, on the Talang Hill, about twenty-five metres above the level of the sea, an eye-witness wrote: At 6.20 I went to Kampong (village) Kankong, about 1400 metres distant from the barracks, to see the destruction which the wave had caused the night before. After I was there I saw a wave rushing on to us; we hastened to the hills, the villagers following us. When I had reached the barracks, I saw Kampong Kankong had disappeared, and so had the other villages near the beach. Before the darkness began the water rose. At Katimbang they perceived in the morning what damage had been done—by little and little it became dark.

At 10 o'clock it was so dark aboard the *Loudon* that not even outlines of the ship or persons were visible; she stopped for eighteen hours. Rain of mud covered the deck 0.50 metre thick. Needle of the compass violently agitated; barometer extremely high; breathing difficult through damp; some people got unwell and sleepy. After the darkness began the sea became violent, the wind increased; at last it was a hurricane. Then several heavy seas came, some of which came across and almost capsized the vessel. The flash of lightning struck the *Loudon* seven times, went along the conductor, but, when still above the deck, sprang over into the sea. This was accompanied by a dreadful crackling. At such moments the vessel and the surroundings were brightly lighted; it was a fearful sight, everything being covered with a grayish mud. During all this time the *Loudon* was under steam, steaming slowly at two anchors. St. Elmo's fires at the masts and yards. August 28, at 4 a.m., feeble moonlight (moon's rise at Batavia, August 28, at 2.15 a.m.) at the horizon. After the sun had come up she tried to leave the bay. It seems worth attention that during all these fearful hours no detonations were heard aboard the *Loudon* (this is expressly mentioned in the report).

At Merak an immense wave came by 9 o'clock from the west and rushed to the east. The European who alone escaped went to the hills, while darkness surrounded him. The mate of the *Marie* writes:—By 10 a.m. (August 27) three heavy seas came after each other; quite dark; at once a fearful detonation. Sky in fire, damp. By 3 p.m. three seas again, after this the sea quite calm. Dark till next morning, then (28th) *Marie* was found afloat again. From the barracks (Telok Betong) it is reported:—By 9.30 a.m. a downpour of ashes, later stones and mud; about half an hour afterwards the level of the water was only 1 or 2 metres below the top of the hill. Now it was taken into consideration to give up the barracks and retire to a higher point. In the night the rain of mud ceased by little and little, the sky cleared up, stars appeared. When, at Katimbang, it had become quite dark, fearful detonations, like thunder and reports of guns, were heard. By 11.30 pouring down of stones began (the biggest as large as a fist). Half an hour after, 12 o'clock, it became quite dark; heavy rain of ashes soon afterwards, hot ashes (during a quarter of an hour), then cold ashes; darkness continued (it is not said when it dawned). From the *Charles Bal* is repotted: "At 11.15 there was a dreadful explosion in the direction of Krakatoa, now over thirty miles distant. We saw a wave rush right on to the Button Island, apparently sweeping right over the south part, and rising half way up to the north and east sides. This we saw repeated twice, but the helmsman says he saw it once before. The same wave seemed also to run right on to the Java shore. At the same time the sky rapidly covered in, the wind strong from south-west by south; by 11.30 we were inclosed in a darkness that might almost be felt, and at the same time commenced a downpour of mud and sand, &c., which put out the side lights. At noon the darkness was so intense that we had to grope our way about the decks, and although speaking to each other on the poop, yet could not see each other. This horrible state and downpour continued till 1.30, the roarings of the volcano and lightnings being something fearful. By 2 p.m. we could see some of the yards aloft, and the fall of mud ceased. (Here the explosion and the beginning of the darkness are reported about two hours later than from Lampong Bay or from Anjer, and still more astonishing is it that nothing is said about the wave which annihilated Merak). At 5 p.m. the sky cleared up in the north-east, but till midnight sky dark, now and then ashes falling. Though the vessel was sixty-five to seventy miles distant from Krakatoa, the roaring of the volcano was still audible." From the *Berbice* is reported: At 11 a.m. (27th) strong wind south-east; at 3 p.m. high wave (about 20 feet high) struck the vessel so hard that the chronometers were arrested. Thunder, &c., continued, and the hands of the barometers were violently agitated between 28 and 30 inches. At 6 p.m. no change, sea relatively calm, lightning allowed us to see the vessel surrounded by a sea of pumice stone; at midnight, weather calm, lightning more remote. August 28, at 4 a.m., calm, maintopsail set. Darkness continued. At 8 a.m. they saw daylight again. Weather calm and bright. Ship covered with ashes about 8 inches thick. During the eruption about 40 tons of ashes were thrown overboard; more sail set; had full sail at 12 o'clock, and went straight on to Java Head. Floating pumice-stone diminished the speed of the vessel. At midnight light of First Point was seen; when they passed Prince's Island they saw banks of pumice-stone 18 to 24 inches thick. In the afternoon they passed between Krakatoa and the Java shore. As far as they could see the island was by two gaps divided into three parts. The sea was covered with pumice-stones and floating corpses.

I continue the report of the *Loudon*:—Ashes and pumice-stone were still falling, but only slightly; the vessel was near the shore; it was a dreadful sight, trees buried under ashes and mud, the sea covered with pumice-stone and driftwood. Near Pulutiga the entrance of the bay was obstructed by islands of pumice-stone, like cliffs; they formed a bridge between Pulutiga, Sebuku, and the mainland. Since the channel of Lagundi Straits seemed comparatively open, the *Loudon* made for it, but she met there with an island of pumice-stone, about 3 m. thick; she went ahead against it, the pumice-stone gave way, and though there were some difficulties at the pumps, the *Loudon* got free; now it was resolved to go to Anjer, the vessel came to the Sunda Straits, west (in the report is said east, which seems a slip to me), then south of Krakatoa; when this island was at larboard (I think it means when the *Loudon* went to the north, passing between Krakatoa and the Java shore, for after having left the Lagundi Straits, she continually had Krakatoa on the larboard) it was seen that the greater part of the island had disappeared; there was a steep craterwall, the peak as it were cut into two. In the wall large cracks filled with smoke were remarked. In the sea between Krakatoa and Sibessie several volcanic reefs were seen, there, as it seemed, volcanic powers were still at work. At eight different places columns arose, which, after having originated in a dark point, grew larger, got as it were a white bordering, arose to a considerable height, and gave way to another column. It could not be made out whether these phenomena were waterspouts or volcanic eruptions.

It is known that the detonations were heard all over the Dutch colonies and further; I only beg to record that at Acheen, 5½° N. lat., they were so distinctly heard that military forces were sent out, since it was supposed that a fort had been attacked. It may be interesting to see a report from Padang Panjang, which runs as follows: August 27, 8.30 a.m., at once a heavy explosion, a single thick cloud of smoke arose (from Mount Merapi 0° 20′ S. lat., 100° 28′ E. long. Greenwich) drove directly away; now smoke arose from a point at some distance from the crater, uncertain whether it originated in ejected matters, or whether there were fumaroles. After five minutes the same phenomena were observed; afterwards it was perfectly quiet. At 10.50 a.m. hollow groaning; another column of smoke arose; ashes falling eastward; two columns of smoke During all this time a fearful noise was heard from afar, which became stronger after 11 a.m.

Dr. B. Hagen wrote to the editor of the *Ausland* (*Ausland*, No. 46) from Tandjong Morawa (Deli, Sumatra, almost 1000 km. distant from Krakatoa): In the afternoon (27th) thick white clouds were seen coming from the volcano Sipaiak (or Guming Balerang), more than 30 km. distant to south-west.

From Menggala (130 km. from Telok Betong to the north-west) is reported: Slight concussion of the air, rain of ashes, darkness. From Sukadana (105 km. from Telok Betong to the north-east) is reported: Much damage done by falling ashes and stones.

During the eruption there were still two vessels near the Sunda Straits the reports of which are to be mentioned. The *Annesley* (*Times*, weekly edition, Oct. 12), Capt. Strachan, from Singapore, August 27, for Mauritius: At 10 a.m. it was so dark that they had to light all the lights. Barometer rising and falling ½ inch to 1 inch in the minute. Ashes and pumice-stones falling. Towards the night ashes stopped, but it was as black as night. August 28, they passed the Sunda Straits, and heard from the lighthouse-keeper (Java's First Point) that he had had fearful weather. Had some of the ashes as far as 100 miles clear of Java Head.

The hopper barge *Tegal* made from Batavia for Merak, August 27, early in the morning. On the way they met with ashes and stones pouring down; it became quite dark, sea rough; came to anchor by 12 o'clock; dreadful weather; she dragged her anchor. Towards 3 o'clock the sky cleared up, then went on till 5 p.m. In the night they saw a bright light in the south and west, many flashes of lightning, and balls of fire; several sea-quakes; at once sea like glass. In the morning (August 28), when it dawned, the *Tegal* was off St. Nicholas Point; now she entered the straits; they saw the devastation. At Dwars-in-den-Weg the sea had still deepened the deep places which were there before; Saleier and Tempora had disappeared; the height of the waves at Merak was estimated from 30 m. to 40 m. by the chief of the works at Merak (*Nieuws van den Dag*, October 10).

The *Prins Hendrik*, a Dutch man-of-war (2000 tons, 400 h.p., 5·5 m. draft, 8 guns, 229 Europeans, 53 natives) was sent to the Sunda Straits for the safety of the vessels arriving there (*Nieuws van den Dag*, November 17). She first went to Vlakke Hoek, but could not communicate on account of the pumice-stone; another vessel succeeded in communicating (September 3), and found of the men of the lighthouse (5 Europeans, 14 coolies) 10 natives dead, 3 Europeans and 4 natives wounded. The base of the lighthouse is 2·5 m. above the level of the sea; the first (iron) floor was broken, the lodgings near the lighthouse swept away. The *Hendrik* observed that the north part of Krakatoa had disappeared; from the part which remained, from Verlaten and Lang Island, and the new ones (Calmeyer and Seers), smoke continually arose; now and then, by night, a flame was seen. September 16, the *Hendrik* tried to enter Semungka Bay. They found a place where the sea was not covered with pumice-stone, but landing was impossible, the breakers being too strong; next day a boat was sent again, which was beset in the floating masses. The pumice-stone around the *Hendrik* was now 5 feet thick, and one could stand on it. The boat had at last to be given up, the crew (being one lieutenant, Dutch Navy, two boatswains, fourteen sailors) went on shore. The *Hendrik* tried to leave the bay, but could hardly turn round; a condenser exploded, and they had to come to anchor. As far as they could see, the sea was covered with pumice-stone. After thirty hours the engine had been repaired and cleared, and after much trouble the steamer got out of the bay.

Though the reports which I have mentioned are far from being complete (I shall try to complete them), I think they are sufficient to draw some conclusions:—

1. As to the height of the wave, we have seen that the first waves at Anjer were more than 10 metres high (August 27, 6 a.m.). At Merak the height of the most destructive wave (by 9 o'clock) is estimated at 30-40 metres by the engineer himself, and Mr. McColl (the *Scotsman*, November 24) estimated it to be 135 feet (about 41 metres). At Telok Betong (Talang hills) it was about 23 or 24 metres, but here it was not properly speaking a wave, but it seems that the water in Lampong Bay was dammed up as it were I suppose that the bay by the first waves was filled, and the mass of water broke here the force of the explosion, and the wave by which the latter was followed was turned to the east (from Merak the wave came from west). In general I do not

suppose that we may speak about "waves" in the ordinary sense. Besides the previous commotions, which were of course very strong, I suppose that by the explosion (let us say August 27, 9.30) an immense mass of water was driven to the north, and escaped as far as it could into the Java Sea; probably other concussions followed, and afterwards the mass flew back (this was the wave the *Berbice* met with at 3 o'clock), and went into the Indian Ocean. If this supposition be true, I think Vlakke Hoek lighthouse was also struck by the wave in the afternoon (which, of course, I do not know). That the water was really dammed up, we learn also—though the effect was not so strong—from the report from Telok Betong about August 26. The men, being on the pier, had to make their way home through the water, which at the time was rather high, and they could never have done it if there had at that moment been a flowing off of the wave. From different reports it results that the waves produced their effect in a certain direction, and not around (*e.g.* destruction in the night 26th to 27th, Sirah, south of Anjer; 26th, in the evening, destruction at Merak, only slight commotion at Anjer).

2. The barometer. From the *Berbice* it is reported: 28 to 30 inches, violently agitated. *Annesley:* rising

and falling ½ to 1 inch in half an hour. *Prinses Wilhelmina* at Tandjong Priok: 789-763mm. (*Nieuw. Rotterd.* Nov. 26) (789 seems a misprint, *Nieuws van den Dag* has 750, perhaps it should be 759). *Loudon:* extremely high.

3. Compasses. Spun round (*Loudon*).

4. Degree of darkness. From all reports results that there was a moment when "no outlines of ship or men were seen." From the report of the *Annesley* results that the darkness continued after the downpour of ashes had ceased, therefore the darkness is not depending on the pouring down of ashes; it is sufficient that the sunlight be intercepted by a thick cloud of ashes. From the *Berbice* is reported:—Darkness from 26th, p.m., to 28th, a.m. From all other places is reported:—Bright, August 27, from 6 to 9 a.m., and 28th, from 6 a.m.

5. After having read the reports, the question arose to me, Was the mud ejected from the crater, or were the ashes, &c., mixed with rain or sea water? I think the latter; I remember, at least, that in 1863 (an eruption of the Merapi, Java, took place) I came into a slight downpour of ashes. I was travelling on horseback, and after some time a thunderstorm came on. All around me, which had been ashes before, was changed very soon into mud. In the report of the *Berbice* the "rain of mud" is not mentioned, but it is said that the yards were covered with a "crust," because a slight rain had met the ashes, which, however, on deck were still "ashes," because, I suppose, the rain was not hard enough to change such a thick layer into a "crust."

6. Detonations, though they were heard in Saigon, Singapore, Acheen, Ceylon, &c., were not heard on board the *Loudon*. I think this might be explained by the thunderstorm, the pouring down of mud into the sea, and the hurricane (which in Lampong Bay did more damage than the wave itself).

7. The part of Krakatoa which has disappeared sank probably August 27; at least in the report from the *Loudon* the island is described as it is now. From the *Berbice*, however, it is reported:—Saw it divided in three parts (29th); but probably they saw the remains of Krakatoa, Verlaten Island, and Lang Island, which before, when seen from the east, appeared as one island.

8. Sibessie was from the sea to the top buried under ashes (all people killed).

9. The floating pumice-stone was, in the Lampong Bay, in September, 14 feet thick; in the Semungka Bay it was very strong too. Probably, if circumstances are favourable, new islands are to be formed; though at the end of October steamers came to Telok Betong, in November a hopper-barge was, during eleven days in the Lampong Bay, beset by pumice-stone.

Besides this I beg to record:—

10. After the eruption of Krakatoa in the Indies many volcanic phenomena were observed, and they prophesied an eruption of Mount Merapi (Java) for February next. Whether they had heard of Mr. Delaunay's prophecies I am unacquainted with.

11. Up to November 1 they counted 32,635 persons killed by the eruption, &c. For the burial of the corpses the Government had spent 6000*l.*

When the Survey under my direction (1868-69) was busy connecting the triangles of Java with the Sumatra coast, the peak of Krakatoa was also chosen for a point.

Whether there were several hills on the island I cannot say, for when I saw Krakatoa it was covered with a splendid vegetation, and in such a case it is not so easy to judge of the configuration as it is when the trees are burnt, but I dare say there was only one peak.

Of the results of the Survey I keep only a map, of which I inclose a rough copy. From this it results that the signal was a little to the north of 6° 8½'; Kuyper puts it in 6° 9', which is certainly wrong; he inserts also a peak in the centre of the island (622 metres), and says it had disappeared; this is, I am sure, a mistake. If the military survey (which was at work now) had not yet finished its work so far as to give a map of Krakatoa (though perhaps they have not undertaken a survey of the island, since administratively it belongs to the Lampongs, and not to Bantam), it might perhaps be useful to consult the notes of the *Geographische Dienst*, which are deposited in the Archives, and a sketch of the Sunda Straits, which I offered in 1875 to the Minister of the Dutch colonies.

E. METZGER

Stuttgart, January

NOTES

WE regret to learn that Mr. C. W. Merrifield died at Brighton on New Year's Day at the age of fifty-six.

MANY of the friends of the late Dr. Hermann Müller in this country will be glad of the opportunity of testifying to their respect for his memory and their sense of the value of his work by contributing to the fund which is being raised to establish a "Müller Foundation." In the first instance the proceeds will be used to assist the widow of Dr. Müller during her lifetime, and afterwards as an endowment to some poor and deserving student at the Public School of Lippstadt desirous of devoting himself to natural science. An influential Committee has already been appointed on the Continent, including the name of Prof. Haeckel. The movement, we are sure, will commend itself to many of our readers, who may send their subscriptions either to Herr Stadtkaemmerer Wilhelm Thurmann, Lippstadt, or to the care of the Editor of NATURE.

FIVE HUNDRED POUNDS in prizes are offered by Mr. Francis Galton for extracts from the family records of competitors. They are to be sent him before May 15, drawn up according to the conditions and under the restrictions published in his recent book, "Record of Family Faculties" (Macmillan and Co., 2*s.* 6*d.*), which contains full explanations, together with sufficient blank forms for the records of a single family.

M. BOULEY has almost unanimously been appointed Vice-President of the Paris Academy of Sciences for 1884, and President for 1885.

EARTH tremors seem to have been of almost daily occurrence in Tasmania recently. Mr. J. R. Hurst of Longwood, near Moorina in the north-east of the colony, sends to the *Launceston Examiner* of November 12 a record extending from August 31 to October 20, 1883, noting the occurrence of several daily, some of them so serious as to be alarming. In a note in its issue of November 19 the *Examiner* says:—"The vibratory motions of the earth's surface which have been so frequent for several months past still continue with a periodicity which is at least remarkable. Ordinary tremors now scarcely arrest attention, but occasionally a quivering of unusual severity startles those who happen to notice it, and reminds them that there are forces in operation in nature which are mysterious and appalling. One of these occurred yesterday afternoon about six minutes to three o'clock, which was felt in every part of the town, and set windows and furniture rattling. Some persons fancied that they could detect a distinct undulatory motion. The shock lasted for twelve or fifteen seconds. It may be mentioned that the whole of yesterday was very stormy—frequent and heavy showers of rain, with thunder and hail, and a very low barometer. Last evening the mercury began to rise."

PROF. J. P. LICHERDOPOL writes from Bucharest, Roumania, that on January 1, at 6.13 a.m., two horizontal shocks of earthquake, from north to south and *vice versâ*, were felt there, and were preceded by a loud noise, as of a distant train coming from the north. The furniture was slightly shaken and crackings were heard. The atmosphere was calm, but charged with a very thick and persistent fog.—Earthquake shocks were also felt during Sunday week in various parts of France. At Argèles (Hautes Pyrénées) there was one in the early morning, a second at nine o'clock, and a third about mid-day. At Dorignies, an industrial hamlet near Douai (Nord), the shock was sufficiently strong to cause real alarm. It occurred between six and seven in the evening. Houses shook, their timbers cracked, and glass and earthenware in cupboards were shattered.

THE Hungarian astronomer, Herr von Konkoly, who is mentioned as the future director of the Brussels Observatory, is expected to arrive there in about a week, for the purpose of explaining to the Science Department of the Belgian Academy his recent discovery relative to the cometary spectrum.

WE understand that Messrs. McLachlan and Fitch, having been appointed by the Entomological Society of London a committee for the purpose of examining, and reporting upon, certain vine-roots forwarded by the Government of Victoria, through Kew, find as the result of their examination that the *Phylloxera* is present in considerable numbers on the roots, which were those remaining in the ground after the vines themselves had been destroyed.

A TELEGRAM has been received from Prof. Hull, F.R.S., the chief of the Geological Expedition to the Holy Land, announcing the safe arrival of himself and his party at Gaza, where they are at present detained in quarantine. A letter, dated December 2, was also received from him a few days ago, which has been brought by camel post *viâ* Naklhl from Akabah, where the party arrived on November 27. In this letter Prof. Hull writes:—"We had every reason to be satisfied with the conduct of our Towârah Arabs. We spent three days in the neighbourhood of Jebel Musa, and made the ascent of the mountain, from the top of which Major Kitchener took angles to several prominent points; while on the same day Mr. Hart ascended Mount Catharina, a feat hitherto unperformed in one day, and was rewarded by finding several plants—representatives of colder climates. From Jebel Musa to Akabah we took the upper route, partially explored by Palmer. This has enabled us to add considerably to the accuracy of the geology and topography of the district; we have also taken a considerable number of photographs. On Saturday week we traversed a magnificent gorge cut through granite cliffs and extending for several miles, which, we believe, has not hitherto been described. It commences at the head of the Wady el Ain. We found the escarpment of the Tih much more broken and indeterminate than is represented in the maps, owing to the existence of several large faults or dislocations of the strata which traverse that district in a generally northerly and southerly direction, and we have finally determined the position of the leading line of fracture to which, at least, this portion of the Wady el Arabah owes its existence. Our course through to the Dead Sea by the valley is barred, owing to a blood feud between two tribes. We have, however, contracted with one of the tribes to be escorted as far as the Wady Musa and Petra, after which we shall strike off west across Tih Plateau to Gaza. This will enable us to do the greater part of the work in the Wady Arabah which we proposed. We are all in good health, and have made excellent collections to illustrate the botany, geology, and zoology of the district."

THE budget of the Ministry of Public Instruction in France reaches the unprecedented sum of six millions sterling. Half of this sum is absorbed by the primary and infant schools. The dotation for astronomy and meteorology is 40,000*l.*, exclusive of municipal credits voted by Marseilles, Toulouse, Bordeaux, Lyons, for their astronomical observatories; Besançon, Clermont, Paris, and Toulouse, for Besançon, Puy de Dôme, Montsouris, and Pic du Midi meteorological establishments. The National Library of Paris receives 30,000*l.*, and other public libraries in Paris, 11,000*l*; National Archives, 8000*l*. The pecuniary grants given to learned men amount to 8000*l.*; voyages and missions, 11,000*l.*; Collège de France, 20,000*l.*; Superior Normal School, 20,000*l.*; National Institute, 28,800*l.*; Academy of Medicine, 3000*l.*; School of Hautes Études, 19,000*l.*; Faculté d'État (Universities), 400,000*l.*; Grammar Schools (Lycées), 319,000*l.*; Museum (Jardin des Plantes), about 40,000*l.*

THE following arrangements have been made for the meetings of the Society of Arts. The papers to be read at the ordinary meetings will be:—Electric Launches, by A. Reckenzaun; Science Teaching in Elementary Schools, by William Lant Carpenter; Coal Gas as a Labour-Saving Agent in Mechanical Trades, by Thomas Fletcher; Sanitary Progress, by B. W. Richardson, F.R.S.; The Progress of Electric Lighting, by W. H. Preece, F.R.S.; Forest Administration in India, by Dr. Brandis, F.R.S.; Reclamation of Land on the North-Western Coast of England, by Hyde Clarke; Water Regulation in England, by General Rundall; Telpherage, by Prof. Fleeming Jenkin, F.R.S.; New Process of Permanent Mural Painting (invented by Adolph Keim, Munich), by Rev. J. A. Rivington; Slate Quarrying, by W. A. Darbishire. At the meetings of the Sections the following papers will be read:—Foreign and Colonial Section—Canada as it will appear to the British Association in 1884, by Joseph G. Colmer, Secretary to the High Commissioner for Canada; The Portuguese Colonies of West Africa, by H. H. Johnston; Reflections on Chinese History, with reference to the present situation of affairs, by Demetrius G. Boulger; Borneo and its Products, by B. Francis Cobb; The Rivers Congo and Niger as Entrances to Mid-Africa, by R. Capper. Applied Chemistry and Physics Section—Manufacture of Gas from Limed Coal, by Prof. Wanklyn and W. J. Cooper; The Upper Thames as a Source of Water Supply, by Dr. Percy F. Frankland; Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues, by C. R. Alder Wright, F.R.S.; Economic Applications of Seaweed, by Edward C. Stanford. Indian Section—State Monopoly of Railways in India, by J. M. Maclean; The New Bengal Rent Bill, by W. Seton-Karr; Trade Routes in Afghanistan, by Griffin W. Vyse; The Existing Law of Landlord and Tenant in India, by W. G. Pedder. The courses of Cantor lectures will be on Recent Improvements in Photo-Mechanical Printing Methods, by Thomas Bolas; The Building of London Houses, by Robert W. Edis, F.S.A.; The Alloys used for Coinage, by Prof. W. Chandler Roberts, F.R.S., Chemist of the Royal Mint; Some New Optical Instruments and Arrangements, by J. Norman Lockyer, F.R.S.; Fermentation and Distillation, by Prof. W. Noel Hartley.

THE Portuguese explorers, Senhores Capello and Ivens, have just sailed for West Africa. They proceed first to Loanda, thence northward to Zaire. It is expected that they will be absent for about two years.

M. ACHARD's continuous electric brake has been worked successfully in competition with the Westinghouse and other systems. The electricity is obtained by a dynamo worked by the train itself, and can give light for signals and other purposes, when worked by the engine. The sliding valve of locomotives for admitting steam has been replaced by a piston, which renders similar service. A large diminution of friction and wear results from this improvement. The economy in coals is stated to have been 5 per cent.

DR. NACHTIGAL, the well-known African traveller, who is now German Consul-General at Tunis, has received the gold medal for Art and Sciences from the Grand Duke of Mecklenburg-Schwerin.

THE members of the International Polar Commission will meet in Vienna early in May next, where preparations for this meeting are already being made.

THE death is announced of Dr. Wilhelm Gintl, an eminent telegraph engineer, and formerly director of all Austrian telegraphs. He died at Prague on December 22, 1883, aged eighty years.

LIEUT. WOHLGEMUTH, the leader of the Austrian Polar Expedition, has read a paper on the results of the Expedition at the last meeting of the Viennna Geographical Society; 124 auroræ were observed, amongst which about ten were crown-shaped. Amongst the old lava streams and in the crevices of the numerous craters of the island of Jan Mayen, Lieut. Wohlgemuth found traces of a still progressing volcanic activity, and three times observed well-marked subterranean shocks.

A SERIES of ornithological observatories has been established throughout Austria-Hungary at the instance of Crown Prince Rudolf, with a view of paying special attention to the migrations of birds, as well as to their breeding habits. The work done by these stations is satisfactory enough; yet it has been found that a complete insight into the periodical movements of birds cannot be obtained so long as similar stations are not spread over the whole globe. The subject is to form one of the principal topics for discussion at the approaching Ornithological Congress, which will be held under the auspices of the Crown Prince at Vienna on April 16 next and the following days.

AT Cobern, near Coblenz, a Franconian burial-ground has been discovered, containing many objects of interest, such as ornaments, weapon , glass and clay vases, stones with inscriptions, &c.

THE Turin Academy of Sciences has given a prize (480*l.*) to Mr. Hormuzd Rassam for his discoveries in the domain of Assyrian and Babylonian antiquities.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Madame Kettner; two Rhesus Monkeys (*Macacus rhesus* ♂ ♀) from India, presented by Mr. G. Glyn Petre, F.Z.S.; a White-throated Capuchin (*Cebus albifrons* ♀), a Crab-eating Opossum (*Didelphys cancrivora*) from the West Indies, presented by Lady Brassey, F.Z.S.; a Common Genet (*Genetta vulgaris*) from West Africa, presented by Capt. A. North Daniel; a Canadian Porcupine (*Erithizon dorsatus*) from North America, presented by Mr. A. Glidden; a Kinkajou (*Cercoleptes caudivolvulus*) from Brazil, presented by Dr. Byres Moir; a Ring-hals Snake (*Sepedon hæmachates*), a Robben Island Snake (*Coronella phocarum*), an Egyptian Cobra (*Naia haje*), a Rhomb-marked Snake (*Psammophylax rhombeatus*), a Many-spotted Snake (*Coronella multimaculata*), a Hissing Sand Snake (*Psammophis sibilans*), a Smooth-bellied Snake (*Homalosoma lutrix*), a Spotted Slow-worm (*Acontias meleagris*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Gold Pheasants (*Thaumalea picta* ♂ ♀) from China, two Common Peafowls (*Pavo cristatus* ♂ ♀) from India, deposited; five Knots (*Tringa canutus*), a Common Guillemot (*Lomvia troile*), British, purchased.

OUR ASTRONOMICAL COLUMN

THE SOLAR MOTION IN SPACE.—The recently published volume of the *Memoirs of the Royal Astronomical Society* contains a paper by Mr. W. E. Plummer, of the Oxford University Observatory, on the Motion of the Solar System. The data on which the author has founded his discussion are the proper motions of the stars in the southern hemisphere, as determined by Mr. Stone in the Cape Catalogue. The work is therefore a repetition and extension of the inquiry conducted by the late Mr. Galloway, and it would appear that the necessity of a re-discussion was suggested to Mr. Plummer by the discordances between the values of the proper motions there employed and those given by Mr. Stone. To illustrate the uncertainty in the result, particularly when based upon an insufficient number of stars, the position of the apex of the solar system is first derived from the same list of stars as that used by Mr. Galloway, but with improved values of the proper motion. The more trustworthy result from these restricted data places the apex in the constellation Ophiuchus some thirty degrees south of the generally received position.

Incorporating, however, all the southern stars whose known proper motions exceed one-tenth of a second (which raises the number of stars employed to 274), a more accordant result is obtained. If the apparent magnitude be adopted as a criterion of distance, and the irregularities of proper motion be supposed due to the peculiar motions of the stars themselves, the co-ordinates of the apex are $\alpha = 270° 8'$, $\delta = + 20° 20'$, and the annual motion of the sun, viewed from the mean distance of the first magnitude stars, subtends an arc of $1''\cdot690$. Unfortunately, if the corrections computed on this supposition be applied to the individual proper motions, the sum of the squares of the residuals is slightly larger than the sum of the squares of the original motions.

Selecting as a second hypothesis the suggestion that the distances of the stars vary inversely as their proper motions, the position of the apex is given in $\alpha = 276° 8'$ and $\delta = + 26° 31'$, and the annual motion of the sun seen from the distance of stars whose annual proper motion is about $1''\cdot5$ seconds of arc, is $0''\cdot926$. Introducing the necessary corrections, the sum of the squares of the proper motion in R.A. is reduced from $124''\cdot9$ to $70''\cdot4$, and in declination from $54''\cdot6$ to $39''\cdot3$, a result that tends to support the reality of the second hypothesis.

THE LATE M. YVON VILLARCEAU.—Antoine-François-Joseph-Yvon Villarceau was born at Vendôme on January 15, 1813. He first studied in the local college, and subsequently went through the course of instruction at the Conservatoire in Paris, where, in 1833, he gained a first prize. In the same year he proceeded to Egypt with Felicien David, and joined the mission under Enfantin: in this way his attention was directed to engineering. Returning to France in 1837 he was admitted to the École Centrale, which he left in 1840, being then first in the Mechanical Section. Already possessed of an independent fortune, in the years immediately following he was chiefly occupied with mathematical studies, with the view to qualify himself for the higher branches of mechanics and astronomy. In 1845 his first memoir upon comets, which was judged worthy of insertion in the "Recueil des Savants Etrangers," brought him under the notice of Arago, who, impressed with the originality of his ideas, offered him, in 1846, a place at the Observatory of Paris, to which establishment he was attached until the close of his life, at first as assistant, and since 1854 as titular astronomer. Villarceau was the author of a large number of memoirs upon mechanical and geodetical subjects, amongst others, on the stability of locomotives in motion, and on the theory of arches, accompanied by extensive tables and numerous practical applications, on the theory of the gyroscope of Foucault, and the compensation of chronometers; he made geodetical determinations in France between 1861 and 1865, which led to several important deductions. Amongst his earlier astronomical work was the development and application of a new method of investigating the orbits of the revolving double stars, which he applied to η Coronæ Borealis and other binaries; this was followed by a memoir on the determination of the orbit of a planet, founded on the method of Laplace. In 1851, on the discovery by D'Arrest of the short-period comet which bears his name, Villarceau determined the orbit rigorously, and by means of his predicted places the comet was again observed, in 1857, by Maclear at the Cape of Good Hope. It was upon his plans that, while Leverrier was in direction of the Observatory of Paris, the great equatorial in the west tower, which constituted a notable advance in the construction of such astronomical instruments, was erected. Villarceau died on December 23. At the funeral discourses were delivered by Col. Perrier in the name of the Academy of Sciences (of which Villarceau had been a member, in the Section of Hydrography and Navigation, since 1867); by M. Faye in the name of the Bureau des Longitudes; and by M. Tisserand in that of the Paris Observatory.

THE ENGLISH CIRCUMPOLAR EXPEDITION[1]

On April 14, 1882, I was informed that I was appointed to the command of the Circumpolar Expedition. I at once proceeded to London, and was occupied until the day of sailing in practice with the magnetic instruments at the Kew Observatory, and the purchase of stores, &c., for the expedition.

On May 1 Sergeant F. W. Cooksley, Royal Horse Artillery, and Gunner C. S. Wedenby, Royal Artillery, and on May 6 Sergeant Instructor of Gunnery J. English, R.H.A., reported themselves to me, and commenced attendance at Kew for instruction.

Journey to Fort Rae.—We sailed from Liverpool on May 11, and arrived at Quebec on the 23rd. Here I spent some days, finding that the steamer for the north did not leave Winnipeg till June 10, and my party was very kindly afforded quarters in the citadel by Lieut.-Col. Cotton, commanding the Canadian Artillery at that place.

Having obtained a free pass for our baggage on the Grand Trunk Railway, I started at once for Winnipeg, proceeding by the lakes, that being the cheaper route, and the one which, on the whole, exposed the instruments to the least knocking about.

We reached Winnipeg on June 9, and left on the following day by the *Saskatchewan* steamer. On June 26 we reached Carlton, where it was necessary to engage carts to take our baggage to Green Lake, a distance of 140 miles.

On the 29th the carts were taken across the river, and on the 30th we started for Green Lake, which we reached on July 9, having been delayed by the extreme badness of the road. The heat of the weather also rendered a long halt necessary in the middle of the day, and the flies prevented our animals from feeding properly, incapacitating them for long marches or fast work, and on one occasion forcing us to halt for a whole day, the oxen being so worried by them as to be unable to march.

At Green Lake we entered upon the system of water communication that forms the only roadway in the north, and by way of Portage la Loche, and the Clearwater and Athabasca Rivers, we reached Fort Chipewyan on July 30. Here we had to await the Mackenzie River boats, there being no other means of reaching Fort Rae, and it was not until August 17 that we were able to start on this last stage of our journey. We reached Great Slave Lake on the 22nd, on the evening of which day a gale arose which stove in and sunk our boat, damaging most of our provisions. Fortunately we were able to repair the boat, but it was not until the 25th that the weather allowed us to proceed, and on the 27th we were again detained by a fresh storm, so that it was not until 10 p.m., on August 30, that we arrived at Fort Rae.

Fort Rae.—Fort Rae is situated in lat. 62° 38′ 52″ N., and long. 115° 43′ 50″ W., at the south-west extremity of a peninsula that juts out from the north-east shore of a long gulf running in a north-westerly direction for more than 100 miles from the northern shore of the Great Slave Lake. It is almost entirely surrounded by water, as shown in the annexed plan. The formation is limestone. The land rises to a height of some 200 feet, and it is covered in part with moss, in part with pines and scanty brushwood. A few vegetables are grown in the summer in the garden attached to the Roman Catholic Mission, but for food the inhabitants chiefly depend upon the produce of the nets, and on deer, which are brought in by the Indian hunters attached to the post.

On arrival it was found that the magnetic instruments required a good deal of setting to rights, their boxes being filled with water and the fittings loosened, so that not a single instrument was quite in working order. There was, moreover, no building ready for their reception, so that it was not possible to keep August 31—September 1, as a term day, but we succeeded in getting the meteorological instruments in position so as to commence observations with them at midnight on the 31st.

We were fortunate in finding a building that admitted of conversion into a magnetic observatory, it only requiring a floor, fireplace, door, and windows to be habitable. This work was at once commenced, and on September 3 the declinometer, on the 4th the bifilar, and on the 6th the vertical force magnetometer were mounted in their places. This observatory was finished on September 10, and another one commenced for astronomical and absolute magnetic observations, the continual wind rendering out-door observations unsatisfactory.

[1] "Report on the Circumpolar Expedition to Fort Rae," by Capt. H. P. Dawson, R.A. Communicated to the Royal Society by Prof. G. G. Stokes, Sec. R.S.

The men of my party were accommodated in the house of one of the sub-officers of the fort, and I had a room in the house of the Hudson's Bay Company's officer in charge.

The instruments, on the whole, suffered but little from the journey. One barometer and one thermometer were broken, and the object glasses of the telescopes of most of the magnetic instruments were nearly opaque, the cement joining the two lenses having, from some cause or other, melted on the journey. Our provisions were more damaged, 190 lbs. of sugar, 30 lbs. of tea, all our rice, and most of our baking powder having been destroyed.

The observations were then carried on without interruption until August 31, 1883.

Magnetic Observations.—The balance magnetometer was the only magnetic instrument whose performance was not satisfactory, as not only did it frequently get out of adjustment, but in times of magnetic disturbance it often vibrated through so large an arc that exact reading was impossible. The other instruments were remarkably free from vibration, and there was never any difficulty in reading them, but it was found necessary to extend the scale of the bifilar on the side of decreasing force, owing to the great movements of this instrument.

The greatest magnetic disturbance was on November 17, 18, and 19, 1882, when all the instruments moved at times beyond the limits of their scales. On the first of these days the difference between the extreme easterly and westerly positions of the declinometer magnet exceeded 10°.

Aurora.—Aurora was observed on almost every clear night, and was usually attended by more or less magnetic disturbance. It did not appear to me, however, that the two phenomena stood in the relation of cause and effect, but rather that they were both due to a common cause. The most marked instance of connection between the two phenomena consisted in a rapid decrease in both vertical and horizontal magnetic forces which attended a sudden outburst of aurora in the zenith. This was observed on several occasions. The bifilar almost always showed a reduction of horizontal force during a display of aurora. I also think that the declinometer magnet tended to point towards the brightest part of the aurora, but that (*sic*) I have not yet had time to make that careful comparison of the auroral and magnetic observations which will be required to decide this point. It was found impossible to obtain photographs either of the aurora or of its spectrum—the latter invariably presented the characteristic yellowish green line, and occasionally, but rarely, several other bright lines were visible for a few moments towards the violet end of the spectrum, and once a bright band was seen in the red.

I was also unsuccessful in my attempts to measure the height of the aurora, chiefly from the want of a well defined point to measure to, also from the fact that some hours were required to prepare for this observation, whereas the appearance of a suitable aurora could not be predicted, and was, in fact, not of frequent occurrence, and then often only lasting a few seconds. For this observation two stations some miles apart should be connected by telegraph and occupied for many days, or even weeks, in succession.

Although I paid attention to the point, I never heard any sound from the aurora save on the occasion mentioned in a former memorandum, but I made many inquiries on the subject from residents in the country, both English and French, and their statements agree so well, both with one another and with what I myself heard, that I am forced to conclude that the aurora is at times audible, and that on these occasions it appears to be, and probably is, very near the earth.

Meteorological Observations.—With regard to the meteorological observations, the station was somewhat unfavourably placed for observations of wind, on account of the hill to the north-east, but as winds from this quarter were rare, the effect on the results will not be great, especially as one of the anemometers was on an island in the lake, in an entirely open situation.

The anemometers did not work quite satisfactorily, being at times choked by ice; but I hope by the comparison of the two satisfactory results may be attained.

The wind was usually either south-east or north-west; and when it blew from the former quarter, the motion of the upper clouds often showed the existence of a north-westerly current.

The hair hygrometers were found to be useless out of doors in cold weather, on account of the formation of ice on the hair.

The earth thermometers were read every alternate day; the observations were interrupted by a carcajou, or other animal, which extracted the thermometers from their tube for the sake of the fur in which it has been found necessary to envelop them, and broke them all; other thermometers were, however, substituted, and the observations continued. It was found impossible to obtain the temperature of the soil at a greater depth than four feet, on account of the rocky nature of the ground.

A series of observations of terrestrial radiation was made by means of a thermometer placed on the surface of the snow, but the almost continual wind detracts much from the value of these readings.

I was told by the residents of the country that the year was an unusually dry one, and certainly the rainfall is remarkably small; they also said that the winter was particularly mild and free from storms, which, from all accounts, and from the journals kept at the fort, seem to be both frequent and severe; as it was, we only experienced one, in February.

Astronomical Observations.—My first determination of the longitude was made by means of lunar distances, and time was found by the method of equal altitudes, but after the observatory was finished both these points were determined by transits, and the first value of the longitude found to be more than a minute in error. The latitude was determined by transit observations in the prime vertical, and is probably within a few seconds of the truth. The longitude may be ten seconds in error. The time was generally correct to within three or four seconds.

A more solidly constructed transit instrument would have been desirable, as it was found that in the cold weather it required so much force to move the telescope of the transit theodolite on its axis that there was great risk of disturbing the adjustments of this instrument, composed as it is of so many parts.

Food, &c.—Our supply of provisions proved quite sufficient. I had brought enough flour to admit of my issuing the usual ration of ¾ lb. per diem, and tobacco 1 lb. per month to each man. We also had a supply of Chollet's preserved vegetables, and a reserve stock of bacon, besides tea and sugar. Of the latter we were somewhat short, owing to the loss sustained on the journey up. We usually had fresh meat throughout the winter; in the summer we were occasionally reduced to dried meat. During the journey there and back we chiefly lived on pemmican. The Rev. Père Roure, of the Roman Catholic Mission, most kindly furnished us with fresh vegetables and potatoes throughout the summer.

The conduct of the men under my command was everything that could be desired. They took great interest in the observations, and did their best to carry them out with accuracy and punctuality, and were always contented and cheerful, in spite of the inevitable discomforts of their winter quarters and the occasional hardships of the journey.

Return Journey.—We were running great risks of being overtaken by the winter, and therefore lost no time in our departure.

The last hourly observation was made at midnight on August 31, 1883, after which the instruments were dismounted and packed, their cases having been previously arranged in readiness outside the observatory. The remainder of the baggage was already in the boat, so that by 2.30 a.m. on September 1 we were *en route*, and reached Fort Chipewyan on September 17, and Portage la Loche on October 4, having experienced some delay in surmounting the rapids of the Clearwater, the hard frosts having frozen all the small tributary streams, thus considerably lowering the water in the river.

The boat awaiting us on the south side of the portage was frozen in, but fortunately the wind changed and the ice broke up before our arrival. Had it been otherwise, we must have waited until the rivers were thoroughly frozen and travelling with dog-trains possible. In that case we should have been compelled to abandon our instruments and baggage.

On the 21st we reached Carlton on the Saskatchewan, where we were detained a day, the man engaged to transport our baggage across the prairie having refused to proceed. Another man was engaged, and on October 31 we reached the railway at Qu'Appelle, arriving at Winnipeg the following day. We were fortunate in crossing the prairie with so little difficulty, as at the same time last year it was covered with three feet of snow.

At Winnipeg I remained a couple of days to adjust accounts with the Hudson's Bay Company, and on November 4 we started for Quebec, going by rail *via* Chicago. We reached Quebec on the 8th, and Liverpool on November 20.

In conclusion, I have to acknowledge the assistance received from the officers of the Hudson's Bay Company, who spared no trouble in carrying out my wishes, especially Chief Commissioner Grahame at Winnipeg, Chief Factors MacFarlane and Camsell in charge of the Athabasca and Mackenzie River Districts respectively, and Mr. King in charge at Fort Rae. To their hearty co-operation the success of the expedition is in great part due.

Results of Expedition.—The following is a list of the observations taken at Fort Rae, the result of our year's work there, which I have now the honour to lay before the Royal Society:—

Magnetic

Hourly—

Declination from September 3, 1882, to August 31, 1883.
Hor. Force ,, 4, ,, ,,
Vert. Force ,, 6, ,, ,,

Term Day—

In accordance with programme laid down by St. Petersburg Conference—from September 15, 1882, to August 15, 1883.

Occasional—

Absolute observations of Hor. Force Dip and Declination.

Meteorological

Hourly—

Barometer	from Sept. 1, 1882, to Aug. 31, 1883.
Dry and Wet Bulb Therms.	,, ,, ,,
Anemometer	,, ,, ,,
Wind, Clouds, and Weather	,, ,, ,,
Aurora (when visible)	,, ,, ,,

Hair Hygrometer (when in working order).
Terrestrial Radn. (occasionally in clear weather).

Daily—

Max. and Min. Solar and Terrest. Radn. Therms.
Rain Gauge.

Earth Thermometers every two days.

THE EVIDENCE FOR EVOLUTION IN THE HISTORY OF THE EXTINCT MAMMALIA[1]

II.

COMING to the vertebræ as a part of the osseous system, I will mention the zygapophyses, or antero-posterior direct processes, of which the posterior looks down and the anterior looks up. They move on each other, and the vertebral column bends from side to side. In the lower forms of mammals they are always flat, and in the hoofed mammals of the Puerco period they are all flat. In the Wasatch period we get a single group in which the articulation, instead of being perfectly flat, comes to be rounded; in the later periods we get them very much rounded; and finally, in the latest forms, we get the double curve and the locking process in the vertebral column, which, as in the limb, secures the greatest strength with the greatest mobility. In the first stages of the growth of the spinal cord it is a notochord or a cylinder of cartilage or softer material. In later stages the bony deposit is made in its sheath until it is perfectly segmented.

Now all the Permian land animals, reptiles, and batrachians retain this notochord with the beginnings of osseous vertebræ in a greater or less degree of complexity. There are some in South Africa, I believe, in which the ossification has come clear through the notochord, but they are few. This characteristic of the Permian appears almost alone—perhaps absolutely alone as regards land animals. There is something to be said as to the condition of that column from a mechanical standpoint, and it is this: that the cord exists, its osseous elements disposed about it; and in the batrachians related to the salamanders and the frogs, these osseous elements are arranged under the sheath in the skin of the cord, and they are in the form of regular concave segments, very much like such segments as you will take from the skin of an orange—parts of spheres, and having greater or less dimensions according to the group or species. Now the point of divergence of these segments is on the side of the column. They are placed on the side of the column where the segments separate—the upper segments rising and the lower segments coming downward. To the upper segments are attached the arches and their articulations; and the lower segments are like

[1] A lecture by Prof. E. D. Cope of Philadelphia, given in general session before the American Association for Advancement of Science at Minneapolis, August 20, 1883. Stenographically reported for *Science*. Continued from p. 230.

the segments of a sphere. If you take a flexible cylinder and cover it with a more or less inflexible skin or sheath, and bend that cylinder sidewise, you of course will find that the fractures of that part of the surface will take place along the line of the shortest curve, which is on the side; and, as a matter of fact, you have breaks of very much the character of the segments of the Permian batrachia. It may not be so symmetrical as in the actual animal, for organic growth is symmetrical so far as not interfered with; for, when we have two forces, the one of growth and the other of change or alteration, and they contend, you will find in the organic being a quite symmetrical result. That is the universal rule. In the cylinder bending in this way, of course the shortest line of curve is right at the centre of the side of that cylinder, and the longest curve is of course at the summit and base, and the shortest curve will be the point of fracture. And that is exactly what I presume has happened in the case of the construction of the segments of the sheath of the vertebral column in the lateral motion of the animal swimming always on one side, and which at least has been the actual cause of the disposition of the osseous material in its form. I have gone beyond the state of the discussion in calling attention to one of the forces which have probably produced this kind of result. That is the state of the vertebral column of many of the vertebrata of the Permian period.

I go back to the mammalia, and call attention to the teeth. The ordinary tooth of the higher type of the mammalia, whether hoofed or not, with some exceptions, is complex with crests or cusps. In cutting the complex grinding surfaces we find they have been derived by the unfolding extensions of four original cusps or tubercles. They have been flattened, have been rendered oblique, have run together, have folded up, have become spiked, have descended deeply or have lifted themselves, so that we have teeth of all sorts and kinds, oftentimes very elegant, and sometimes very effective in mechanism. In many primary ungulates, the primitive condition of four conical tubercles is found. In passing to older periods we find the mammalia of the Puerco period, which never have more than three tubercles, with the exception of three or four species. In the succeeding periods, however, they get the fourth tubercle on the posterior side. Finally, you get a complicated series of grinding or cutting apparatus, as the case may be.

Last, but not least, we take the series of the brain. No doubt the generalisation is true, that the primitive forms of mammalia had small brains with smooth hemispheres; later ones had larger brains with complex hemispheres. In general, the carnivora have retained a more simple form of brain, while herbivorous animals have retained a most complicated type of brain. The lowest forms of mammalia display the additional peculiarity of having the middle brain exposed, and the hemispheres or large lobes of the brain, which are supposed to be the seat of the mental phenomena, are so reduced in size at the back end that you see the middle brain distinctly, though it is smaller than in reptiles and fishes. It is beyond the possibility of controversy that these series have existed, and that they have originated in simplicity, and have resulted in complication; and the further deduction must be drawn, that the process of succession has always been towards greater effectiveness of mechanical work. There are cases of degradation, as in the growing deficiency in dentition in man. There is no doubt that a large number of people are now losing their wisdom-teeth in both jaws.

We are now brought to the question of the relations which mind bears to these principles. The question as to the nature of mind is not so complex as it might seem. There is a great deal of it, to be sure; but on examination it resolves itself into a few ultimate forms. An analysis reduces it to a few principal types or departments—the departments of intelligence and of emotions (with their modified smaller forms, likes and dislikes), and the will, if such there be. Those three groups, proposed by Kant, are well known, and adopted by many metaphysicians; and they stand the scrutiny of modern science perfectly well in both men and the lower animals. But the question of the material of the mind, the original raw stuff out of which mind was made, is one which is claiming attention now from biologists, as it always has done from physiologists proper and physicians. This is sensibility, mere simple sensibility, unmodified sensibility, or consciousness. Sensibility, in connection with memory, is sufficient for the accomplishment of wonderful results. It is only necessary to impress the sensibility with the stimuli which this world affords, whether from the outside or the inside, to have the record made, and to have the record kept. Among wonderful things this is perhaps the most wonderful: that any given form of matter should be able to retain a record of events, a record which is made during a state of sensibility for the most part, a greater or less degree of sensibility, which is retained in a state of insensibility, and is finally returned to the sensibility by some curious process of adhesion, and the results of impresses which are found on the material tissue concerned.

And these simple elements of mind are found in animals. No zoologist who has perception or honesty, nor any farmer or breeder, nor any person who has charge of animals in any way, can deny sensibility to all the lower animals at times. The great stumbling-block in the way of the thinker in all this field is the great evanescence of this sensibility: the great ease with which we dissipate it, the readiness with which we can deprive a fellow-being of his sense, is a stumbling-block in more ways than one. While it is a question of the greatest difficulty, nevertheless, like other departments of nature, doubtless it will ultimately be explained by the researches of physiologists. I only need to call attention to the fact as an important factor in evolution.

Of course, if these structures are suggested, affecting the mechanical apparatus, the question arises whether they were made ready to hand, whether the animal, as soon as he got it, undertook to use it, and whether he undertook to use the organism under the dire stimuli of necessity, or amended through ages these modifications in his own structure. We are told by some of our friends that law implies a Lawgiver, that evolution implies an Evolver; the only question is, Where is the Lawgiver? where is the Evolver? where are they located? I may say, it is distinctly proven in some directions, that the constant applications of force or motion in the form of strains, in the form of impacts and blows, upon any given part of the animal organism, do not fail to produce results in change of structure. I believe the changes in the ungulates to which I have called your attention are the result of strains and impacts, precisely as I have shown you the manner of the fracture of the vertebral column of the primitive vertebrates of the Permian period. This would require long discussion to render clear; nevertheless I venture to make the assertion that this series of structures is the result of definite and distinct organic forces, directed to special ends. We have yet to get at the conflicting forces which have produced the results we see. Mechanical evolution will give us a good deal to do for some time to come. Of course, if motion has had an effect in modifying structure, it behoves us to investigate those forces which give origin to motion in animals. First in order come the sensibilities of the animal, which we have traced to simple consciousness; stimuli, upon notice of which he immediately begins to move. The primary stimulus of all kinds of motion is necessarily touch. If a stone falls upon the tail of some animal which has a tail, he immediately gets out of that vicinity. If a jellyfish with a stinging apparatus runs across an eel which has no scales, the eel promptly removes. External applications of unpleasant bodies will always cause an animal to change his location. Then he is constantly assaulted by the dire enemy of beasts, hunger, which is an instinct which is evidently universal, to judge from the actions of animals. This seems to have fashioned, in large part, all forms of life, from the least to the greatest, from the most unorganised to the most complex. Each exercised itself for the purpose of filling its stomach with protoplasm. Then come the stimuli, which should be included under the class of touch, changes of temperature. No animals like to be cold or too hot; and when the temperature is disagreeable the tendency is to go away from that locality. Among primary instincts must be included that of reproduction. After that comes the sensation of resistance, or, carried to a high degree, of anger: when an animal's interests are interfered with, its movements resisted, it prompts to the most energetic displays. So you see it is a matter of necessity that mental phenomena lie at the back of evolution, always provided that the connecting link of the argument—that motion has ever affected structure—be true. That is a point which of course admits of much discussion. I have placed myself on the affirmative side of that question; and, if I live long enough, I expect to see it absolutely demonstrated.

Of course the development of mind becomes possible under such circumstances. It is not like a man lifting himself up by his boots, which it would be if he had no such thing as memory. But with that memory which accumulates, which formulates first habits, and then structures, especially in the soft, delicate nervous tissue, the development of the mind as well as the machinery of the mind becomes perfectly possible. We develop our intellect through the accumulation of exact facts, through the collation of pure facts, no matter whether it be a humble kind of a truth—as the knowledge of the changes of the seasons, which induces some animals to lay up the winter's store—whether it be knowledge of the fact that the sting of the bee is very unpleasant, or knowledge of the fact (of which the ox, no doubt, is thoroughly aware) that the teeth of the wolf are not pleasant to come in contact with, or whether it be the complex knowledge of man. When the cerebral matter has become larger and more complex, it receives and retains a much greater number of impressions, and the animal becomes a more highly educated being.

As regards the department of emotions or passions, it is also much stimulated by the environment. Animals which live in a state of constant strife naturally have their antagonistic passions much developed, while amiable, sympathetic sentiments are better and more largely produced by peace-loving animals. Thus it is that the various departments of the mind have the beautiful results which we now find in the human species.

There are some departments of the mind which some of our friends decline to admit having had such an origin. The moral faculty, for instance, is excepted by many from this series. But the reasons why they object to its production in this way are, to my mind, not valid. The development of the moral faculty, which is essentially the sense of justice, appears to them not to fall within the scope of a theory of descent or of evolution. It consists of two parts. First is the sentiment of benevolence, or of sympathy with mankind, which gives us the desire to treat them as they should be treated. It is not sufficient for justice that it is unmixed mercy, or benevolence, which is sometimes very injurious, and very often misplaced. It requires, in the second place, the criticism of the judgment, of the mature intellect, of the rational faculty, to enable the possessor to dispose of his sentiments in the proper manner. The combination of rational discrimination and true judgment with benevolence constitutes the sense of justice, which has been derived, no doubt, as a summary of the development of those two departments of the mind, the emotions and the intellect.

It is said that a sense of justice could not be derived from the sense of no justice; that it could not have been derived from the state of things which we find in the animals, because no animal is known to exhibit real justice: and that objection is valid as far as it goes. I suspect that no animal has been observed to show a true sense of justice. That they show sympathy and kindness there is no question; but when it comes to real justice they do not display it. But do all men display justice? Do all men *understand* justice? I am very sure not. There are a good many men in civilised communities, and there are many tribes, who do not know what justice is. It does not exist as a part of every mental constitution. I never lived among the Bushmen, and do not know exactly what their mental constitution is; but in a general way the justice of savages is restricted to the very smallest possible circle—that of their tribe or of their own family. There is a class of people who do not understand justice. I do not refer to people who know what right is, and do not do it; but to the primitive state of moral character, in which, as in children, a sense of justice is unknown. I call attention to the fact because some of our friends have been very much afraid that the demonstration of the law of evolution, physical and metaphysical, would result in danger to society. I suspect not. The mode in which I understand this question appears to me to be beneficial to society, rather than injurious; and I therefore take the liberty of appending this part of the subject to its more material aspect.

To refer to another topic, and that is to the origin of life, the physical basis of life. The word "life" is so complex that it is necessary to define it, and so to define it away that really the word "life" does not retain its usual definition. Many phenomena of life are chemical, physical, mechanical. We have to remove all these from consideration, because they come within the ordinary laws of mechanical forces; but we have a few things left which are of a different character. One is the law of growth, which is displayed in the processes of embryonic succession; secondly, the wonderful phenomena of sensibility. Those two things we have not yet reduced to any identity with the ordinary laws of force. In the phenomena of embryology the phenomena of evolution are repeated, only concentrated in the early stages through which animals have to pass. So whatever explains the general phenomena of evolution explains the phenomena of embryology.

What is the nature of physical sensibility? In this planet it is found residing only in one form of matter which has a slightly varied chemical constitution, namely, protoplasm; so called from a physical standpoint. Now this world, as you all know, has passed through many changes of temperature. Its early periods, it is probable, were so very hot that protoplasm had a very poor chance. The earth has passed through a great many changes of temperature, many of which would not permit the existence of protoplasm. Again, can we assume for a moment that this little speck in the great universe is the only seat of life? I suppose scarcely any scientific man will venture to do so. If, therefore, life exists in other parts of this great universe, does it necessarily occupy bodies of protoplasm in those different, remote spheres? It would be a great assumption. It is altogether improbable. The certainty is that in those planets which are in proximity to the sun's heat there could be no protoplasm. Protoplasm in the remote planets would be a hard mineral, and near the sun it would be dissipated into its component gases. So that, if life be found in other parts of this universe, it must reside in some different kind of material. It is extremely probable that the physical conditions that reside in protoplasm might be found in other kinds of matter. It is in its chemical inertness and in its physical constitution that its adaptation to life resides; and the physical constitution necessary for the sustentation of life may be well supposed to exist in matter in other parts of the universe. I only say the door is open and not closed: any one who asserts that life cannot exist in any other material basis than protoplasm is assuming more than the world of science will permit him to assume. And that it is confined to this single planet, and not in the great systems of the universe,—that assumption will not for a moment be allowed. Therefore the subject is one which allows us a free field for future investigation: it is by no means closed in the most important laws which it presents to the rational thinker. I hope, therefore, if the evidence in favour of this hypothesis of the creation of living forms be regarded as true, that no one will find in it any ground for any very serious modification of existing ideas on the great questions of right and wrong, which have long since been known by men as a result of ordinary experience, and without any scientific demonstration whatsoever.

THE REMARKABLE SUNSETS

WE have received the following further communications on this subject:—

REFERRING to Mr. Meldola's letter in your last number (p. 224), I beg leave to state that I likewise observed an astonishing atmospheric luminosity, outside of this town, at 2–3 a.m. in the moonless and foggy night of January 1–2. It is reported that in these days the "Dämerungserscheinungen" have again been very striking at many places in Germany. Here the state of the atmosphere has of late been unfavourable for observing these phenomena; their most brilliant display, a "red glow" of oextraordinary extent and intensity, I witnessed on the morning of December 1, beginning about two hours before sunrise.

The view that these luminosities are caused by volcanic dust acting as nuclei for the condensation of vapour in the higher strata of the atmosphere will have suggested to many of your readers the probability of so-called cosmical dust being often derivable from similar terrestrial sources. To me it has, moreover, recalled an hypothesis on the origin of meteorites, put forth some twenty years ago in an elaborate treatise by Mr. P. A. Kesselmeyer of Frankfurt-on-the-Maine ("Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft," vol. iii.). Mr. Kesselmeyer contends for the derivation of meteorites from condensation of metallic and other vapours issued from volcanoes; he distinctly supposes those of Eastern Asia as chief sources, and, among other ingenious reasons for these views, he particularly insists on remarkable statistics of geographical and seasonal distribution of stone-falls (NATURE, vol. xvi. p. 558).

I am well aware of the momentous difficulties of this hypothesis, which fails to explain why such masses of vapour (or dust), after travelling for enormous distances, become condensed into solid bodies. On the other hand, there appears to me not to be such a contradiction to astronomical theories as might seem at first sight; the view in question would merely involve the assumption that there are fireballs and fireballs: those which precede the fall of meteorites being of a distinct nature from those which accompany the periodical swarms of shooting stars, and thereby manifest their cosmical origin. As far as I know there does not exist a connection, which might be expected by the usual theory, between these periodical swarms and increased frequency of stone-falls; on the other hand, it is evident that the late extraordinary manifestations of volcanic activity must furnish a crucial test for the hypothesis in question; if it were right, there must be expected an augmented fall of meteorites to follow this period of dust-spreading. D. WETTERHAN

Freiburg, Badenia, January 5

AMONGST the many interesting points for consideration in connection with the late sunset phenomena is the very general prolongation of twilight produced by them, doubtless from the reflection of the sun's rays from clouds or diffused vapour at a more than ordinary elevation, after the sun had set to all at a lower level. In reference to this subject, Mr. E. Douglas Archibald states that he estimated the height of a *glowing stratum* (*i.e.* diffused clouds) as from ten to thirteen miles; that Miss Ley, from calculation, had given thirteen miles as the height of a similar cloud, and in continuation he says:—"I think this height is far more probable than forty miles, as calculated by Prof. Helmholtz. Besides, can we imagine either vapour, or volcanic dust, or a mixture of both, to be capable of remaining in suspension in the air of such tenuity as must exist at such an altitude?" (NATURE, December 20, 1883, p. 176). To this question I would reply by another, and ask if we can imagine vapour or volcanic dust to be capable of remaining in suspension in air of some 17,000 times less density than water, as, at thirteen miles, high, that is about the calculated comparative density of the two.

Or I will go farther, and ask if any one can imagine that water, which is about 860 times heavier than the air at sea-level, can be suspended in the atmosphere without the aid of some buoyant power.

A theory on the cause of rain, storms, the aurora, &c., which I submitted to the British Association at the Glasgow Meeting, 1840 (see Report), was briefly as follows:—

That, as electricity coats the surface of all bodies, occupies space, and has no weight, in evaporating, the minute particles of water take up electricity in accordance with their surface and temperature, and are buoyed up into the atmosphere by it, where, if condensed (*i.e.* cooled), their capacity for electricity is reduced, and the surcharge is retained or passes away in accordance with the conducting or non-conducting state of the atmosphere. I cannot go further into particulars in this paper, but I may say that I have no knowledge of any phenomenon connected with the cause of rain which is not explicable in accordance with the theory, although forty years' exertion has not enabled me to bring it fairly under consideration.

In my first paper I suggested, as a test for the theory, that conductors should be raised from the earth to the regions of the clouds, under the idea that the withdrawal of electricity by this means would produce rain in temperate, and the aurora in frigid regions. And I hold that I am fully borne out on both these points by Prof. Lemström's grand auroral experiment; as, on the connection being made between the wirework on the top of the mountain and the earth at the foot of it, electric currents were observed, the aurora became visible, and the formation of ice on the wirework was so heavy as to break it down; thus showing that rain would have fallen if the experiment had been tried in a lower latitude. I hold also that the experiment already proves that electricity is the buoyant power of vapour in the atmosphere.

With respect to the undoubted great elevation of vapour and volcanic dust thrown up by the Java eruption, I have long been led to believe that electricity coats the surface of bodies in accordance with their temperatures, and that the non-burning property of superheated metal is from the intense force with which electricity coats the surface, and thus the hand is not actually in contact with the metal when placed upon it; and in the case of effluent high-pressure steam, I believe the particles are so completely wrapped up in their coatings of electricity that they do not touch the object the steam impinges on. Bearing these points in mind, it may easily be imagined that particles of dust or water as vapour, when cast up from a volcano, may be at the highest conceivable temperature, and charged with electricity in a like degree, and that, being driven up by currents of heated air, the particles may rise to an elevation far above that of ordinary vapour, and may remain suspended there, more or less, in accordance with the non-conducting condition of the atmosphere at such elevations. G. A. ROWELL

Oxford, January 2

AMONGST the many interesting questions raised by the discussion on the recent sunsets, not the least interesting is the question of the upper currents of the atmosphere. Mr. Norman Lockyer, in his article in the *Times* of December 8, writes of the presumed translation of volcanic dust round half the equatorial circumference of the earth in six days as being in accordance with our actual knowledge of these currents. There are probably many readers of NATURE besides myself who would be glad to be referred to the observations upon which this statement is founded.

An opinion prevails that, in the rotation of the earth about its axis, the higher parts of the atmosphere must to a certain extent lag behind, thus producing an east wind relatively to the surface of the earth; and if we allow ourselves to adopt this view, we may easily imagine that in the equatorial regions there may exist an upper current from the east having sufficient velocity to meet the case supposed. But can this view be justified? Is it not more reasonable to consider that the whole of the earth's atmosphere rotates with the earth as if it were part and parcel of it? It is difficult to see why it should not do so, unless we suppose a resisting medium occupying the inter-planetary spaces.

It is certainly remarkable how well (on the volcanic hypothesis) the entire observations of the coloured sunsets and associated phenomena agree with the supposition of an east wind sweeping round the earth with hurricane speed in the upper regions of the atmosphere. Not only the observations from the Mauritius, Cape Coast Castle, Brazil, and the West Indies, but even those from the Sandwich Islands and from Australia, may be made to harmonise with this theory, and the dust from Krakatoa may be said to have made "a girdle round the earth" in a fortnight. But in case the theory should prove to be inadmissible, it may be worth while to inquire whether some of these earlier observations may not find their explanation in an earlier eruption of the same volcano. The first eruption of Krakatoa is said to have occurred on May 20, and it is evident that long before the date of the great eruption (August 26) enormous quantities of material had been ejected, vast fields of floating pumice having been met with in the neighbouring seas at various times between July 9 and August 12. GEORGE F. BURDER

Clifton, January 7

ONE feature of the recent sunrises I have not seen described, viz. a large and striking pink semicircle opposite the sun, having a bluish centre. I have only twice seen it well marked, viz. on November 27 and December 15. This seems to be one distinct mark of difference between these sunrises and ordinary ones, inasmuch as I never saw it before, though possibly this may be partly owing to the phenomenon only lasting a few minutes at each time. On November 27 it was at its height at 7.43 a.m. At 7.50 there was only a trace of it left. On December 15 it was at its height at 8.6 a.m. At 8.4 it was very faint, and by 8.16 it had again become so, and was whitish. At 8.6 a.m. the north-western sky was darkish to an altitude of about 5°, and light pinkish purple thence to 10°: so far the appearance was quite ordinary; but on the darkish sky rested the broad half ring, which was pink, but the inner part inclining to salmon-coloured. Being much brighter than the pinkish purple, it obscured it where they crossed. I estimated the radius of its outer edge at about 25°, and therefore its apex was about 30° in altitude. Within the ring was a bluish-white semicircle of about half the radius of the pink semicircle; which was thus 12° or 13° in width. The sky beyond was blue. The phenomenon seemed to be an ordinary cirrus, though this was of an indefinite type; the spaces between its wisps were pretty blue in all parts of the north-western sky, but partook somewhat of its colour. On November 27 there did not appear to be any cirrus, but the semicircle must have been on the film which has been so remarkably coloured during sunrise and sunset. I have noticed traces of this semicircle on one or two other mornings, but so faint that I should not have noticed it if I had not looked for it. I presume that it is of the same character as the pink circle with green or blue centre that has been visible round the sun by day. This also is a phenomenon which I never observed previous to last month; it was most striking about the 26th, but continues to be seen almost daily. This favours the volcanic dust theory; for it is strange that I should never have noticed it before, if it is of common occurrence; still we know that a phenomenon is more easily seen again after it has once been observed, than seen in the first instance. Can these pink rings be accounted for optically? If they could, would it not throw much light upon the cause of the fine sunrises and sunsets?

With regard to the height of the film which has caused these, I should like to ask whether it is considered proved that the sun is actually shining on it so far into the twilight, or whether the glow may not be caused by reflection from bright sky upon which the sun is really shining. The after-glow among the Alps is clearly caused in this latter way, and not by the sun shining upon the mountains them elves. At the same time, the appearance of cirrus clouds dark against the bright sky, as occurred this morning at about 7.40 a.m., seems to point to the film being far above them. THOS. WM. BACKHOUSE

Sunderland, December 19, 1883

P.S.—This morning the pink half-ring was again conspicuous, only the inner half was nearly white; within was the blue, darkish, as before. It was at its best at 8.10 a.m.

December 20, 1883 T. W. B.

I learned from a Dutch paper (but I forget from which) that a *blue sun* was observed at Paramaribo in the beginning of September (I think it was the 2nd or the 6th).

Stuttgart, January E. METZGER

The following letter appears in the *Times* of Tuesday:—

"A shower of matter having 'a white sulphurous appearance' is reported from the vicinity of Queenstown, Cape Colony, towards the close of November. The appended paragraph, giving an account of the phenomenon, is extracted from a Kimberley (Griqualand West) newspaper of December 1. Taken in connection with the description in your correspondence columns of December 25 of a somewhat analogous shower at Scutari, the paragraph is certainly interesting, and, perhaps, of value to physicists investigating the cause of the recent celestial phenomena. "WALTER CLARK

"Edinburgh, January 3

"'We were informed yesterday of the occurrence at Glen Grey, about twelve miles from Queenstown, of a phenomenon which, while it lasted, nearly terrified the white and native population out of their wits. On the afternoon of Wednesday a thick shower of matter, presenting a white sulphurous appearance, fell in the valley in which this village is situate, and, passing right over it from east to west, covered the entire surface of the country with marble-sized balls of an ashy paleness, which crumbled into powder at the slightest touch. The shower was confined to one narrow streak, and while it lasted, we are told, the surrounding atmosphere remained unchanged and clear, as it had been before. Great noises accompanied the shower, and so frightened the people working in the fields, who at first were under the impression that it was a descent of fire—the white substance glistening in the sun—that on perceiving it they fled into their houses for shelter No damage was caused by what fell, and upon examination of the substance afterwards it was found to be perfectly harmless. At first the little balls were soft and pulpy, but they gradually became dry and pulverised, crumbling at the touch. We have before us a piece of earth on which one of them fell, and the mark left behind resembles a splash of lime-wash or similar matter. It does not smell of sulphur.'"

MR. JOHN TEBBUTT, of Windsor Observatory, N.S.W., writes as follows to the *Sydney Herald*:—The appearance presented by our evening skies for some weeks past has been the subject of general remark. Last evening, the 14th, the sky was almost cloudless after sunset, and the usual brick-red light again made its appearance along the west-south-west horizon. It was reflected apparently from an almost invisible and gauze-like cloud in the higher regions of the atmosphere. About seven o'clock the red glow was at its maximum, when a solitary cloud, whose apparent surface did not exceed ten square degrees, presented itself above it at an altitude of 25°. This cloud, which was at first white, quickly changed to a beautiful green, its borders being of a deeper tint. Of all the cloud phenomena that I have witnessed, it was one of the most remarkable. It retained its green colour for the space of about ten minutes, being all the time subject to much internal commotion. It soon afterwards resolved itself into several cloudlets, and finally disappeared. Two or three other small clouds were visible at the same time, and about the same altitude above the northern horizon, but these were of a gray colour throughout. The eastern sky about the moon was of that deep blue which is frequently observed to surround her when rising during the winter oppositions. Shortly after the dispersion of the green cloud, the ruddy glow gave place to the ordinary pale gray of the twilight, but by half-past seven o'clock the western sky became suffused with red, but this time of a clearer and more aurora-like tint. It did not appear, as in the former case, to be reflected from hazy cloud, and it extended much higher in the sky. This repetition of the ruddy glow on the same evening is a phenomenon which I had witnessed on several occasions during the present month. I remember that many years ago (probably twenty-five) a somewhat similar patch of red light used to make its appearance regularly after sunset in the west-north-west. This phenomenon occurred previously to the commencement of my regular meteorological observations in 1863, and was, I think, contemporaneous with a very dry winter. That the present ruddy skies are not merely a local phenomenon is obvious from the fact that they have been regularly observed during the past three months over a considerable portion of the Indian Ocean.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following appointments have been made in accordance with Grace No. 19, confirmed on December 6 last:—J. H. Randell, B.A., Pembroke College, Assistant Demonstrator in Physics; J. C. McConnell, B.A., Clare College, Assistant Demonstrator in Physics; R. H. Solly, Demonstrator in Mineralogy, and Assistant Curator of the Museum; Walter Gardiner, B.A., Clare College, Demonstrator in Botany; A. Sheridan Lea, M.A., Trinity College, Senior Demonstrator in Physiology; W. D'Arcy Thompson, B.A., Trinity College, Junior Demonstrator in Physiology; A. Harker, B.A., St. John's College, Demonstrator in Geology. Baron Anatole von Hügel has been appointed Curator of the Museum of General and Local Archæology.

SCIENTIFIC SERIALS

THE *American Journal of Science*, December, 1883.—Some points in botanical nomenclature, a review of "Nouvelles Remarques sur la Nomenclature Botanique," par M. Alph. de Candolle, Geneva, 1883, by Asa Gray. The main object of this very valuable contribution to the vexed subject of botanic nomenclature is to enforce the principles and supplement the data supplied by M. de Candolle in his epoch making work. His doctrines are on the whole cordially accepted, and often very ably illustrated, while here and there some useful suggestive remarks and criticisms are offered on matters of detail upon which diversity of opinion and practice still prevails.—Pre-carboniferous strata in the Grand Cañon of the Colorado, Arizona, by Charles D. Walcott. The results are here embodied of over two months' careful examination especially of the Kaibab Division of the Grand Cañon and lateral gorges undertaken during the winter of 1882-3. The author, an active member of the United States Geological Survey, concludes that the Grand Cañon and Chuar groups correspond to that of the Keweenawan of Wisconsin, both being referable to the Lower Cambrian. Jointly with the Paradoxides horizon of Braintree, Massachusetts, and St. John's, New Brunswick, the olenellus of Nevada, Vermont, New York, and Newfoundland, and the Potsdam series of Wisconsin, New York, Canada, &c.; they constitute the Cambrian age as so far determined in North America. —Contributions to meteorology, nineteenth paper, with three plates, by Prof. Elias Loomis. This paper deals at some length with the barometric gradient in great storms. The results confirm in a general way the accuracy of Ferrel's formula:—

$$G = \frac{1076 \cdot 4\,(2n \cos \psi + \nu)\, sP}{\cos i\,(1 + \cdot 004t)\, P'},$$

where G denotes the barometric gradient in millimetres per degree of a great circle, or sixty geographical miles. But it is shown that the effect of friction is considerably greater than was supposed by Ferrel.—A brief study of Vesta, by M. W. Harrington. The author considers it probable that this asteroid has a diameter of over 500 miles, that she resembles the moon in her albedo, hence lacks an appreciable atmosphere and water, that the irregularities of her light indicate a very rough surface and rotation on her axis; lastly, that what is true of Vesta is likely to be true, *mutatis mutandis*, of the other asteroids.—On a new form of selenium cell and some electrical discoveries made by its use, by Charles E. Fritts. This new form of selenium cell has the following properties:—(1) its resistance can be made as low as desired, down to nine ohms; (2) the light is made to strike the cell in the same plane as the current; (3) it is far more sensitive to light than any before known, one cell having had fifteen times as high resistance in dark as ordinary diffused daylight in a room. Since the paper was written, the author announces the discovery of a new form of selenium, quite colourless and transparent, obtained under conditions excluding everything but selenium.—The Ischian earthquake of July 28, 1883, by C. G. Rockwood, jun. The author concludes that this disturbance had its orgin in a rupture taking place along an old volcanic fissure running roughly north and south, and extending radially under the northern slope of Mount Epomeo; and that the cause of the increased tension resulting in this rupture must be referred to the residual volcanic activity which Ischia shares with the adjacent mainland, rather than to any merely local subsidence, as suggested by Prof. Palmieri.

Annalen der Physik und Chemie, Bd. xx. No. 11, 1883.—R. Clausius, on the theory of dynamo-electric machines. This is a remarkably clear and able paper, dealing with the fundamental points in the theory of dynamo-electric machines in a masterly way, and introduces several new notions requiring the determination of the arbitrary constants in different machines. The questions of self-induction and mutual induction between different segments of the armature receive special attention. The author promises a further paper with applications of the equations.—L. Sohncke and A. Wangerin, on interference-phenomena in thin and particularly in wedge-shaped films. This paper is a continuation of one in last month's issue, giving new fundamental formulæ for Newton's rings and other interference-phenomena of thin films.—B. Hecht, on the determination of the axis-ratios of the elliptic paths in elliptic polarisation in quartz. A discussion of formulæ of Cauchy, Lommel, Voigt, and Jamin, in reference to the author's experiments.—W. Voigt, on the theory of light: a polemic against Herr Lommel respecting the latter's views on the possible intermolecular friction of the luminiferous ether.—H. Wild, on the application of his photometer as a spectrophotometer; this instrument, constructed by Hermann and Pfister, of Bern, contains a slit, a calc-spar rhombohedron, a Foucault prism, a second rhombohedron, a selenite plate, a Nicol prism, a pair of adjustable glass prisms, a 5-prism Amici direct-vision prism, and sundry lenses. The light to be examined has to pass through these successively.—Researches on forced vibrations of plates; part ii., on vibrations of square plates, by A. Elsas. This paper, which is accompanied by a set of forty-nine figures, is in continuation of a previous research on forced vibrations of round plates. The author points out that we already have the well-known researches of Chladni and Wheatstone on the figures due to natural vibrations of such plates. The aim of this research was to ascertain whether Savart's rule, that the forms of the forced vibrations merge into one another by a perfectly continuous series of modifications, is true for square plates; whether the figures corresponding to forced vibrations agree with those of the free vibrations of the same pitch; and whether the legitimacy of Wheatstone's method of superposition is confirmed or disallowed. The most important of all the results is that it is impossible for a square plate to vibrate in response to any time whatever, higher than its own fundamental, that may be forced upon it.—On Boltzmann's theory of elastic reaction, by Prof. E. Riecke; a mathematical discussion of Boltzmann's equations.—On aqueous solutions, by J. A. Groshans. A discussion of the dependence of the density of the solution on the quantity and molecular constitution of the soluble substance.—Measurement of the quantity of electricity produced by a Zamboni's pile, by Prof. E. Riecke. The values were calculated from currents traversing a long-coil galvanometer and a very high resistance.—On the galvanic-temperature coefficients of steel, rod-iron, and cast-iron, by V. Strouhal and C. Barus. For steel this coefficient diminishes as the hardness of tempering increases, while the specific resistance increases with the hardness. Glass-hard steel has about three times the specific resistance of soft steel.—On the relation between viscosity and electric resistance of solutions of salts in various solvent media, by E. Wiedemann. There appears to be no such relation as has been conjectured to exist.—On Arabian measurements of specific gravity, by E. Wiedemann.—Simplifications in experimenting with the air-pump, by K. L. Bauer, suggests the expedient already well known in England, of placing a sheet of soft caoutchouc under the receiver of the pump instead of greasing its rim; also similarly between the edges of the Madgeburg hemispheres. Gutta-percha paper is suggested as a substitute for bladder to be burst by air-pressure.

SOCIETIES AND ACADEMIES

London

Chemical Society, December 20, 1883.—Dr. W. H. Perkin, F.R.S., president, in the chair.—The following gentlemen were elected Fellows of the Society:—W. P. Bloxam, A. Cobb, J. C. Chambers, A. E. Ekins, F. P. Haviland, F. Keeling, W. H. R. Kerry, J. J. Pilley, M. Percy, J. Phillips, A. W. Rogers, W. J. Saint, G. Smith, A. Smithells. The following papers were read:—Researches on the gums of the arabin group, by C. O'Sullivan. Part I. Arabic acid; its composition, and the products of its decomposition. In this most important paper the author has studied the action of dilute sulphuric acid upon arabic acid. The arabic acid was prepared by the method of Neubauer, and the sulphuric acid was allowed to act for various lengths of time from fifteen minutes to several hours. The molecule of arabic acid, $C_{89}H_{142}O_{74}$, is broken down, a series of eleven acids of gradually decreasing molecular weight (differing by $C_6H_{10}O_5$) having been isolated, and the barium salts formed and analysed; the lowest acid is $C_{23}H_{38}O_{22}$, and is comparatively stable; these acids the author calls α, β, &c., arabinosic acids. Simultaneously a series of sugars having the composition $C_6H_{12}O_6$ is formed of gradually decreasing optical activity, which the author names α, β, γ, and δ arabinose. Arabic acid is the chief constituent of all the lævorotatory gums, but other acids are present which bear a simple relation to it. In a future paper the author promises an account of the dextrorotatory and optically inactive gums, the acids of which are built up in the same manner as arabic acid.—On the decomposition of ammonia by heat, by W. Ramsay and S. Young. This decomposition commences about 500°, and is nearly equal in extent with porcelain, glass, iron, and asbestos, but at 780° ammonia is almost completely decomposed by passing through an iron tube. Copper, when heated, is not so active.—On the halogen compounds of selenium, by F. P. Evans and W. Ramsay.—On the preparation of pure chlorophyll, by A. Tschirch. This substance is obtained by the action of zinc dust on chlorophyllan (*Bot. Zeit.*, 1882, 533); its spectrum is identical with that given by living leaves.

Zoological Society, December 18, 1883.—Prof. W. H. Flower, F.R.S., president, in the chair.—Dr. F. Leuthner read an abstract of a memoir which he had prepared on the Odontolabini, a subfamily of the Coleopterous family Lucanidæ, remarkable for the polymorphism of the males, while the females remained very similar. The males were stated to exhibit four very distinct phases of development in their mandibles, which the author proposed to term "priodont," "amphiodont," "mesodont," and "telodont." These forms were strongly marked in some species; but in others were connected by insensible gradations, and had been treated by the earlier authors as distinct species. The second part of the memoir contained a monograph of the three known genera which constitute the group Odontolabini.—Mr. E. B. Poulton, F.Z.S., read a memoir on the structure of the tongue in the Marsupialia. The tongues of species of nearly all the important groups of this subclass were described in detail. It was found possible to classify the tongues in three divisions. Of these, *Halmaturus* was the type of the lowest, *Phalangista* of the intermediate, and *Perameles* of the most advanced, division.—Mr. J. Wood-Mason, F.Z.S., read a paper on the Embiidæ, a little-known family of insects, on the structure and habits of which he had succeded in making some investigations during his recent residence in India. He came to the conclusion that the Embiidæ undoubtedly belong to the true Orthoptera, and are one of the lowest terms of a series formed by the families Acridioideæ, Locustidæ, Gryllidæ, and Phasmatidæ.—Mr. G. A. Boulenger, F.Z.S., read an account of a collection of frogs made at Yurimaguas, Huallaga River, Northern Peru, by Dr. Hahnel. The collection contained examples of eighteen species, eight of which were regarded as new to science.—Mr. W. F. R. Weldon read a paper on some points in the anatomy of *Phœnicopterus* and its allies. An account was given of the air cells of the Flamingo, which were shown to differ from those of Lamellirostres, and to agree with those of Storks (1) in having the præbronchial air-cell much divided, (2) in the feeble development of the posterior intermediate cell, and (3) in the great size of the abdominal cell. The pseudopiploon was also shown to differ from that of Lamellirostres, and to agree with that of Storks, in extending back to the cloaca. A detailed comparison between the muscles, especially those of the hind limb, gave the same results. The larynx, however, being Anserine, and the skull intermediate, the position expressed by Huxley's term "Amphimorphæ" was considered fully justifiable.—Mr. Sclater read a paper, in which he gave the description of six apparently new species of South American Passeres.

Anthropological Institute, December 11, 1883.—Prof. Flower, F.R.S., president, in the chair.—The election of Mr. E. W. Streeter was announced.—Mr. Walton Haydon exhibited some photographs of North American Indians.—A paper by Mr. A. W. Howitt, on some Australian ceremonies of initiation, was read by Dr. E. B. Tylor. The ceremonies described by the author are common to a very large aggregate of tribes in the south-eastern part of Australia, and as himself an initiated person, Mr. Howitt has had unusual opportunities of observation and of obtaining information from the Blacks. When it has been decided that there is a sufficient number of boys ready for initiation, the headman sends out his messenger, who travels round to the headmen of the same totem, who then communicate the message to the principal men of the different totems which form the local groups. The messenger carries with him, as the emblems of his mission, a complete set of male attire, together with the sacred humming instrument, which is wrapped up in a skin and carefully concealed from women and children. The ceremonial meeting having been called together, that moiety of the community which called it prepares the ground and gets all ready for the arrival of the various contingents. Mr. Howitt then described at length the procession from the camp to some retired and secret place where the ceremonies are to be performed, each novice being attended by a guardian, who fully explains to him all that is said or done. A camp is formed when the spot is reached that has been fixed upon for the site of the tooth-knocking-out ceremony, which was fully described by the author in the latter part of the paper.—Dr. R. G. Latham read a paper on the use of the terms "Celt" and "German."

Geological Society, December 19, 1883.—J. W. Hulke, F.R.S., president, in the chair.—Rev. W. R. Andrews, Robert James Frecheville, and Rev. Philip R. Sleeman were elected Fellows of the Society.—The following communications were read:—On some remains of fossil fishes from the Yoredale series at Leyburn in Wensleydale, by James W. Davis, F.G.S.—Petrological notes on some North-of-England dykes, by J. J. H. Teall, M.A., F.G.S. The author described the stratigraphical relations and the structure, macroscopic and microscopic, of a number of dykes which occur in the north-east of England, giving analyses. He pointed out that they fell into four more or less distinct groups: (1) the Cleveland dyke and that of Acklington; (2) the Heth and its related dykes; (3) the dykes of Hebburn, of Tynemouth, of Brunton, of Hartley, and of Morpeth; (4) the High Green dykes. Groups (1) and (3) resembled one another in specific gravity and chemical composition, as did (2) and (4), the percentage of silica in the first two (except in the Morpeth dyke) varying from 57 to 59, and the specific gravity being about 2·7 or 2·8, while the others had a silica percentage of from 51 to 53, and a rather higher specific gravity. The former present some microscopic differences, the latter are very closely related. The Cleveland, Acklington, and Heth dykes have been examined at intervals far apart, and exhibit no variation or relation to the surrounding rocks; so that evidently they have not taken up any appreciable portion of the material through which they have broken. The dykes of Group (3) being probably pre-Tertiary (the author does not himself find it possible to distinguish igneous rocks by their geologic age) would be termed melaphyres on the Continent; but those of (2) and (4) are nearer to the group of diabases. The Cleveland dyke (Group 1) is almost certainly of Tertiary age, and its structure and composition entitle it to the name of an augite-andesite.—The Droitwich brine springs and saliferous marls, by C. Parkinson, F.G.S.

EDINBURGH

Royal Society, December 17, 1883.—Robert Grey, vice-president, in the chair.—Prof. Tait communicated a paper by Mr. A. Campbell, containing the results of additional experiments on the Peltier effect. The results agreed closely with their values as calculated from the thermoelectric diagram.—Dr. Sang read a paper on the problem of the lathe band, and on problems therewith connected.—Prof. Tait read a note by the Astronomer-Royal for Scotland, on Brewster's line Y in the infra-red. The object of the note was to point out that this line, which had been ascribed by some recent observers to air, and therefore omitted from the spectrum, is a true solar line, which has been found to be due to sodium.—Mr. John Murray read a communication by Mr. P. H. Carpenter, on the Crinoidea of the North Atlantic between Gibraltar and the Faröe Islands; with notes on the Myzostomidæ, by Prof. T. von Graff, Ph.D.—Mr. R. W. Felkin, F.R.G.S., gave a very interesting account of the Madi or Moru tribe, from which the flower of the Egyptian army has been drawn.—A paper was also read, on the structure of the pitcher in the seedling of Nepenthes, as compared with that in the adult plant, by Prof. Alexander Dickson, M.D. Prof. Dickson gave the results of his examination of Nepenthes seedlings lately raised in the Edinburgh Royal Botanic Garden. One of the most important points to which he drew attention was in connection with the annulus or rim of the pitcher orifice. In the seedlings this structure is seen even in the pitcher leaf immediately succeeding the cotyledons, and a row of cushion- or button-like glands is to be found just within its inflexed edge. From observing these glands, Prof. Dickson was led carefully to examine the annulus in the adult plant, with the result of his discovering their representatives in a remarkable series of gigantic glands. If the inflexed rim be examined, there is to be found, just above its free edge, a single line of small orifices, alternating with the ridges of the corrugated annulus and with their tooth-like prolongations, when these are present. On dissection, each of these orifices is seen to be the outlet of a canal-like fossa, from the bottom of which a cellular, nipple-shaped body or mammilla projects. This mammilla is the free apex of a gland, the great bulk of which is immersed in the parenchymatous substance of the annulus. These glands vary in length, according to the species, from 1/37 (*N. ampullaria*) to the enormous measure of 1/12 of an inch (*N. destillatoria*, *N. phyllamphora*, &c.). Prof. Dickson could not speak definitely as to the function of these glands, but thought that they probably secrete honey, affording to the insect the last drops just as it is on the brink of destruction! Sir J. D. Hooker, in his address on insectivorous plants delivered at the Belfast meeting of the British Association, had spoken of the pitcher rim as secreting honey, but without making any reference to these remarkable marginal glands.

BIRMINGHAM

Philosophical Society, December 13, 1883.—Peculiar absorption of a compound of iodine by aluminium, by Dr. G. Gore, F.R.S. This paper contains a statement of the discovery of a peculiar fact by the author, viz. that when a sheet of aluminium was simply immersed in a solution composed of 17½ grains of pure iodic acid dissolved in 3½ ounces of distilled water, it absorbed as much as 16 per cent. of its weight of a foreign substance, and emitted a strong odour of iodine. It retained its metallic appearance, although it had become peculiarly rough by corrosion. When struck by a hard substance it emitted a less metallic sound. In several similar experiments the plates gained much more in weight by absorption than they lost by corrosion. By examining the edges of the sheets under a microscope, the sheets were found to be partly disintegrated into thin layers. A variety of other methods were tried, including electrolytic ones, to produce the same effect, but in no instance did the metal emit much odour of iodine, or appear to have absorbed freely a foreign substance. With aluminium immersed in dilute hydriodic acid containing dissolved iodine, similar though much less conspicuous effects of disintegration and emission of odour of iodine were, however, observed. By immersing a sheet of the metal in a solution of bromic acid, the metal did not appear to absorb much bromine. A partial investigation was made of the phenomena. By washing the sheets with water, the water became strongly coloured by iodine, and continued to do so after many washings. Although, after having been washed and dried, they continued to emit a strong odour of iodine, they did not by immersion in carbonic bisulphide at 60° F., during thirty-six hours, yield any iodine, or impart any colour to that liquid; the absorbed substance was not, therefore, simple iodine. A flat sheet of aluminium varnished on one side, and then immersed in aqueous iodic acid, did not assume a curved shape. A chemical analysis of the absorbed substance has not yet been made.—Reduction of metallic solutions by means of gases, &c., by Dr. G. Gore, F.R.S. This paper is a record of a number of instances in which various solutions of metals were reduced to the metallic state by contact with gases, and different organic compounds. The solutions chiefly employed were those of palladium, iridium, platinum, gold, silver, and mercury, and less frequently those of copper, lead, iron, manganese, chromium, vanadium, and tellurium. The gases used were hydrogen, carbonic oxide, coal gas, and crude acetylene. The organic compounds included both liquid and solid substances; the liquids were amylene, petroleum, benzene, Persian naptha, xylol, toluol, carbolic acid, "petroleum ether," mesitylene, and liquid chloride of carbon, and the solids were paraffin, ozokerite, naphthalene, anthracene, chrysene, elaterite, solid chloride of carbon, &c. By contact with gases the metals were generally reduced in the form of films upon the surface of the liquids, as well as in that of precipitated powder; some of the films produced, both by the contact of gases and by that of non-miscible liquids, were remarkably beautiful, and of a surprising degree of thinness. Amongst the most conspicuous instances of reduction were the following:—a solution of palladic chloride was rapidly reduced by carbonic oxide, hydrogen, coal gas, and amylene. One of terchloride of gold was quickly decomposed and reduced by coal gas, carbolic acid, and amylene. The most beautiful films were those produced by a solution of terchloride of gold, with coal gas or with amylene. Solutions of chloride of palladium were usually more rapidly decomposed than those of chloride of gold. The films of metal thus produced might prove of service in some optical and other physical investigations. It is worthy of consideration also by geologists, whether the reduction of metals to the native state in the interior of the earth may not in some cases have been effected by contact of their solutions with liquid or gaseous hydrocarbons derived from coal and other mineral substances of organic origin.

Paris

Academy of Sciences, December 31, 1883.—M. Blanchard, president, in the chair.—Action of heat on aldol and paraldol, by M. Ad. Wurtz.—On a white rainbow (Ulloa Circle) observed at Courtenay (Loiret) on the morning of November 28, by M. A. Cornu. This extremely rare phenomenon occurred under atmospheric conditions closely analogous to those described by Bravais in the *Journ. de l'École Polytech.*, xxx. p. 97. The radius appears to have been much shorter than that of the ordinary rainbow.—Mission to Cape Horn: Summary report on the researches made in natural history and anthropology by the *Romanche*, by Dr. Hahn. In the north-eastern islands of Tierra del Fuego acquaintance was made with the Ua people, who present several remarkable peculiarities. Although living on friendly terms and even intermarrying with the more southern Yahgans, they seem to be related in stock and speech rather to the continental Patagonians. They appear even to exceed them in stature, and thus to rank as the very tallest race on the globe.—Note on the tidal curves registered between November, 1882, and September, 1883, by the maregraph at Orange Bay, Cape Horn.—Observations of the Pons-Brooks comet at the Observatory of Nice (Gautier-Eichens equatorial), by M. Perrotin.—Spectroscopic study of the Pons Brooks comet made with the reflector of 0·50 m. at the Observatory of Algiers, by M. Ch. Trépied. The following results were obtained:—

	Comet	Flame of alcohol
Reading for line D	13·18	—
First green line (less refrangible) ...	13·92	14·09
Second green line	15·12	15·20
Blue line	16·76	17·04

showing that in its visible parts the spectrum of the comet is identical with that of a flame of alcohol.—On the multipliers of the linear differential equations, by M. Halphen.—On a means of determining the factor of integrability, by M. W. Maximovitch.—On the generation of surfaces, by MM. J. S. and M. N. Vanecek.—Reply to M. Larroque's observations on the experiments recently made in connection with the study of earth currents, by M. E. E. Blavier.—On the temperature obtainable by means of boiling oxygen, and on the solidification of nitrogen, by M. S. Wroblewski. Reserving a description of his process, the author announces as a first result an approximate temperature of −186° C. When subjected to this intense degree of cold, nitrogen became solidified, falling like snow in crystals of a remarkable size.—On the maximum of solubility of soda, by M. E. Pauchon.—On an incomplete oxygenised monamine (oxallyldiethylmine, by M. E. Roboul.—On the fluorides of sodium, by M. Guntz.—Researches on ptomaïnes and analogous compounds, by M. A. Gabriel Pouchet.—Action of copper on the health of persons engaged in the copper industries; history of a workshop and of a village, by MM. A. Houlès and de Pietra-Santa. The history of this village (Tarn, Durfort) extends over a period of a hundred years, and tends to show that coppersmiths (forgers, braziers, &c.) are on the whole as long-lived if not more so than the agricultural population of the same district.—On the anatomy of a human embryo in the fourth week, by M. H. Fol.—On a new species of the genus Megaptera (*Megaptera indica*) from the Bay of Bassora, Persian Gulf, by M. P. Gervais.—On a rare species of Dolphin (*Orca gladiator*, Gray = *Delphinus orca*, Fab.) recently captured off Tréport, Seine-Inférieure, by M. H. Gadeau de Nerville.—On the vitelline nucleus of the Araneidæ, by M. A. Sabatier.—New ophidological discoveries, by M. Lichtenstein.—On a phenomenon accompanying the red afterglow of the sunsets of December 26 and 27, 1883, at Tortosa (Spain), by M. José J. Landerer.—Terrestrial physics: the Krakatoa catastrophe; velocity of the earthquake waves, by M. Erington de la Croix. From observations made in Ceylon, Mauritius, and other places, the earthquake wave of August 27, 1883, seems to have been propagated across the Indian Ocean at the prodigious velocity of about 550 m. per second, or 2000 km. per hour.

Berlin

Physiological Society, December 7, 1883.—Prof. Waldeyer brought before the Society the results of investigations pursued by Herr Koganei in his Institute into the histogeny of the retina. It was known that the retina was a development of a vesicular projecting flap of the brain (*Hervorstülpung des Gehirns*), and that this membrane of the eye consisted in its early stages of fusiform cells. Whether there were other cells besides contained in it, how they were developed, and how the different constituents of the developed retina were differentiated, were, on the other hand, all matters of debate. Herr Koganei had now found that in the earliest stages this membrane of the eye was composed of two series of cells, one of fusiform cells on the distal side of the membrane, the other of round cells supplied with caryokinetic nuclei on the proximal side. The fusiform cells were called "fundamental," the round cells "prolific," these latter alone multiplying, as they did, by scission, and furnishing the whole material for building up the retina. The increase in retina elements proceeded therefore altogether from the proximal side, whence the newly-produced cells intercalated themselves into the layer of fusiform cells, all which phenomena entirely corresponded with those of the brain, it likewise growing only by multiplication of cells on the ventricular side. The differentiation of the fusiform cells into separate retina layers began after the ocular chamber was formed by the invagination of its most anterior part which becomes transformed into a double saucer shaped form, or rather it was only the innermost saucer which became the retina, while the outer saucer was converted into the pigment layer, the cells of which were filled with pigment. The differentiation followed a law of quite universal application. In every case it began on the distal side, which, on the invagination of the ocular chamber, became the inner side, and advanced gradually to the outer side of the retina. It began consequently with the oldest fusiform cells, and passed gradually over to the later-formed fundamental cells. As analogous to this was next recognised the membrana limitans interna, with the supporting fibres of Müller. These formed themselves out of the innermost layer of the oldest fusiform cells, which ranged themselves strongly out in a longitudinal direction, and became flattened on their inner end. The basal laminæ (*Fussplatten*) of these cells impinging on each other formed the membrana limitans. Then the layer of ganglion cells appeared, and, almost simultaneously, the layer of optic fibres intervening between the layer of ganglion cells and the membrana limitans. The mode by which the ganglion cells were developed was through the rounding of the fusiform cells and their emission of offshoots. With regard to the layer of nerve-fibres it was ascertained that they developed themselves out of continuations of the ganglion cells. Whether and in what manner they came later into confluence with the optic fibres proceeding from the brain was a point which must be reserved for further investigation. Prof. Waldeyer deemed it not impossible that the optic fibres growing out of the ganglion cells penetrated into the brain, and there merged into the central ganglion. Thereafter was developed the so-called molecular layer. This name had been given to it in consequence of its finely granular appearance under slight enlargement. With the powerful amplification which was now customary it was, however, at the present day, universally recognised as consisting of an extremely fine network of the most delicate filaments. In the middle of this layer Herr Koganei had found a series of round cells which, having issued from fundamental cells, formed the mother-cells of this layer. Since it was now known that cellular protoplasm consisted of a reticular coating and fluid contents, it became intelligible how, from the protoplasm of the series of mother-cells occupying the middle zone, the fine fibrous net of the molecular layer was formed by more vigorous development of the protoplasmic coating and the proportionate reduction of the liquid contents. In the further development of the embryonal retina there now appeared the internal granular layer with the median granular layer, followed, shortly after, by the external granular layer. Both granular layers developed themselves from the fusiform fundamental cells through the latter becoming round and partially emitting continuations. In this manner they formed themselves into ganglion cells, as the granules of the granular layer must be considered. The median granular layer was in the highest probability a layer of fibre-nets intercalating itself, like those of the molecular layer. In the granular layers, besides round and ganglion cells, fusiform cells were also met with. These fusiform cells, by vigorous longitudinal growth, developed themselves into supporting fibres (*Stützfasern*), flattened themselves at their extreme ends, and by superimposition of their terminal laminæ formed the membrana limitans externa. On the development of this last membrane the ganglia or granules of the granular layer began to send continuations outwards striking through the membrana limitans, which, therefore, very soon appeared occupied with the little blunt endings (*Stümpfchen*). These again grew to be granular interior members of the rods and pins that, finally, developed the hyaline external members which were powerfully refractive and cylindrical, or cone-shaped, the last members in the series of the development of retina elements. At this point the fact, of supreme importance to the physiologist, was established, that new-born animals only began to see when the exterior members of the rods and cones were developed. From the foregoing observations, Prof. Waldeyer deduced an important general conclusion, which had equal applicability to the brain as to the retina. The development of the retina demonstrated that all its morphological constituents, the ganglion cells, the nerve fibres, and the supporting fibres were developed from the same fundamental cells. The supporting fibres of the retina, and in like manner the neuroganglia of the brain, must consequently be classed as belonging to the nervous system, and having nothing in common with the ligamental tissue. They were nervous apparatus, which only did not perform nervous functions. In the case of regenerative processes, however, they played an important part. It was known that highly differentiated tissues were not capable of regeneration, which was therefore impossible in the case of ganglion cells and nerve fibres. Supporting fibres and neuroganglia, on the other hand, were capable of regeneration, and, being developed from neurously constituted cells, were also capable of undertaking nervous functions or of further differentiating themselves for those higher functions. This highly important question deserved a very thorough investigation.

Vienna

Imperial Academy of Sciences, October 11, 1883.—On the genetic formation of the flora of New Zealand, by C. von Ettingshausen.—On isobutyl-biguanidine, by A. Smolka.—On the Diatomaceæ collected by the Austro-Hungarian North Polar Expedition in Franz-Josef Land, by A. Grumov.—On gravitation, by A. Iarolimek.—On the comet discovered by Brooks, by E. Weiss.—On some spectral analytical researches carried out with the large refractor of the Vienna Observatory, by C. H. Vogel.

October 18, 1883.—On the theory of diffusion of gases; part ii., dealing with the diffusion of a gas into itself, by L. Boltzmann.—On the quantity of work which can be obtained by chemical combination, by L. Boltzmann.—On the forms and chemical composition of the scapolith series, by F. Tschermak.

October 25, 1883.—On roemerite, botryogen, and natural magnesia iron vitriol, by T. Blaas.—Ichthyological contributions, (thirteenth paper), by T. Steindachner.

November 8, 1883.—Contributions to general nerve- and muscle-physiology; xii., on the change of the electromotor behaviour of muscles produced by electric irritation, by E. Hering and W. Biedermann.—Supplement to his paper on the quantity of work which can be obtained by chemical combination, by L. Boltzmann.—On a series of new mathematical principles, by O. Simony.—Report on the French Expedition sent to the Manihiki Islands to observe the solar eclipse of May 6, 1883, by T. Palisa.

November 16, 1883.—On the *rôle* of the inferior asteroids, by F. Chapel.—On the intercellular spaces of the epithelium of the Polmonata, by A. Nalepa.—On the axis of the tail of the comet 1827 III., by T. von Hepperger.

November 22, 1883.—Contribution to general nerve- and muscle-physiology; xiii., on Du Bois Reymond's researches on the secondary electrical phenomena of muscle, by E. Hering.—On the genetic formation of the flora of Hong Kong, by C. von Ettingshausen.—Contributions to the theory of respiratory innervation (fourth communication), by Ph. Knoll.—On the species, sub-species, varieties, and hybrids of the section Ptamica of the Achillea genus, by A. Heimerl.—Contributions to the knowledge of the fishes of the Adria, by E. Steindachner and G. Colombatovic.—Contributions to the knowledge of the chemical composition of starch-granules, by B. Bruckner.

December 6, 1883.—On a vertebral synostosis in *Salamandra maculosa*, Saur., by T. H. List.—On the mechanism of the distant action of electrical forces, by T. Odstrril.—Calculation of the altitude of the pole and of the azimuth at the Kremsmünster Observatory, by W. Tinter.—Report on his geological researches carried out in the western Balkan and the adjacent regions, by F. Toula.—Determination of the orbit of the *Russia* planet (232), by N. Herz.

December 13, 1883.—Histological and physiological studies on the organ of taste, by O. Drasch.—On the satellite curves and satellite planes, by G. Kohn.—Struggle of physical axioms, by T. Sehlesinger.

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THURSDAY, JANUARY 17, 1884

FAMILY RECORDS

Record of Family Faculties. By Francis Galton, F.R.S. (London: Macmillan and Co., 1884.)

Life-History Album. By Francis Galton, F.R.S. (London: Macmillan and Co., 1884.)

MR. GALTON is indefatigable in his zeal to promote the cause of eugenics. His most recent efforts in this direction have resulted in the publication of two quarto books, which respectively bear the titles above given, and which betoken no small amount of labour on the part of their author. Feeling the importance of casting a wide net for the capture of facts bearing on the science of eugenics which he hopes to inaugurate, Mr. Galton has here presented to the public a formidable array of blank forms or tables, to be filled up by any one who may have caught a spark of his own enthusiasm in the new cause. And not only so, but, to stimulate the energies of a blind and foolish generation, he has offered rewards or prizes to the extent of 500*l.* for the best writing up of the Records of Family Faculties. Lest any of our readers, however, should be induced from sordid motives alone to invest a few shillings in the purchase of this curious book, we think it is desirable to warn them at the outset that if they intend to write for one of the prizes they must know a good deal more about their family history than was known even by the writer of the book, which begins—"This is the book of the generations of Adam." For, as far as it appears from his preface, Mr. Galton would not award even the least of all his prizes to any one who could prove direct descent from Adam; nay, it would be useless to prove such descent even from any particular gorilla. For, we are expressly told, "no countenance is given to the vanity that prompts most family historians to trace their pedigree to some notable ancestor. . . . We should remember the insignificance of any single ancestor in a remote degree. . . . One ancestor who lived at the time of the Norman Conquest, twenty-four generations back, contributes (on the supposition of no intermarriage of kinsfolk) less than one part in 16,000,000 to the constitution of a man of the present day."

What Mr. Galton wants, therefore, is not the record of a long pedigree, but an accurate and detailed account of a short one. And this is just what makes his tables so difficult to fill up. We must not only know all about our father and mother and grandfathers and grandmothers, but also about our father's father's father, father's father's mother, father's mother's father, father's mother's mother, mother's father's father, mother's father's mother, mother's mother's father, and mother's mother's mother. Even this, indeed, is not enough to satisfy Mr. Galton; for, "besides the direct ancestors, the brothers and sisters of each of them have also to be taken into account," and are accordingly all provided for in the blank tables. Obviously not many of us could answer any of the following questions touching, say, a mother's father's mother's brother:—Date and place of birth, occupation, residences, age at marriage, ditto of spouse, number and ages of sons and daughters, mode of life, height, colour of hair and eyes, general appearance, degree of strength, perfection or imperfection of special senses, mental powers, personal character, favourite pursuits, artistic aptitudes, minor ailments, graver illnesses, cause and date of death, and age at death.

The impossibility, however, of any one competitor filling up all the tables is of course no argument against setting the questions. The same questions are submitted to all the competitors, and those who can answer most or best will receive the 500*l.* Perhaps a few years hence, when Mr. Henry George shall have effected his social revolution in this country, our aristocratic families (who are favourably handicapped in their knowledge of ancestry) will be thankful to assist the science of eugenics upon the terms now offered by Mr. Galton.

The "Life-History Album" is, in size, date, and general appearance, a companion to the "Record of Family Faculties." It runs to 72 pages, which are arranged for entries in five-yearly periods from birth to 75 years of age. We can imagine the melancholy aspect of a man who in the year 1959 sits down to fill up the last page of a copy of this album, the first page of which is now being begun by his parents. What a retrospect will lie before his dim and saddened gaze! Every tooth that he gained in childhood, and every tooth that he lost in age has been duly chronicled; all the fluctuations in his weight, health, and strength are recorded; he can trace the dawn and rise of all his bodily and mental powers from infancy to manhood, and can measure with the most painful nicety their continuous decline from manhood to old age. He has before him a little picture gallery of fifteen photographs taken at five-yearly periods, to impress upon him with yet more cruel vividness what a wreck he has become; and now there is no further page whereon to continue the record so long and so faithfully kept. Even the interest of Mr. Galton in all that he was to be and all that he was to do has come to an end; he has literally turned over the last page of his life, and if his poor old eyes do not drop a tear upon the closing tragedy, it can only be because his zeal for science has devoured every other emotion.

But although this aspect of the matter is irresistibly suggested by the close of the album at 75 years of age, without even the provision of a blank page for any further possibilities (with trembling fingers these might, indeed, be pasted in), we must remember that the evil here lies in the fact of mortality. So long as a man is alive, it may be useful to him in many ways—apart from eugenics—to have such a physical record of his life thus kept from his earliest days. No doubt the sooner it is begun the more value it will subsequently have; but Mr. Galton virtually tells us that, as in the Pilgrim's Progress, so in the pilgrimage of life, "better late than never" in making a beginning.

In order to show some of the personal, as distinguished from any scientific, advantages which may reasonably be expected to arise from keeping such a biological history of one's self, we shall conclude by quoting an extract from Mr. Galton's own exhortation.

"*To the Owner of this Book*

"1. It will show whether, and in what way, your health is affected by the changes that take place in your residence, occupation, diet, or habits.

"2. It will afford early indication of any departure from health, and will thus draw attention to conditions which, if neglected, may lead to permanent disorder. Without such a record, the early signs of disease, which are commonly slight and gradual, are very likely to pass unrecognised, and thus the opportunity will be lost of seeking advice at the time when preventive or curative measures can be most successfully taken.

"3. A trustworthy record of past illnesses will enable your medical attendants to treat you more intelligently and successfully than they otherwise could, for it will give them a more complete knowledge of your 'constitution' than could be obtained in any other way. This knowledge is so important that life itself may in many illnesses depend upon it.

"4. The record will further be of great value to your family and descendants; for mental and physical characteristics, as well as liabilities to disease, are all transmitted more or less by parents to their children, and are shared by members of the same family. 'The world is beginning to perceive that the life of each individual is in some real sense a prolongation of those of his ancestry. His character, his vigour, and his disease, are principally theirs. . . . The life-histories of our relatives are, therefore, more instructive to us than those of strangers; they are especially able to forewarn and to encourage us, for they are prophetic of our own futures.'—(*Fortnightly Review*, January, 1882, p. 31)."

We have now said enough to show the general character of these original publications. We ought to add, however, that they may be purchased separately, and therefore, notwithstanding the prizes offered for the best Records of Family Faculties, we think it probable that the "Life-History Albums" will have the better sale. They are inexpensive to buy, and, apart from the trouble of writing them up at intervals, require for their keeping no other kind of expenditure. GEORGE J. ROMANES

SIAM

Temples and Elephants: The Narrative of a Journey through Upper Siam and Lao. By Carl Bock. (London: Sampson Low, Marston, and Co., 1884.)

THE expedition undertaken by Mr. Bock in 1881–82 to the Indo-Chinese mainland was practically a continuation of his previous ramblings in the Eastern Archipelago, a graphic account of which he has given us in his "Head-Hunters of Borneo." Of both the main object appears to have been rather archæological and ethnographical than strictly scientific, and of both the incidents and results have also been somewhat analogous. In each case some hitherto unvisited tracts were explored, or at least traversed, each was marked by a striking absence of any stirring adventures "by flood or field," both yielded, besides some additions to our geographical and ethnological knowledge of the regions in question, a considerable amount of "curios and treasure-trove"; but the quest of the "tailed people" proved as bootless in Further India as it had in Borneo.

In other respects "Temples and Elephants," although far less profusely illustrated, compares not unfavourably with "The Head-Hunters." It is uniformly written in surprisingly good English, and it gives us for the first time a tolerably clear account of the region of the water-parting between the head waters of the Menam and the Middle Mekong basins, and indeed of the whole course of the Menam almost from its source to the Gulf of Siam. The source itself was not actually reached, but it was ascertained with some certainty to lie altogether within Lao territory, or about 20° N., 99° E., and not further north in the Shan States, as shown on all recent maps, even that accompanying vol. viii. of Reclus' "Géographie Universelle." By taking boat at the now ruined city of Fang, and sailing down the Me-Fang and Me-Kok, the Mekong was reached just below Kiang-sen, where, a thousand miles from its mouth, it was found to be still a magnificent stream "twice as wide as the Menam at Bangkok." This was the furthest point reached, and on the return route the narrow but rugged water-parting was crossed by a pass 2000 feet high leading down to the Meping, as the Upper Menam is here called. Henceforth the rest of the journey was made entirely by water, proving that for small craft the Menam is navigable almost from its source to its mouth. Even the dangerous rapids near Mutka, above the Lao and Siamese frontier, were successfully run by the ingeniously constructed boats specially adapted for navigating this section of the great Siamese artery.

All the chief towns in this basin were visited, and a very full account is given of such important but almost unknown places, as Raheng (Rahein), Lakhon, Lampoon (Labong), Cheng-mai (Kiang-mai), Muang-Pau (Prau), and Kiang-hai), all except Raheng lying within the western Lao domain. Raheng, the northernmost town in Siam proper, appears to be the centre of a very considerable trade with the surrounding lands, and some strong arguments are urged in favour of the projected railway between that place and the capital. Such a line would present no engineering difficulties, running as it would through an almost perfectly level country; it might be cheaply constructed by Chinese coolie labour, available on the spot; it would run through the most densely peopled districts in Siam, and would at once open up a vastly productive region, whose almost boundless resources are now lying waste.

"The agricultural resources of the district of which it [Raheng] is the centre and natural outlet are extremely rich. Its timber alone is sufficient to insure prosperity; but it has further sources of wealth in the varied indigenous products of the country, and still more in the entirely undeveloped resources of its fertile soil. All that it wants is a railway to carry the products of the country at all seasons and without delay to the markets of the world, and to enable it to receive the large imports which an increasing population would at once necessitate" (p. 137).

But most readers will probably turn most eagerly to the chapters devoted to the habits and customs of the Karians (Karens), Mussus (Mossos), Ngiou (Shans), and especially of the Laosians (Laotians, Laos), whose political and social institutions, domestic life, religion, arts, and daily pursuits are here very fully described. The remarks on all these subjects will be found both interesting and valuable to the ethnologist, because mainly the result of personal studies made on the spot by a shrewd and experienced observer. Mr. Bock speaks of the Laos as of a finer type, fairer, and better-looking not only than the Malays but even than the kindred and more civilised Siamese. They are described as of superior physique, lighter complexion, with good, high foreheads, more regular features, and nostrils not so dilated as those of their neighbours. A curious peculiarity is the power of bending the elbow the wrong way, and similarly distorting the wrist joint, so that the hand can be bent over till the back of it touches the arm. This, however, does not appear to be the result of any special conformation of the joints, but rather of a long and severe course of training, in which "force is often resorted to in order to distort nature's handiwork" (p. 321). It will be remembered that one of the distinctive features of Krao, the little specimen brought from Bangkok by Mr. Bock, was a remarkable pliancy of the joints, extending even to the toes, which were almost as prehensile as those of the higher apes.

Amongst the illustrations is a curious design by a native artist (unfortunately "invested with artistic merit" by the English engraver) representing a scheme of the universe, with Mount Zinnalo, the Meru of the Hindus, as the centre. Above all is the outer darkness, or Buddhist *Nirvana*, usually supposed to involve extinction, or at least absorption in the divine essence, but which our author agrees with Mr. Alabaster in identifying rather with the highest heaven, a place of perfect happiness or repose. But however this be it is obvious that the Laotian Buddhism has been otherwise profoundly modified by the older cult, on which it has been engrafted, and from which it still takes its colouring. This older cult was little more than a universal spirit-worship, probably the first distinct stage in the evolution of all religious systems. Hence "the desire to propitiate the good spirits and to exorcise the bad ones is the prevailing influence on the life of a Laosian. With 'phees' to right of him, to left of him, in front of him, behind him, all round him, his mind is haunted with a perpetual desire to make terms with them, and to insure the assistance of the great Buddha, so that he may preserve both body and soul from the hands of the spirits, and, by making merit either in almsgiving, in feeding the priests, in building temples or prachedees, he may ultimately attain supreme happiness" (p. 198). At Muang-Fang the people are shown a telescope, whereupon they immediately ask, "Can you see the spirits through it?" And when it is reversed so that everything seems to fade away in the distance, they are hugely delighted at such a wonderful instrument, which has the power of making all things—spirits of course included—near or far off at the will of the owner!

Then these spirits, some of which, such as the phee-ka, are very baneful, require to be thwarted by all sorts of counter-charms, conjurings, exorcisms, spirit-dancings, and other devices of the professional medicine-men, and even of "paid mediums." For this institution—somewhat of an anachronism in the West—still flourishes in the Far East, where almost every family has its private mediums, who are consulted on all urgent affairs, and who, when required to question the spirits, work themselves into a state of ecstasy, and utter short, incoherent sentences, regarded as the oracles of the spirit world.

Amongst the illustrations are a coloured engraving by the author, giving a good idea of the "white elephant" visited by him at Bangkok, and a life-size portrait of the enlightened young King of Siam, to whom the work is dedicated. There are also an index and a small sketch-map of the route followed, in which the geographical nomenclature is, as usual, at variance with that of the text. Thus we have Kiang-mai, Toune, Me-ouang, Chandaw, for Cheng-mai, Tunn, Me-wang, and Shandau respectively. A. H. KEANE

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Remarkable Sunsets

ALTHOUGH the prevailing mist and fog do not make the summit of Ben Nevis as a rule a favourable situation for viewing sunsets, yet, when clear and fine, the colours of the sky shine out with far greater clearness and purity than at lower levels. For about a week at the end of last month we had fine weather, and the colours of the sky before sunrise, after sunset, and even during the day, were of the most extraordinary character.

On December 30 before sunrise the lower sky to eastward, between a cloud-bank and a thin dark band of stratus, was pale green, above the stratus it was yellow, passing into red higher up. This arrangement of colour was not observed again; on other days the sky was red or yellow at the horizon, passing into green and blue higher up At sunset on the 30th the colours were of the most gorgeous description—dark smoky red below, passing into blue and violet without any intermediate shade of green.

Similar colours have no doubt been seen as well at lower levels at sunrise and sunset, but here we see the sky round the horizon coloured in the most wonderful manner all day long—usually a copper red under the sun, and a peculiar dirty green at the opposite azimuth. But it is impossible to give any idea of the exceeding beauty and weirdness of the tints at sunrise and sunset—the whole sky near the sun gleaming with constantly changing masses of colour, indescribable tints of red and green mingled in wild confusion.

On December 31 the thin edge of the crescent moon (three days old) was bright green, but I have not observed any unusual colour in the sun itself. R. T. OMOND

Ben Nevis Observatory, January 9

I BEG your acceptance of the two inclosed clippings from the *Saturday Press* of this city, together with an advance sheet from Thrum's *Hawaiian Annual* for 1884, which contain nearly all that has been put into print here about the wonderful "afterglow" which has excited such attention in so many parts of the globe. In the first communication of September 19, I recorded the important date of September 5, when the first and most brilliant display was observed, being moved thereto by the arrival of the news of the Java eruption, whose proximity in time seemed to lend especial importance to the phenomenon. In the second notice is recorded an observation of like phenomena in lat. 24° 06′ N., long. 140° 29′ W., 1100 miles east-north-east of us, from the log of the bark *Hope*, Penhallow, master, on September 18.

In my article in the *Hawaiian Annual*, the record is brought down to November 25, during which month the glow continued, somewhat diminished. Since then it has again increased in a marked degree. I have also been enabled to definitely connect ourselves with Melanesia and Micronesia. Brig *Hazard*, Tierney, master, arrived from those parts on December 5. Capt. Tierney is reliable and intelligent. He reports to me that on September 1, when off the south-west coast of New Ireland, about lat. 5° S., long. 152° E., he first observed the "glare," as he termed it; and again on September 3 off New Hanover, two degrees further west. It was identical in character with what he has seen since arriving in Honolulu. It would seem to have been rather less brilliant than was first observed here September 5, as described in the inclosed clipping. During his voyage from New Hanover, sighting Ascension, calling at the Marshall Islands, and thence to Honolulu, over ninety days in all, the "glare" was of *constant occurrence.* By the arrival of O.S.S. *Mariposa* from San Francisco, December 1 to 8, I am happily able also to trace a continuous line of these phenomena hence to that point. They were not observed there until about November 23. Two of our leading citizens who came down by the *Mariposa* assure me that the appearances there were identical with ours, and further that they were of frequent recurrence during the whole passage. We thus prove a continuous chain of these phenomena from New Zealand to California.

Permit me to call special attention to the very peculiar corona or halo extending from 20° to 30° from the sun, which has been visible every day with us, and all day, of whitish haze, with *pinkish* tint, shading off into *lilac* or purple against the blue. I have seen no notice of this corona observed elsewhere. It is hardly a conspicuous object.

The long continuance and extending diffusion of this haze or dry fog seems to justify expectation that it may become visible around the globe, and give ample opportunity for investigation.

Although not seen in San Francisco until November 23, it was brilliant in Santa Barbara on October 14. A rapid upper current seems to have borne it in a belt within the tropics in a very few days, leaving a slow diffusion to extend it to the temperate zone. Australia is perhaps an example of this.

I trust this letter may be a useful contribution towards a complete history of the diffusion of this very peculiar element around the globe. A good record of dates of earliest appearances might contribute something to our limited knowledge of currents in upper strata of the atmosphere.

Honolulu, December 14, 1883 SERENO E. BISHOP

[We have already referred to Mr. Bishop's letters in the Honolulu journal, but give here the following extract from his article in the *Hawaiian Annual*:—

"It now seems probable that the enormous projections of gaseous and other matter from Krakatoa have been borne by the upper currents and diffused throughout a belt of half the earth's circumference, and not improbably, as careful observation may yet establish, even entirely around the globe. This implies an amount of matter discharged that seems incredible. We learn, however, that the ocean was thickly and closely covered with floating pumice for hundreds of miles from the crater. A steamer 150 miles distant reports her barometer falling and rising half an inch every two or three minutes! This almost incredible statement implies a terrific undulation of the atmosphere, such as could only be produced by a vast and continuous jet of gas projected upwards beyond the limits of the atmosphere, and driving the air in vast waves in every direction. So abnormal and gigantic a force may well have propagated not only its tidal waves as it did across the Pacific, but it may also have transmitted its portentous and lurid vapours to belt the globe with flaming skies."]

FOR the last two months these appearances have in this province excited no small wonder and admiration, not unaccompanied in some cases with awe and dismal forebodings of impending calamity. As an example of what has been witnessed in greater or less intensity almost every morning and evening, about an hour before sunrise and after sunset, I may instance what was observed on the evening of the 29th and morning of the 30th ult. The ground from my residence rises towards the south and west, and the city of Fredericton lies towards the north-east, on a flat 100 feet lower, and at a distance of half a mile or more. On the evening in question, at an hour after sunset, the red glow in the sky was very conspicuous, and seemed to light up the whole heavens, so that the houses in the city were distinctly seen by the reflection from their sides, and the intervening snow appeared of an orange colour. It was bright enough to suggest the impression of a second sunset. Next morning at an hour before sunrise the deep red glow was equally decided. W. BRYDONE-JACK

Fredericton, New Brunswick, January 3

IN response to your note in NATURE of December 13, 1883 (p. 157), I beg to inform you that the recent red sunsets have been especially observed by me on the following occasions:—

November 30, 1883, lasting until 5.30 p.m.; barometer at 1 o'clock 30·22 inches, at 9 p.m. 30·10.

January 2, 1884, lasting until 7.30 p.m.; barometer at 1 p.m. 30·48, at 9 p.m. 30·43.

January 3, 1884; Barometer at 1 p.m. 30·30, at 9 p.m. 30·23.

On several other occasions the same phenomenon has been observed in a less degree. AD. WENTZ'L, JUN.

Krasnieza Wola, Grodzisk, near Warsaw, January 11

THE "red glow" has again been very brilliant here on the evenings of January 9 and 10, as well as on the morning of January 10. On the following morning, January 11, the sky being likewise very clear, I confidently expected another display, but to my astonishment no trace of red did appear, the sun rising after an ordinary twilight of pale yellow. During the night a strong south wind had set in, which prevailed through the whole day, with extraordinary transparency of the air. In the evening clouds arose in the west, at first showing the red marginal colouring of ordinary sunsets, but later on there came again, distinctly higher than even the cirri, a very brilliant and lasting red luminosity.

It would be interesting to know whether at other places too the phenomena in question had been, as it were, suspended on the morning of January 11, in spite of a clear sky, or whether such a suspension had occurred on other days under similar meteorological circumstances. D. WETTERHAN

Freiburg, Badenia, January 12

THE last two days and nights here have been very fine with sunrises and sunsets as already described. This evening especially the colours were most brilliant, and did not fade away until at least an hour after sunset. It may interest those who are trying to account for this extraordinary appearance of the sky to know that here it has been followed by excessive rain and very bad weather. During December we had 9·57 against an average for the last twenty-two years of 4·46 inches. The greatest December rainfall registered at our Scutari Cemetery was 10·36 in 1862, the least being one inch in 1868. A printer's error makes me speak, in my letter of December 21, of a crescent moon "eighteen" days instead of 1·8 day old. W. E. J.

Constantinople, January 11

Dust Atmosphere of China

IN the remarkable work on China by V. Richtofen, he gives (vol. i. p. 97) the following description of the *dust atmosphere* of the Loes country, China, which, it seems to me, bears upon the question of the influence of dust on the appearance of the sun and sky, the question now under discussion.

"All these, and other similar operating causes, give rise to that dust atmosphere (*Staubatmosphäre*) so characteristic of Central Asia, and still more particularly of the Loes District. Even during nearly complete calms the air is often for many days yellow and opaque. The view is completely hemmed in, and the sun appears merely as a dull bluish disk. More markedly is this character presented by these peculiar dust-storms so well known to travellers visiting Tien-tsin and Peking, and even more so to those who travel in the interior of the north-western provinces of China. The wind then blows from Central Asia; when it acquires motion, everything becomes coated with a fine, yellowish dust coating.

"In Shensi, where the atmosphere is but rarely clear and transparent, the whole landscape has a yellow tint; streets, houses, trees and crops, even the traveller one meets on the road, and the air itself, one and all are yellow-coloured."

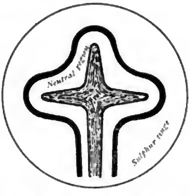
He also cites Johnson's "Journey to Ilchi, the Capital of Kotan" (*R. Geogr. Soc.* xxxvii. 1867, p. 5), as bearing on this same character of those dry, dusty atmospheres.

Dublin, January 7 J. P. O'REILLY

Electric Shadows

ON reading Prof. Thompson's communication to NATURE of the 13th ult. (p. 156), giving the result of Prof. Righi's researches on the production of electric shadows in air at the ordinary pressure, I at once endeavoured to repeat the experiments with such simple means as were at hand. Two sticks of sealing-wax stuck to a small iron stand sufficed to support a long, big-headed pin and the screen or object for casting the shadows. Instead of a plate of ebonite I used a cake of resin of six inches diameter, which serves ordinarily for the production of Lichtenberg's figures; and from subsequent experiments it would seem that the resin serves the purpose *almost* as well as ebonite as far as clearness of definition is concerned. A metal plate, which may or may not be insulated, formed a base for the resin. I mention these details since the ebonite rods and plate are not so well within every one's reach, on the score of greater expense and the necessity of having them specially constructed for the experiments. A plate machine of some size (18-inch plate) seems necessary, as I find that, unless the Leyden jar is charged to rather high potential, no shadow is formed, and, further, that the sharp definition of the shadows increases with the charge of the jar. The screen used was a design, cut out in cardboard and tinfoil pasted over it, very similar in shape to that given in Fig. 2 in Prof. Thompson's paper, and the shadows obtained were substantially similar to that in Fig. 3. But here a small point not before recorded came out:—If the pin, from whose point the discharge is made to take place, be slanted in any direction, which is easily done with the sealing-wax holder by simply heating, the shadow of the object then lengthens out curiously, just as do the shadows formed by an object intercepting light rays as the obliquity of incidence is increased.

The new feature, however, which appeared from my experiments, and which is not recorded by Prof. Thompson, although very likely the experiment may have been done before, is as follows:—Instead of starting with the resin plate in a neutral condition, I gave it a rather strong negative charge by rubbing it vigorously with a fox's brush and discharging the Leyden jar as before on to the pin, using precisely the same object to cast the shadow as before. Its character now, however, was completely altered, appearing as I have endeavoured to represent it in the figure. A simple cross, having little resemblance as to outline



with the object, was the result. The red-lead of course was picked out by the negatively-charged resin under the object and piled up to form the cross, which was much more strongly red, as one would expect, than the former shadow. There was also a rather wide neutral region around the cross, considerably more than in the former experiments. It seems to me that this effect is something more than the attenuation of the shadow spoken of by Prof. Thompson, where the screen is electrified independently. Since the subject is one of considerable interest, perhaps it may be useful to show that any one having access to a fairly good electrical machine can repeat and possibly extend Prof. Righi's investigations. W. F. SMITH

17, Colville Mansions, W.

Cosmic Dust

I FOUND in the *Nieuws van den Dag* of December 28, 1883, that a violet sand had been found in the dunes (probably near Scheveningen). The paragraph runs as follows:—When seen under the microscope (feeble magnifying) the ordinary yellow sand seemed to be composed for the greater part of almost white transparent grains, among which were a few light yellow, and pink, and single black grains The violet sand, however, showed almost all the grains imbibed by a light violet tint, and moreover it contained a very great number of black glittering grains. An idea which occurred to me made me take up a small magnet, and on stirring with it in a glass full of the sand, the ends were covered by feathers formed by the black grains quite the same as the feathers which are formed on putting a magnet into filed dust. Probably I had there grains of a combination of iron; of the latter there was a great deal in it. Now this is the question: Are these grains of the same kind as those which the naturalists have found and gathered on the snow-fields in the Polar regions, thus called cosmic dust?

Stuttgart, January E. METZGER

Diffusion of Scientific Memoirs

I THINK it would promote scientific information if it were more the custom for those who need copies of papers to make direct application for them. Authors are usually provided with separate impressions for distribution, but are often much in the dark as to how to turn them to the best advantage. The bulk of such copies usually find their way to men of established scientific position who have worked at the subject of the paper in past years, but have perhaps ceased to take interest in it; while those who are actively engaged upon the subject, if they do not happen to have already published matter of importance, are left unprovided for.

I believe that most authors would willingly send copies of their memoirs to younger men, known to be engaged in scientific work, who should make application. But there is one rule which must be observed with the utmost stringency—otherwise I should feel that the evil of the present suggestion outweighs the good—viz. *the applicant must never expect a written answer.*

Cambridge R.

Weather on Ben Nevis and Snowdon

I WAS much interested with the account of a visit paid to the Ben Nevis Observatory on December 26, 1883, described in NATURE of January 3 (p. 219), more particularly as the weather experienced on the summit was almost identical with that on Snowdon at the same time. I ascended Snowdon on December 23, 25, and 26 from the west, east, and north, and a neighbouring mountain, Glyder Fach, on the 24th. The views from the summit on the 25th and 26th can be best described by the following quotation from NATURE (p. 219), referring to Ben Nevis:—"The view from the summit was magnificent. All round there floated a billowy ocean of white mist" (extending from the slopes of the mountain to the horizon north, south, east, and west), "through which rose here and there black mountain peaks." "Overhead the sky was blue," and the sun shone brilliantly. The upper surface of the ocean of clouds was on the 25th about 2000 feet, and on the 26th 1000 feet, above sea-level.

On the 24th I ascended Glyder Fach through about 2500 feet of mist, and, to again quote from NATURE (p. 219), on reaching the ridge "suddenly emerged from the gloom of the mist into the brightest of daylight. Overhead the sky was blue, a fresh light breeze was blowing" from the north-west. I here noticed a curious phenomenon. I became suddenly aware, whilst standing in the sunlight on the ridge, that the air was full of an exceedingly minute dust driven by the wind from the north-west and descending at an angle of about 40°. The fall ceased quite suddenly one or two minutes after I noticed it. The impression left on my mind was that anything popularly spoken of as dust would be exceedingly coarse compared with it. There was no snow on the ground.

The phenomenon known under the name of the "Brocken Spectre," mentioned by Mr. Chrystal, may frequently be seen from the summit of Snowdon by any one not afraid of a little mist. T. SINGTON

Kersal Moor, Manchester, January 7

Teaching Animals to Converse

J. S. B. seems to have misunderstood Sir John Lubbock's idea. It would be no great test if drawings were made, as the dog would see so little difference. Thus a dog of mine knows instantly whether he may go out with my housekeeper or not according to whether she wears her hat or her bonnet. In the first instance he knows she is going where he may go, and he is on his feet barking with joy as soon as she appears. If she has the bonnet on, he knows it to be church, or a visit to friends in the country, where he cannot go, and, like the "eldest oyster" (I quote from memory), he "winks his eye, and shakes his hoary head." If drawings of hat and bonnet were made, he would know them at once.

Some years since I had a remarkably clever Skye terrier, whose wisdom was at the time shown in a letter to the *Times*. This dog I taught as follows. When I went out it was quite sufficient to say "Yes" or "No" in an ordinary tone; but wanting to take him beyond that, I taught him very quickly to know the two words when printed on cards, YES or NO, and after a few weeks' teaching he never mistook them. I have no time now for much teaching; if I had, I am sure it could be done with the dog I now have. The intelligence of cats is greatly underrated. My wife's favourite cat follows her everywhere, and comes when called wherever she may be. Cats, too, are very grateful for kindness. When I went into the Malakhoff I found a cat on whose paw a bayonet had fallen and pinned it to the ground. I released it and took it home, and it always followed me all over the camp till the end of the war. And this cat did as follows. I took her to a doctor of the nearest regiment for two mornings to have her foot dressed. The third morning I was away on duty before daylight, and the cat went herself to the doctor's tent, scratched the canvas to be let in, and then held up her paw to be doctored. The intelligence that can be developed in almost any animal depends in most cases on our treatment of it. H. STUART WORTLEY

South Kensington Museum, S.W., January 14

Circling to the Left in a Mist

ONE generally reads that persons walking without landmarks perform a large circle and cut their old tracks again. This circling, as far as my present knowledge goes, is *to the left*.

My present theory is that in most persons the right leg is the stronger and the more forward to step over any obstacles, and hence that it slightly outwalks the left; this theory involving as further consequences that those in whom the left leg is the stronger would circle to the right, while those whose legs are of equal strength would either keep straight on or would wander either way indifferently. I imagine this "outwalking" of one leg by the other to be similar to the manner in which a body of troops wheels to one side or the other.

In the following I use the expression "*right-legged*." By this I mean that the right leg is that chosen to kick with, jump from, &c.

My negative evidence is as follows:—

1. I myself am right-legged, and in a mist I always circle to the left. I have only come across cases similar to my own in these respects. On the other hand, my left arm has been trained (by always rowing on the bow-side) to be stronger than my right for rowing purposes; and in sculling I always circle to my right side.

2. Those savages of whom I have read that they could keep a straight course without any landmark were also represented as using both arms (and legs?) impartially.

I have given the above evidence chiefly to show how weak it is, in the hope that some of your readers will try to collect data of the following nature from any of their acquaintance who have had experience in the matter:—

(*a*) To which side, if any, do they circle?

(*b*) Are they right- or left-armed, right- or left-legged? or are the two sides equally strong?

It might also be interesting to learn from boating friends if they have observed any connection between the side on which they have been accustomed to row and the side to which they circle in sculling; such connection as that indicated above.

Finally, I may suggest that more might be known on the question of the heredity of right- or left-sidedness; and as to whether persons are often right-armed but left-legged, &c. But it must be remembered that tendencies of this nature are often "educated out" in childhood. W. LARDEN

Cheltenham College

THE PORPITIDÆ AND VELELLIDÆ

PROFESSOR ALEXANDER AGASSIZ has quite recently (July) published an important contribution to our knowledge of the morphology and embryology of these families of marine Hydrozoa. This appears as one of the quarto memoirs of the Museum of Comparative Zoology at Harvard College, and is illustrated with twelve plates. While at the Tortugas, during March and April, 1881, examining the structure of the coral reefs, Prof. A. Agassiz took advantage of every possible opportunity of exploring the surface fauna of the Gulf Stream, and when not otherwise occupied he devoted his time to completing the notes and drawings which he accumulated regarding Porpita and Velella under less favourable circumstances at other points of Florida, at Newport, and on board the *Blake*. These notes are now published as forming the principal points in the natural history of a small and limited group of oceanic hydroids, interesting from their affinities on the one hand to the Tubularians, with which Vogt, Kölliker, and Agassiz were inclined to associate them, and on the other hand with the Siphonophoræ proper, with which they have, however, but little in common. Mr. C. O. Whitman was sent this spring to Key West to complete this memoir, and especially to investigate anew the whole subject of the structure and functions of the so-called yellow cells; but although he spent six weeks at Key West, he was unable to accomplish the object of his trip, as not a single Velella appeared at Key West during the whole of his visit. Under these circumstances Prof. A. Agassiz thought it advisable to at once publish his drawings and notes, completing the descriptive part when the necessary preparations can be finished. The Florida species of Velella (*V. mutica*, Bosc) is much larger than the Mediterranean form (*V. spirans*); specimens measuring nearly four inches in length are not uncommon. On plate 1 is figured in profile and from above and below a huge Velella nearly five inches in length, and in all the glories of its metallic colouring. Thousands of this species are brought by favourable winds and tides into Key West Harbour; they are usually seen in large schools, and although capable of considerable independent movement by means of their tentacles in a smooth sea, yet are they practically at the mercies of the winds and currents. Even moderate waves destroy them in vast numbers. When kept in confinement they soon die, and are rapidly decomposed. The dead floats are thrown ashore in enormous numbers. The large central polypite of the system is the main feeding mouth, but the smaller lateral polypites feed also to a limited extent. All these are connected at their base with the general vascular system, through which as in the polypites the fluids are rapidly propelled by the action of ciliæ lining the inner walls. At the base of the polypite there are, according to its size, from five to eight clusters of Medusæ buds: the small ones already contain the peculiar yellow cells so characteristic of the free Medusæ. The young Medusæ have a very striking resemblance to such Tubularian Medusa as Esuphysa and Ectopleura. It has like them a row of lasso cells extending from the base of the tentacles to the abactinal pole. The yellow cells are arranged in clusters along the sides of the four broad chymiferous tubes, as well as on the surface of the short, rounded, conical, rudimentary proboscis. The young Medusæ move with considerable activity by sudden jerks. The air-tubes branch much less frequently than is the case in the Mediterranean species. All the Velellæ floats examined were left-handed.

The Florida species of Porpita (*P. linneana*, Less.) is nearly related to but is larger than *P. mediterranea*. It is capable of a considerable control over its movements, and is not stranded at all in the same numbers as is Velella. If upset by wind or waves it can, by the great size and power of its numerous long marginal tentacles force itself back again into its normal position. It does this by bringing its tentacles together over the disk and throwing up the free edge of the mantle slowly in a given direction, then expanding the tentacles of one side far over in the opposite direction beyond the central part of the disk, it readily changes the centre of gravity, and so tilts the overturned disk back again. Round the base of a large central polypite are five to six rows of small, stout, flesh-coloured, feeding and reproductive polyps; these have a slightly rectangular head capable of considerable expansion, with four clusters of lasso cells. At their base are to be found Medusæ buds in all stages of development. When the clusters of these are well developed they completely fill the space between the small polypites, giving to the ring which they occupy on the lower surface of the float, a dark yellowish tint from the colour of the yellow cells, found along the rudimentary proboscis of the Medusæ buds, as well as along the chymiferous tubes. The large marginal tentacles are of a bluish tint, their knobs of a darker colour. The smaller polypites occupy on the lower surface that portion of the mantle which covers the ring formed by the so-called white plate of Kölliker round the base of the single central polypite. Sometimes these polypites are seated in cavities of the white plate, and sometimes projections of this latter will be found to extend far up into the lower part of the small polypites. This white or pinkish plate consists of an irregularly anastomosing system of needles and spurs, or of bars of greater or smaller size, leaving a series of narrow openings for the passage of the tubules. Prof. A. Agassiz suggests the alliance of Porpita with the Hydrocorallinæ, basing this suggestion on the presence of the white plate, and of its peculiar structure, which reminds him of the porous structure of the corallum of Sporadopora, Allopora, Millepora, and although, of course, not having the regular horizontal floors of the latter, yet possessing, like these genera, large pits, the whole mass being riddled with passages and openings, forming the spongy mass of the white plate. If this homology be correct, it shows far-reaching affinities in the Porpitidæ. The Plates, twelve in number, give a great number of anatomical details, and there are full-sized and coloured representations of the two species described.

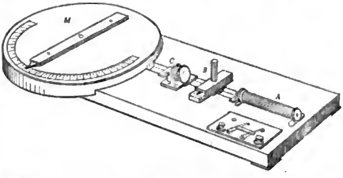
HUGHES' NEW MAGNETIC BALANCE

A NEW magnetic balance has been described before the Royal Society by Prof. D. E. Hughes, F.R.S., which he has devised in the course of carrying out his researches on the differences between different kinds of iron and steel. The instrument is thus described in the *Proceedings of the Royal Society*:—

"It consists of a delicate silk-fibre-suspended magnetic needle, 5 cms. in length, its pointer resting near an index having a single fine black line or mark for its zero, the movement of the needle on the other side of zero being limited to 5 mms. by means of two ivory stops or projections. When the north end of the needle and its index zero are north, the needle rests at its index zero, but the slightest external influence, such as a piece of iron 1 mm. in diameter 10 cms. distant, deflects the needle to the right or left according to the polarity of its magnetism, and with a force proportional to its power. If we place on the opposite side of the needle at the same distance a wire possessing similar polarity and force, the two are equal, and the needle returns to zero; and if we know the magnetic value required to produce a balance we know the value of both. In order to balance any wire or piece of iron placed in a position east and west, a magnetic compensator is used, consisting of a powerful bar magnet free to revolve upon a central pivot placed at a distance of 30 or more cms. so as to be able to obtain delicate observations. This turns upon an index, the degrees of which are marked for equal degrees of magnetic action upon the needle. A coil of insulated wire, through which a feeble electric current is passing, magnetises the piece of iron under observation, but, as the coil itself would act upon the needle, this is balanced by an equal and opposing coil on the opposite side, and we are thus enabled to observe the magnetism due to the iron alone. A reversing key, resistance coils, and a Daniell cell are required."

The general design of the instrument, as shown in a somewhat crude form when first exhibited, is given in the figure, where A is the magnetising coil within which the sample of iron or steel wire to be tested is placed, B the suspended needle, C the compensating coil, and M the magnet used as a compensator, having a scale beneath it divided into quarter degrees.

The idea of employing a magnet as compensator in a magnetic balance is not new, this disposition having been used by Prof. von Feilitzsch in 1856 in his researches on the magnetising influence of the current. In von Feilitzsch's balance, however, the compensating magnet



was placed end-on to the needle, and its directive action was diminished at will, not by turning it round on its centre, but by shifting it to a greater distance along a linear scale below it. The form now given by Hughes to the balance is one of so great compactness and convenience that it will probably prove a most acceptable addition to the resources of the physical laboratory.

WINTER LIFE AT SPITZBERGEN

THE following is an extract of a report by one of the *personnel* of the Swedish Meteorological Expedition of the wintering at Spitzbergen:—

One of the deepest fjords of Spitzbergen is the Ice Fjord on the west coast. On a map of the islands it will be seen, some fifteen miles from the mouth, to split into two smaller ones. The promontory which divides the two is Cape Thordsten. It is formed of slate rocks some 2000 feet in height, from which in some places precipices descend perpendicularly into the sea, and in others valleys slope down into the plain. The latter is furrowed by streamlets and deep ravines, while the rocks around are the breeding places of every sea bird of the Arctic fauna, as, for instance, the seagull, the auk, the rodge, and the *Uria grylle*. In the plain reindeers graze, and on the mountains ptarmigans and snow-sparrows breed. The plain is covered with grass, rather strongly interspersed with moss, but here are to be found many plants and flowers, such as *Polymonium pulchellum*, *Dryas ortopetula*, the white and red saxifrage, the Spitzbergen poppy, and the common buttercup.

In the plain close to the mountain the huts are situated which now bear the name of "Smith's Observatory," from the munificent equipper of the expedition. The buildings were erected here some ten years ago by the Ice Fjord Company, which was formed for the utilisation for guano of the coprolite deposits found in the adjacent mountains.

On July 21, 1882, the vessels of the expedition arrived here, but it was at that period doubtful whether we should establish our station here, as the mountains around contain a large quantity of hyperite, a mineral which it was feared would affect the magnetical instruments. We found on landing a line of metals up the hill, with a gradient of 45°, a winch being fixed at the other end for its working. Here was also, still intact, the little dwelling house on four poles, alongside which we found the material required for the building of a new house as stated in works on Spitzbergen. Near to the house is a cross raised with the following inscription: *Her hviler Stövet af* 15 *Mænd, som döde her i Foraaret* 1873. *Fred med deres Stöv.* This is the epitaph to the Norwegian fishermen who sadly perished here ten years ago.

We found by experiments that the mineral in question did not affect the magnetic instruments, and decided therefore to establish the station here. We had a hard time to get everything in readiness, as, for instance, the building of the magnetic hut and the thermometer cage, by August 15, when the observations were to begin, but on August 22 we had so far advanced that both magnetical and meteorological observations could be prosecuted simultaneously.

The view from the observatory was grand. Heavy clouds generally cover the sky, driven hither and thither by strong gales; below the sea roars, with ice floes floating on its crest, while thousands of sea birds wheel in the air. Suddenly the clouds part, and the sun comes forth, the snow-white peaks flash in the rays, the stony ridges become purple, and down below the dark gloomy sea assumes the colour of the sapphire.

On August 23 the sun set for the first time, and on October 23 it did not appear. Already, on August 31, the ground became covered with snow, but early in September, and towards the middle of October, it again thawed, and it was not until October 21 that the snow remained. The birds now began to leave, and the *Tringa maritima* were last seen on August 20. The brent geese soon departed in flocks, and flew cackling southwards out of the fjord. The last was seen on September 13. On October 14 we saw an eider, and some specimens of *Procellaria glacialis*, and on October 21 a snow-sparrow appeared at the station. From that date none of the migratory fauna was seen until the spring. Quite alone, however, we were not, as the mountain foxes soon appeared, and were not the least shy. Ptarmigans were plentiful, too, in the ravines, where they feasted on *Polygonum* seed. On October 26 we shot the first two reindeer at Sauriehook, but it was not until the spring that they came in any numbers.

Our work progressed too. We had first of all to fix the anemometer and the weathercock on the mountain above the station, or 800 feet above the sea, and to connect it with the observatory by a telegraph wire, as the readings were to be made by electricity. Then there was a workroom to be constructed, and the astronomical observatory for the passage instruments to be erected. On October 3 the wire to the anemometer was ready, and the hut carried up to the top of the mountain, where it was fixed. On October 25 the astronomical observatory was finished. It was now so dark that no work could be done outdoors, and on October 23 it was necessary to light up at 3 p.m., on October 28 at 2 p.m., and on November 2 light was necessary throughout the day. The Polar night had set in.

From October 23 until February 18 the sun remained below the horizon; thus for a period of 118 days and nights. At first it was not quite dark at noon, but from November 11 it was a night throughout. On November 12 a thin layer of ice appeared on the Ice Fjord, which gradually increased in thickness, but it was afterwards broken up and again formed several times during the dark winter. It was only when the light came back that the ice formed in a bridge across the fjord.

Now the island was in darkness and perfectly deserted. The terrible winter storms had commenced, and it was 16° C. below freezing-point. And the snow! Snow on the mountains, snow on the plain, snow on the huts, snow covers the little windows, snow comes in through the chimney, and even the thermometer cage cannot exclude the tiny, pointed crystals which penetrate even a keyhole. In such an hour it was a delightful sensation to seek the hearth in the library!

Again I stand by the shore. The clouds have cleared away; only one enormous mass, which we never saw lifting, lies over the mountains across the fjord. The sky is clear, the ocean roars below, there is no ice; the moon is about to pass her meridian.

Slowly one long tidal wave after another comes rolling towards the shore; they gather into one tremendous wave, which, striking the lofty rocks, sends its spray a couple of hundred feet into the air. Then it recedes with a deep sigh, leaving two or three magnificent ocean algæ, each a yard long, on the shore.

When the moon is absent, it is, however, pitch dark, provided there is no aurora borealis. The aurora borealis was observed throughout the winter, when it was clear, and in every form and position.

Now a faint arc appears far down on the south horizon. Below it is a dark segment. Slowly it travels towards the zenith, increasing in intensity. It is perfectly symmetrical, and both its points almost touch the horizon, and strike east and west as the arc moves upwards. No streamers can be made out in it, and the whole forms one continuous layer of light of a strange transparent yellow colour. The arc is broad; its size is three times that of the rainbow, and its edge, which is far more defined than that of the rainbow, forms a strong contrast to the dark sky of the Arctic heavens. Higher and higher the arc travels; in the whole display there is a solemn rest, and only here and there a wave of light suddenly leaps upwards. Above the snowy fields yonder it begins again to get clearer. Still it is far from the zenith, and already another arc separates itself from the segment in the south, and by degrees others follow. All of them now travel towards the zenith, traverse the point and descend on the northern horizon, while some rapidly recede to where they originated. Seldom, however, does the aurora appear in this regular and defined form.

In the corner of the horizon lies a light cloud-mass. Its upper rim is illuminated, and from this a luminous band is quickly developed, which spreads east and west, increases in intensity, and travels towards the zenith. The colour is the same as that of the arc, but the intensity is greater. In a constantly changing play the band slowly alters, but remains continuous in form and plane. Now it is interlaced into several plaits and folds, but throughout there is an undulatory motion which throws waves of light through the band in its entire stretch from right to left, or *vice versâ*. Again it unfolds itself and forms into draperies and festoons, which are lost in the depths of the horizon.

On another occasion the band assumes quite a different form. It then consists not only of luminous matter, but also of solitary streamers ranged in a parallel plane, all pointing to the magnetic pole. In each of the streamers the intensity is, through the light-waves which follow in rapid succession, greatly increased, which gives the streamers the appearance of being in a constant leaping motion, while the two edges, green and red in colour, move wave-like up and down, according to the play of the coursing waves of light. Often the streamers prolong themselves throughout the entire band; they stretch even as far as the magnetic pole, and then remain at rest. They are sharply defined, but fainter in light than the band itself, and do not lie close together. They are yellow in colour, and appear like millions of fine threads of gold thrown across the firmament. Again a thin veil of light creeps over the starry heavens, and the golden threads of which it is woven stand clearly out from the background, while its lower *garniture* is formed of a broad, intense, yellow-white border with a thousand filaments in a slow but constant motion.

Again it appears in a third form. Throughout the day bands of every form and grade of intensity have been drifting over the sky. It is eight o'clock in the evening, the hour when the aurora borealis reaches its greatest intensity. At the present moment only a few groups of streamers stand in the firmament, while down in the south, just above the horizon, lies a faint band which is hardly noticed. But suddenly it begins to move upwards with great rapidity, spreads its folds out east and west, the light-waves begin to leap in it, and long, solitary pillars shoot towards the zenith. At this moment there comes life into the sky. From every quarter of the firmament streamers come rushing with the speed of lightning towards the zenith. The little, fiery tongues whirl round, or sway to and fro, appearing as though they were Cupids in golden mantles with borders of purple. They dart and leap in vain to reach the zenith; they begin to move wave-like, slower and slower; they seem to get tired, still they whirl on towards the north, when suddenly they lose in intensity, and, in a fraction of a second, vanish!

It is again dark and cold; a thin veil of light again begins to form over the star-covered sky. This is as the aurora appears in its grandest form, and any description of it would fail to give even an idea approaching its real majesty and even grandeur.

In addition to the meteorologieal and magnetic observations, those of the aurora borealis were also made during the Polar night by means of the well known theodolite, and from October the electricity of the air was also examined. On the two agreed dates, the 1st and 15th of every month, the magnets and the aurora were examined and registered every fifth minute, and during one hour, every twentieth second. Besides these observations, meteors and shooting stars were watched and carefully noted, attempts made to measure the quantity of the snow, measurements of the aurora borealis effected, along with astronomical determinations of hour and place, absolute magnetic measurements, simultaneous observations every twentieth second of the magnets, the aurora, and the electrometer, and researches on the moisture of the air, and the nightly radiation, while the temperature of the snow was examined at various depths.

Already in October the remarkable depressing influence which darkness exercises on the human mind, with which every one who has wintered in the Arctic regions is familiar, began to be manifest. In that month it was, however, felt only slightly, but with November it rapidly increased, and at the end of December it had reached "the first stage of insanity." This influence caused a remarkable dislike to conversation, accompanied by great lassitude. When lying down, phantoms of the scurvy crept over one's mind, and the thought uppermost was that here, next to us, the bodies of fifteen brave men were found in a horrible condition ten years ago. The best cure for this was, we found, an exhausting walk, a good dinner, and a few glasses of lime-juice accompanied with the cheering thought that our expedition formed one of the moments in the great work of the human race.

The moonlight during midwinter was very remarkable, and imparted in the day a transparency to the air which we had never seen before. The greatest mountains did not oppress the eye, but seemed to assume a lightness which made them appear as if they were floating on the dark background.

On February 19 the sun was to reappear, but already on January 23 it was so light that we could read fine print out of doors, and on February 8 we could, at 11 a.m., read the thermometers in the cage without a lantern. On February 19 the sun came at last. During these days the scenery was magnificent. On the light sky clouds of every shape floated, coloured in the loveliest tints by the sun's rays, while over the whole was cast a hue of purple and gold.

In the beginning after the sun's return, auroræ were still seen in the night, but on March 25 we saw the last of this phenomenon. Eventually on April 19 the sun became circumpolar, and from that date we had perfect daylight.

We often noticed during the spring a thick, cold haze lying over the landscape, in which mock suns and some other optical phenomena were frequently seen, caused by the reflection of the sun's rays in the ice-crystals.

The fjord was in the light period entirely covered with ice, and, as the sun reappeared, even the open leads which could be seen between the ice-floes became covered with thin ice. Only far out on the horizon above the fjord a "water cloud," bespeaking open water, could be seen, and the increase or decrease of this we watched with great interest.

The migratory birds now began to arrive, and the *Procellaria glacialis* was already seen on February 7. On April 13 the first snow-sparrow came, soon after followed by the auks, the rodges, and the seagulls. The ptarmigans, which had lived in flocks during the winter, now began to separate, and preferred the mountains to the plains.

The observations were steadily continued, and the particular object of the researches of the meteorologist at this period was the radiation from the snow's surface. We thus believe we have discovered that the thermometers in the cage did not give the true temperature of the air, which was to be tested by means of a "swing" thermometer, *i.e.* a thermometer fastened to a cord, and then swung rapidly round, as such a thermometer will give the air's exact temperature as near as possible. Under these observations, which were made every hour, it, however, often happened that the cord broke, and the instrument suffered injury. In order to avoid this a mechanism was constructed, driven by hand, which kept the thermometer in a constant rotary motion, and from May 4 until the end of the month, when the thaw set in, this thermometer was read every hour. Another subject also investigated, from February 15, was the temperature of the snow on the surface and at three different depths.

During the light period three hydrographic-magnetic excursions of research were made on the ice in the Ice Fjord, viz. on April 19, April 24, and May 24. The longest of these, the one on May 24, extended six miles from the shore, and it was very difficult work to drag the sleigh over the rough ice. The results of the same were several absolute magnetic measurements, observations of the temperature of the sea at various depths, and testings of the saltness of the water. The greatest depth found was 250 metres.

At the same time, while the snow still remained on the ground, several topographical works were effected. A base some 600 metres long was measured between the universal instrument and a pole south of the same, while two signal posts were erected on two crests south-west and north-east of the station, and three miles apart. Afterwards the greater base was determined by means of triangular measurements from the smaller, in order to serve as a basis for further work. In addition to this there was built, on the sun's return, an astronomical observatory for the universal instrument, which was finished on February 14, and finally a magnetic hut was built for the Wrede's variation instrument, finished on May 19.

There was, during the dark period, one question which was much discussed, and which we were anxious to test, viz. whether the Polar night has the effect of turning the complexion white. On January 23, therefore, when it was light enough to see out of doors, we assembled in the open to examine our faces, and the concensus of opinion was that the darkness had not affected the skin in the least.

In the end of May the thaw set in in earnest, and soon mosses and shrubs came forth. In the beginning of June the fjord was still covered with ice, but by the 11th it commenced to open towards the sea, and by the 21st it began to break up and drift. On July 4 the fjord was free from ice.

The fauna now began to appear: thus already on June 2 the red blossoms of *Saxifraga oppositifolia* came out from the snow; on June 11 *Salix polaris* was in bloom, as well as *Draba wahlenbergii*, and soon the plains were covered with flowers.

At that time some exceedingly interesting experiments in horticulture were commenced. A small garden was first formed by breaking up the layer of turf on the surface, to enable the sun to thaw the frozen earth underneath, and in this manner sufficient mould was obtained to lay out proper beds. In these were then planted seeds, among others radishes brought from Sweden, while several species of the Spitzbergen fauna were planted here. Both flourished remarkably, as did also the rye and oats which we planted here. The latter grew well, although slowly, and were, at the end of July, six to eight centimetres long. Their growth was measured every fifth day, while studies of the sun's chemical influence on the same were simultaneously prosecuted.

The migratory birds continued to arrive: thus on June 2 the brent geese put in their appearance, and in great flocks took possession of the innumerable lagoons. They were, however, very shy, and comparatively few were shot. Of wild reindeer several were shot, and one Polar bear was seen, but escaped.

At last on June 26, at 4 p.m., the first reminder of the outside world appeared in the shape of a fishing smack, but, although every effort was made to attract attention, she passed northwards. On July 8 an expedition was despatched to Cape Staratschin, the "general post-office" of Spitzbergen, which brought back news, letters, and the literature of the civilised world for a whole twelvemonth, the period of our isolation.

Shortly afterwards we had several calls of Norwegian hunters, among whom may be mentioned the well known Capt. Kjeldsen, of the *Isbjörnen*, who participated in the Payer-Weyprecht expedition of 1872, and in the Austrian to Jan-Mayen, 1882-83. He made the remarkable report that he had found the sea at the Norse Islands early in July this summer entirely free from ice, not even seeing the "ice-blink," *i.e.* the light reflected from new ice formed out of sight. This was in the exact spot where the Swedish expedition was compelled to return on account of enormous pack-ice, at the same period in 1882. He was of the opinion that a steamer would have been able to penetrate very far north of the Seven Islands this summer.

In the middle of August the relief boat *Urd* arrived, and, after having cleared the houses, and nailed up the windows and doors, we went on board, and steamed out of the Ice Fjord on August 25, having for a period of exactly 400 days, contributed our quota to International Polar research.

THE WEIGHTS OF BRITISH NOBLEMEN DURING THE LAST THREE GENERATIONS

IT is of considerable interest to know in an exact way the amount of change that may have occurred in our race during recent generations. I therefore send the following results concerning the changes in weight, which I have calculated from data obligingly furnished to me by Messrs. Berry, of 3, St. James's Street, London. Messrs. Berry are the heads of an old-established firm of wine and coffee merchants, who keep two huge beam scales in their shop, one for their goods, and the other for the use and amusement of their customers. Upwards of 20,000 persons have been weighed in them since the middle of last century down to the present day, and the results are recorded in well-indexed ledgers. Some of those who had town houses have been weighed year after year during the Parliamentary season for the whole period of their adult lives. I examined two of the ledgers at my own house, and was satisfied of their genuineness and accuracy; also that they could be accepted as weighings in "ordinary indoor clothing" unless otherwise stated. Much personal interest attaches itself to these unique registers, for they contain a large proportion of the historical names in our upper classes.

I have ventured to discuss only a small and definite part of this mass of material, and I selected the nobility for the purpose, because the dates of their births could be easily learnt, which had to be done in order to connect the years in which they were weighed with their ages at the time. They formed a more homogeneous group than one that included younger brothers and men about town, who marry late and lead less regular lives. I therefore begged Messrs. Berry to find a clerk for me who should make the required extracts under their direction in an anonymous form for statistical purposes. I also asked to be furnished with an alphabetical list of the persons weighed, that I might know generally with whom I was dealing, and that each schedule should bear a reference to the folio whence it was extracted, so that, whenever verification was needed, the original might be referred to. All this was done, and I am in possession of 139 schedules referring to as many different persons, namely, 109 peers, 29 baronets (who were added as makeweights), and 1 eldest son of a peer. They were born at various times between 1740 and 1830, or thereabouts. Each schedule gives the age and year of the several weighings, the highest and lowest weights recorded in that year, and a copy of such remarks as were entered at the time about the dress. An age-weight trace similar to those in Figs. 1 and 2 was plotted on a large scale on each schedule. My best thanks are due to Messrs. Berry for their careful oversight of the tedious clerical work and for the intelligent assistance they gave in having it satisfactorily accomplished.

Specimens of the Age-Weight Curves of Individuals

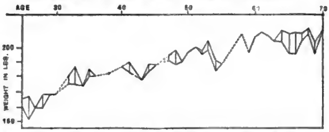


FIG. 1.—One-fourth of the Series are more irregular than this Specimen. (The Upper Quartile.)

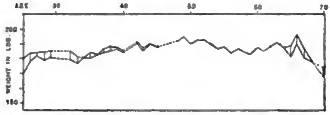


FIG. 2.—One-fourth of the Series are less irregular than this Specimen. (The Lower Quartile.)

The age-weight traces differ widely and in many ways: (1) in the annual range of weight, (2) in its fluctuations from year to year, (3) in the age at which the weight reaches its maximum, (4) in the bluntness of the culminating point.

The annual range is shown in Figs. 1 and 2 by the short, v rtical lines that connect the upper and lower contours. The top of each line corresponds to the highest weight recorded in the year to which it refers, and the bottom of the line to the lowest. I find the average annual range in my whole series of cases to be 6 lbs., and that, in the successive decades extending over ninety years, it has decreased prettily steadily from 7 lbs. to 5 lbs. This points to an irregularity in the mode of life that was greater two or three generations back than now, and we shall shortly see that it is by no means a solitary indication of this well known fact. It would be interesting to learn how much annual irregularity in the weight of an adult is consistent with perfect health.

The only evidence I know that could throw much light upon it is summarised in a Parliamentary paper on prison discipline,[1] whence it appears (p. 54) that a certain amount of irregularity is normal among prisoners, that they are heavier in summer than in winter, and that the changes are abrupt; also, that fluctuations in weight, bearing no sort of proportion to previous changes of diet, are of constant occurrence.

I calculated a rough numerical measure of the irregularity of each trace for the purpose of classifying them. I did so on the same principle that one might adopt to measure the discursiveness of a rambling path, in comparison with that of a straight turnpike road between the same points, namely, by finding the proportion that the length of the one bore to the other. I measured the trace and also the general sweep of the trace with a map-maker's "perambulator," divided one by the other, and corrected each result on the principle that a fluctuation of 12 lbs. in a man of 16 stone should not count more than one of 9 lbs. in a man of 12 stone. I also exercised some judgment in my measurements, to avoid the error of dealing with ups and downs in the trace that were apparently due to the fragmentary character of the observations (sometimes only one record in a year, and sometimes two), as if they were real fluctuations. Each available trace was marked on this principle, and the traces were classified according to their marks. Figs. 1 and 2 are the "quartiles" of this class.

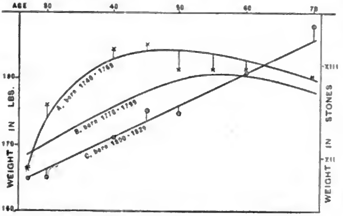


FIG. 3.—Mean Age-Weight of British Noblemen in three successive generations

One quarter of all the traces are more irregular than Fig. 1, one quarter are less irregular than Fig. 2, and the remaining two quarters lie between them. The "median" trace occupies the half-way position; it is unnecessary to reproduce it here, as an imaginary interpolation between Figs. 1 and 2 will suffice.

I next divided the traces into three divisions, A, B, and C, according to the dates of birth of the persons they referred to. It happened that each division covered a period of thirty years, so A, B, and C may be taken to represent three successive generations, born respectively between 1740 and 1769, 1770 and 1799, 1800 and 1829. The numbers of traces available for the present purpose were 21, 22, and 26 respectively. It appeared that the most irregular trace in Group C would rank only as the seventh in Group B, and as the fifth in Group A, and yet C contains the greatest number of cases.

There can be no doubt that the dissolute life led by the upper classes about the beginning of this century, which is so graphically described by Mr. Trevelyan in his "Life of Fox," has left its mark on their age-weight traces. It would be most interesting to collate these violent fluctuations with events in their medical life-histories; but, failing such information, we can only speculate on them, much as Elaine did on the dints in the shield of Launcelot, and on looking at some huge notch in the trace, may hazard the guess, "Ah, what a stroke of gout was there!"

The age at which the weight reaches its maximum is earlier in the earlier generations. I attempted eye estimates, and found it comparatively easy to form them in respect to the traces of the earlier period, where the culmination was usually distinct, and found that it frequently occurred at an early age; the number of times in which it took place in the successive decades of life in those days being as follows: under the age of 29, 2 cases; 30-9, 5 cases; 40-9, 6; 50-9, 7; 60-9, 12; 70 and upwards, 2. In the latter generations the culminating point was frequently too indistinct to be localised, so that I am unable to offer a corresponding statement for comparison that would be trustworthy. In short, the development of the latter generations was more regular.

The clearest evidence of the different age-weights in the three generations, A, B, and C, is obtained by comparing their Means. The following is a brief numerical abstract of them to which the number of cases upon which each mean is based is added in a different type below it. The figures in parentheses are doubly meaned results, those to the left being derived from observations made at the ages of 26 and 28, and those to the right from observations at 68 and 72. For purposes of comparison I subjoin the weights of the professional classes, extracted by interpolation from the table, published by the Anthropometric Committee of the British Association in their Report, 1883, p. 40. The number of observations on which these are based, are given in a form that does not admit of strict comparison with those of my series. They are 24, for observations at the ages 30-35; 24, for 35-40; 44, for 40-50; 13, for 50-60; 5, for 60-70.

Mean Weights at Various Ages

Class	Years of Age					
	27	30	40	50	60	70
A	(166) (13)	176 18	184 24	181 21	181 18	(180) (12)
B	(168) (24)	171 23	172 24	184 26	178 26	178) (15)
C	(165) (36)	165 44	171 43	175 37	181 22	(188) (7)
Professional	151	167	173	174	174	—

These figures are rendered much more expressive by translating them into smoothed curves; those from which A was drawn are shown by crosses; those from which C was drawn are shown by small circles; but those from which B was drawn are omitted for clearness' sake.

Whatever may be the exact significance of these mean values, which is by no means so clear as may at first sight be imagined, and whatever may be their absolute worth, which I do not rate very highly, there can be no doubt as to their differential importance. They show with great distinctness that the noblemen of the generation which flourished about the beginning of this century attained their meridian and declined much earlier than those of the generation 60 years their juniors. They were nearly a stone heavier at the age of 40.

The weights of these two generations were identical at the age of 62 or 63, but at that period of life the earlier generation was declining in weight with almost the exact

[1] Copies of correspondence between the Secretary of State for the Home Department and the Inspector of Prisons, &c., and the Report of a Committee, &c. Ordered to be printed May 20, 1864.

speed at which the latter was continually rising. The steadiness of the rise of the latter from early manhood to late years is very striking; it is almost in a straight line. I have not sufficient data to justify me to say when its curve culminates; I have closed it at 70 with a dotted line.

It is only necessary to add that the ledgers of Messrs. Berry are a quarry from which, with some labour, much further information of the kind just given might be drawn. Perhaps the publication of this paper will suggest methods of treating them that have not occurred to myself.

FRANCIS GALTON

THE ERUPTION OF KRAKATOA[1]

"SIXTEEN volcanoes now working between the spot where Krakatoa was before and Sebesie." Such was one of the first reports which was sent by cable to Singapore, and which we heard at Pontianak. Never before had we been so longing for news from Java, for when H.M. ship *Hydrograaf* steamed into the Padang-Tikar River, we heard heavy detonations and explosions like far-off shots, so that we were alarmed about Java. As we expected, our ship was soon ordered to survey the Sunda Straits. This survey was finished at the end of October, and the reader will probably feel interested to know what really has happened there.

Krakatoa has not entirely disappeared, while, till now, no new volcanoes are visible in the neighbourhood. But the report that new islands were said to have

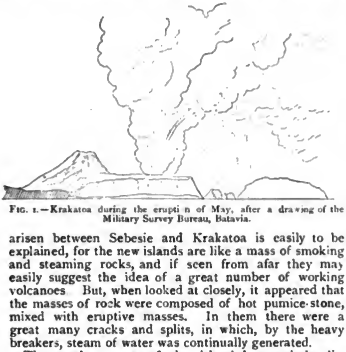


FIG. 1.—Krakatoa during the eruption of May, after a drawing of the Military Survey Bureau, Batavia.

arisen between Sebesie and Krakatoa is easily to be explained, for the new islands are like a mass of smoking and steaming rocks, and if seen from afar they may easily suggest the idea of a great number of working volcanoes. But, when looked at closely, it appeared that the masses of rock were composed of hot pumice-stone, mixed with eruptive masses. In them there were a great many cracks and splits, in which, by the heavy breakers, steam of water was continually generated.

The northern part of the island has entirely disappeared. At what is now the northern edge the peak rises nearly perpendicularly from the sea, and forms a crumbled and rugged wall, and shows a vertical cutting (which is more than 800 metres high) of Krakatoa.

Where was land before, there is now no bottom to be found; at least we could not fathom it with lines of 200 fathoms (360 metres) long. When we had quite calm weather, and steamed slowly and cautiously to and fro along the base of the peak, or had turned off steam and let the ship drift, and were busy in measuring the depth, we could distinctly see the different strata and rocks of the bare, opened mountain. Only here and there a slight trace of melted volcanic matter was to be seen, which, after half of the mountain had crumbled away, had flowed over the wall, which is still there. What remains of the slopes is covered with a grayish-yellow stuff (which, as plainly appears, had been in a melted or fluid state), full of cracks or splits from which steam is continually coming out.

In the same way steam is also coming forth from the deeper cracks of the steep wall, which is still remaining. Sometimes this is accompanied by slight explosions; at that time clouds of brown dust fly up from the cracks, and stones roll down which are often so big as to disturb the sea around the entire base of the mountain. Our

FIG. 2.—Krakatoa after the eruption in May, after a drawing of the Military Survey Bureau, Batavia.

entire survey of the north of Krakatoa suggested the idea that we were above a crater which had been filled with water and quenched by it, and this idea was still strengthened on observing that the decrease of depth, south of Sebesie, had principally been caused by matters which were cast out and flung away.

Almost in every place here the lead came up from the bottom, filled with black sand or carbonised dust, sometimes mixed with pulverised pumice-stone and little black stones, which apparently had been in a red-hot or melted state. Moreover, the soundings were very different, and the new rocks resemble clods of substances which, when

FIG. 3.—Peak of Krakatoa after the eruption in August, by M. C. van Doorn.

in a melted or very hot state, had contact with water. Probably such a whimsical shape of the rocks above the sea-level suggests the state of the bottom of the sea in the neighbourhood. The stones were still too hot to allow us to discover whether massive stones are under the pumice-stone also. It was not difficult, it is true, to knock off large pieces of these rocks by a hatchet or a chopper, but when a big block fell unexpectedly down, the sailors had often to flee on account of the gases which suddenly arose. The knocked off pieces which were brought on board were still warm after they had been in the boat for an hour.

FIG. 4.—Peak of Sebesie and the volcanic rocks before it, by M. C. van Doorn.

As is to be seen from the map, a great part of the lost ground of Krakatoa is found again at the bottom of the sea, a few miles to the north at least, if we suppose that no undulations of the ground took place. After having passed the limits to which the matters were thrown out, one finds the same soundings as were found before, and the decrease of depth is so local that the idea of an upraised bottom is dissipated at once. If such an elevation had taken place, it certainly would be remarked over a far greater extent and be more regularly ascending and descending. The firmer and stronger part of the crater wall, the peak of Krakatoa, which is still there,

[1] By M. C. van Doorn, officer in command of H.M ship *Hydrograaf*. Translated (and partially abridged) by E. Metzger from *Eigen Haard*, 1883, No. 51.

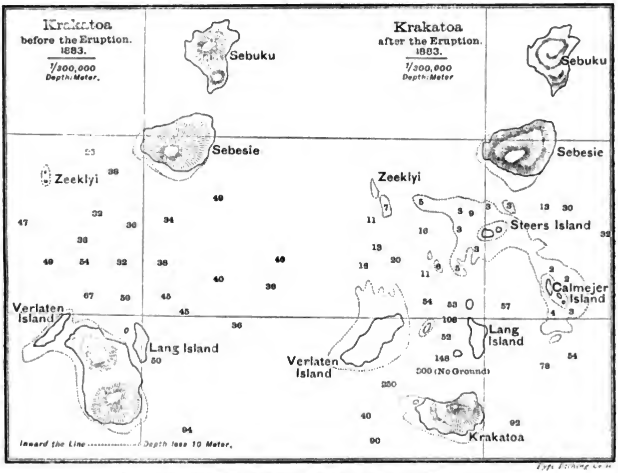
remained standing when the lower and feebler part dropped down, and the water found its way into the fearful boiling pool. We cannot wonder therefore that then a quantity of steam came forth (of which we are not able to form an idea), which caused a strong explosion. The movements of the sea which followed it caused tidal waves, the destroying force of which was experienced in such a fearful manner at the coast of Bantam and the Lampongs.

It is also worth mentioning that a change took place in the figure of Verlaten Island; the area is now triple what it was before, though it is plainly visible that large pieces of the beach were there knocked off a short time ago.

Lang Island, in size and formation, has remained almost unaltered. The sight of these islands, which were formerly covered by a luxurious vegetation, is now very melancholy. They are now buried under a mass of pumice-stone, and appear like shapeless clods of burst clay (*i.e.* covered with cracks). After a torrent of rain, the coming forth of steam is sometimes so dense that these islands, when seen from afar, appear like hilly ground covered here and there with snow. If looking at these spots with the telescopes, one can plainly see that these white specks are formed by a great number of clouds, which issued like steam from the fissures.

Sebesie is also covered with ashes up to the top—859 metres—which appear like a grayish-yellow cloth. But it seems that the cover is already less thick here, for here and there one sees the stumps of dead trees peeping out from the crust.

Sebuku shows a dreadful scene of devastation. Perhaps all that lived here is not so completely destroyed as was the case on the southern islands, but the sight of the bare



Krakatoa and neighbouring islands before and after the eruption, from official surveys.

fields of ashes, alternating with destroyed woods, the trees of which are all either dead or uprooted, gives one a still better idea of the destructive powers which were here at work. It is not until we come to the small islands northward of Sebuku that our eyes are gladdened by little specks of green.

I do not try to describe the scene of destruction and misery which we saw at Anjer and the villages along the coast. The papers have already reported the full particulars, and therefore I do not care to repeat melancholy facts which are already known.

It was a dreadful narrative which was related to us by a native, a lighthouse-keeper of Fourth Point, one of the few men at the lighthouse, who by a wonder was saved.

When the wave approached, all fled to the tower (the light was 46 metres above the sea), which, though shaking, resisted the violent waves for a long time. It was a terrible moment, when at last an enormous rock, which was swept away by the stream, crushed the base of the tower, which then fell down. The man who was saved saw his wife and his children drowned before his eyes. He related this fact in the very resigned way of a Javanese, and considered it the most natural thing in the world that he was now obliged to light the interim light, which was erected as soon as possible.

It has been almost a month that we have been in the Sunda Straits, and even in this short period we could observe that the coasts of Bantam commence to revive. From many places from the heavy rain the ashes are washed down, and a fresh green appears again. Even on the beach young cocoanut trees and banana trees are shooting out between the chaos of dead trees, blocks of rocks, &c.

Off Batavia, October 23, 1883

CHARLES WATKINS MERRIFIELD, F.R.S.

MR. CHARLES WATKINS MERRIFIELD, F.R.S., who died at Hove on the 1st inst., at the comparatively early age of fifty-six, was a native of Brighton. Having entered for the Bar, he in 1847 received from the then Marquis of Lansdowne an appointment in the Education Department of the Privy Council Office. Though called to the Bar in due course, he never practised, but was speedily promoted to the office of an Examiner, the duties of which he discharged with marked attention and success, while finding time for other work which made for him a name among men of science. Though well versed in Greek and Latin, as well as in the classic authors in French and Italian, both of which languages he wrote well and spoke fluently, the bent of his mind was decidedly towards the more exact sciences. He was an early member of the Royal Institute of Naval Architects, of which he was for many years Honorary Secretary, receiving a handsome testimonial on his retirement in 1875. Some mathematical papers he had contributed to the *Transactions* of some of the learned societies, and especially some memoirs on the calculation of elliptic integrals in the *Philosophical Transactions*, led to his election as a Fellow of the Royal Society in 1863. In 1867 the Government established the Royal School of Naval Architecture and Marine Engineering at South Kensington, and Mr. C. W. Merrifield, at the request of the authorities, accepted the office of Vice-Principal. He only intended to take this as a temporary measure, but as the result of the lamented death of Mr. Purkiss, who was to have been Principal, Mr. Merrifield was appointed to that office. On the transfer of the Institution to Greenwich in 1873, he resumed his office of Examiner in the Education Department. Mr. Merrifield was a frequent attendant at the annual meetings of the British Association, and filled the office of Vice-President of its Section of Mechanical Science at the Brighton meeting in 1875, and was President of the same Section at the Glasgow meeting in the following year. He served on many important committees of that Association; one of these was the committee whose report on the stability, propulsion, and seagoing qualities of ships in 1869 was drawn up by him, and another was the committee for reporting on Babbage's celebrated analytical machine. Mr. Merrifield was a member, and in due course became President, of the London Mathematical Society, and he held the office of Treasurer until he was compelled by his health to resign it in 1882. To some of the leading scientific journals and periodical publications his contributions, extending from 1853, have been very numerous; they may be found in the publications of the Royal Society, the *Philosophical Magazine*, the *Assurance Magazine*, the *Messenger of Mathematics*, &c. His acquaintance with mathematical arithmetic, methods of interpolation, and tabular work in general, was very wide and complete. Mr. Merrifield edited many of the works in the Textbooks of Science published by Messrs. Longman, and himself wrote a successful treatise on arithmetic and mensuration as one of that series. Some of his papers on the difficult and scientifically interesting subject of sea waves were translated into Italian for the *Rivista Marittima*, in which they appear, and a footnote to one of them, after bearing testimony to the author's extensive knowledge and excellenee of style, expresses the satisfaction of the editor at his adding to these qualifications that of "writing correctly our language." He was closely connected with the Association for the Improvement of Geometrical Teaching from its foundation, and took an active and leading part in the work of the Association. Mr. Merrifield served on several important Royal Commissions, including one on the seaworthiness of ships, of which the Duke of Edinburgh was President. During the last few years he frequently sat as scientific assessor to Mr. Rothery in the Wreck Court. A part of his unofficial work consisted of the conduct for many years of the mathematical part of the May examinations of the Science and Art Department. All his arrangements for this purpose were completed in 1882, when, in April of that year, he was prostrated by an attack of apoplexy. He had so far recovered as to give hopes that his life might be spared for some years, but on October 18 last he was seized with a third attack, from which he never rallied.

GEOLOGICAL SURVEY OF PRUSSIA

THE Report of this important Survey for 1882 has just been issued as a well-printed octavo volume with maps, sections, and plates of fossils. The first division is devoted to an account of the operations of the Survey in the field. These were conducted in the Harz, where the keen-eyed Lossen still wields his powerful hammer among the eruptive rocks of that classic region; where, also, Dr. von Groddeck and Herren Halfar, Dames, Branco, and von Koenen bore a share; in northern and eastern Thuringia and the Thuringerwald, where ten geologists were engaged; in Hesse-Nassau, with a force of five surveyors; in the southern part of the Rhine province, where Herr Grebe was at work; in Silesia, where the Survey was commenced by Dr. Dathe; in the Berlin district, where the superficial deposits and agricultural features were mapped, and the special geological and agricultural map of that district, consisting of thirty-six sheets, was completely surveyed; in the low grounds about Stendal and Gardelegen, in the plain of the Lower Elbe, and further east in West and East Prussia; and lastly among the diluvial and alluvial formations to the north-west of Halle.

In the course of the year eighteen sheets of maps and sections were published, including fourteen of the geological-agricultural survey of the Berlin district and four sheets of the map of older formations. The total number of sheets now published amounts to 109. There were likewise issued in 1882, besides the Annual Report, three parts of the Transactions of the Survey: viz. an account of the Coal-basin of Lower Silesia and Bohemia, by A. Schütze; descriptions of the Regular Echinids of the North German Chalk, by C. Schlüter; and a monograph of the species of Homalonotus in the Lower Devonian rocks of the Rhine, by C. Koch.

The plan of operations for 1883 included further surveys in the Harz, Thuringia, and the Thuringerwald, Hesse-Nassau, Rhine province, Silesia, and the great lowlands of Prussia.

The most important feature of the Annual Reports of the Prussian Geological Survey is the series of papers by members of the staff and others, with illustrative coloured maps and sections. Of these papers no fewer than twenty-two are published in the Report for 1882, including four by geologists not attached to the staff, and amounting in all to nearly 700 pages, with 23 plates of maps, sections, and fossils. Among these the following important communications may be cited:—"The Kulm of the Upper Harz," and "The Kersantite Dyke of the Upper Harz," by A. von Groddeck; "The Fauna of the Taunus Quartzite of the Rhine," by E. Kayser; "Preglacial Freshwater Formations in the Diluvium of North Germany," by K. Keilhack; "The Variolite-bearing Kulm Conglomerate of Hausdorf in Silesia," by E. Dathe; "New Borings in East and West Prussia," by G. Berendt and A. Jentzsch; "The Lower Devonian Rocks of the Siegerland and their Associated Veins," by H. Schmeisser; "The Trough of Eifel Limestone of Hillesheim," by E. Schulz.

NOTES

PROFESSOR SYLVESTER has been elected a Foreign Member of the Royal Academy of Sciences of Göttingen, of which he was previously a Corresponding Member. *Science*, in speaking of Prof. Sylvester's departure from America, says:—"Prof. Sylvester's departure removes from the University not only the most distinguished scientist but the most interesting personality connected with it; and his absence will make a gap in the general life of the University no less than in his own department. It is somewhat noticeable that no American college has conferred an honorary degree upon him during his residence in this country."

At a meeting on Tuesday, in connection with the memorial to the late Mr. Spottiswoode, Mr. De La Rue stated that he believed a portrait would be painted by Mr. John Collier, and that it would be placed along with those of other presidents of the Royal Society, in the Society's rooms.

The death is announced, in his fifty-third year, of Mr. John Henry Dallmeyer, the well-known optician.

Dr. Johnston-Lavis writes to us from Naples, Jan. 10:—"For some six days the seismographs at the Vesuvian Observatory have been in a disturbed state, and on Monday, January 7, at 1.48 p.m., a distinct shock was registered. As the sirocco was blowing, the mountain was enveloped in fog and cloud, so that on Wednesday morning when the news arrived at Naples of an eruption during the night it was received with half incredulity. The volcano appears to have commenced its violent throes about 1 a.m. on the 9th, when there issued a stream of lava which has flowed down the north-north-west side of the cone and crossed the Atrio del Cavallo. Those who were fortunate enough to look towards the mountain at about 2.30 a.m. on Wednesday morning describe the sight as splendid. The maximum explosive violence was at about 10 a.m. We passed the afternoon and evening on the mountain between the observatory and the lava stream, but were paralysed by the quantity of cloud, which prevented a near approach. To-day the view of the mountain has cleared up, but the activity seems to have much diminished. I hope to visit and photograph the crater to-morrow, when I will send more details." The *Standard's* Naples correspondent, writing on the 11th inst., says:—"The violent eruption of Vesuvius has come to a sudden close. The new mouth, which had opened just below the old crater, and from which a large stream of lava issued, flowing down the north-eastern side of the mountain, has to-day ceased to be active. On examination of the old crater, a fissure can be seen directed in a straight line to the new mouth. No signs of similar activity have been experienced since 1875, and a much stronger eruption is now looked for by Prof. Palmieri."

We understand that Prof. McIntosh, who has undertaken some investigations for the Trawling Commission, is about to institute inquiries at St. Andrew's in connection with the Fishery Board for Scotland, in order to throw some light on the habits and time of spawning of the sole, turbot, and other flat fish. These investigations are intended to enable the Fishery Board, by artificial cultivation or otherwise, to increase the supply of these important and much-esteemed fishes, and bring them within the reach of the general community more than is at present possible, owing to their being in great part imported from Grimsby and other fishing stations, and where, the supply being often very limited, the prices are extremely high. In this and other work we believe the Fishery Board is making arrangements to provide Prof. McIntosh with tanks and other appliances, so that, in addition to assisting the Board in its scientific investigations, he will be better able to prosecute his inquiries for the Trawling Commission. It is anticipated that, while the sole and other flat fish are being studied at St. Andrew's, the herring and its allies will be investigated in a laboratory to be formed by the Fishery Board at North Berwick. Besides Prof. McIntosh, it is expected that Prof. McKendrick of Glasgow, Prof. Stirling of Aberdeen, and Prof. Schäfer of University College, London, will assist in these investigations. It is also interesting to note that, in addition to this work which it is intended to undertake, the fishery officers of the Board, at its twenty-six stations on the coasts of Scotland, and the Board's cruiser *Vigilant*, are engaged with great success in collecting materials for the Board, which, when examined, will go far to clear up many of the mysteries as to the food of fishes. The materials collected are being sent from time to time to the University of Edinburgh, where they are examined by Prof. Cossar Ewart, the convener of the Scientific Investigation Committee of the Fishery Board, and by Mr. J. Duncan Matthews, one of the laboratory assistants.

The thirty-seventh annual general meeting of the Institution of Mechanical Engineers will be held on Thursday, January 24, and Friday, January 25, at 25, Great George Street, Westminster. The chair will be taken by the President at half-past seven p.m. on each evening. The following papers will be read and discussed as far as time will admit:—On Thursday, 24th, Experiments on Friction: Report of the Research Committee (adjourned discussion); On the Consumption of Fuel in Locomotives, by M. Georges Marié, of Paris; on Friday, 25th, On the Physical Conditions of Iron and Steel, by Prof. D. E. Hughes, F.R.S.; On Portable Railways, by M. Decauville, of Petit-Bourg, Paris; On the Moscrop Engine Recorder, and the Knowles Supplementary Governor, by Mr. Michael Longridge, of Manchester.

We are glad to see that Dr. Doberck's enterprise is meeting with the approval it deserves in Hong Kong and China. "Dr. Doberck, the Government Astronomer, who arrived at Hong Kong a few months ago," the *Hong Kong Free Press* of Nov. 6 says, "has since been most usefully employing his time in visiting the different coast ports and Formosa, and returned from the latter yesterday. He has, we understand, verified a number of instruments belonging to the Imperial Maritime Customs of China, and has studied the geographical conditions of the coast as bearing on meteorology, a very necessary matter in order to arrive at accuracy in discussing observations. We are glad to learn that the Chinese Imperial Maritime Customs Authorities evince a strong disposition to cooperate with the Hong Kong Observatory in the matter. It is of the first importance, in order to be able to arrive at any definite results so as to be able to forecast the weather, and compile a reliable weather table, that the meteorological observations conducted at different ports on the China coast should be made at the same hour, in the same manner, and by instruments corrected to the same standard. It is to be hoped therefore that Sir Robert Hart will allow his able staff to take part in this work, and that monthly registers will be kept at all the treaty ports from Newchwang to Pakhoi and transmitted to the Hong Kong Observatory, which, by situation, is best fitted to become the centre of such a system. The Observatory in this colony is on a very modest scale, and the vote for its maintenance is a mere trifle when the good that is to be gained from it is considered, and we trust that the efforts of the astronomer will not be paralysed by too great attention to economical considerations on the part of the local government. The Inspector-General of Customs has always displayed a most laudable desire to promote improvements in lighting the coast and facilitating navigation; and he will, we hope, see his way to promote the success of Dr. Doberck's work by cooperating with the Hong Kong Observatory. The Sicawei Observatory has done some good work, but its operations have necessarily been limited owing to the absence of reliable observations at the ports. What is expected from the Government Astronomer is that ultimately he may be able not only to give forecasts of the weather but to furnish such a guide to mariners as would render it possible to make voyages and to avoid typhoons or bad weather. The value of such a service is not measurable by mere money; it means greater security to life and property, fewer risks to shipowners, and a diminution of loss to underwriters. It would, in short, have an appreciable effect on commerce generally, and the business of this great shipping port in particular." We trust that this just and accurate view will prevail among those in a position substantially to help Dr. Doberck in his valuable work.

PROFESSOR FOREL (Morges) writes in the *Gazette de Lausanne:*—We are again passing through an earthquake period. On December 18, 1883, at 6.25 a.m., a shock was observed at Neufchâtel; on December 22, at 3 a.m., another one at Cortaillod, and at 4 a.m. at Neufchâtel and Cortaillod. On December 17 and 18 earthquakes were noticed in various parts of Italy, and on December 22, at 3.39 a.m., one at Lisbon.—A rather violent shock, followed by another an hour afterwards, was noticed at Laibach on December 31 at 3.30 a.m.—At Sadikli, near Brussa, an earthquake caused some destruction on January 3, fortunately unattended by loss of life.—The Siberian newspaper *Sibir* reports that at Korssa Kowskoje Sjelo on Lake Baikal no less than nine earthquakes occurred during the month of September last, *i.e.* on the 3rd, 7th, 12th, 14th, 17th, 20th, 24th, 27th, and 30th of that month (old style).—A sharp shock, causing some alarm, was also felt at Messina at 11.30 on the night of the 13th inst., but no damage was done.

AT 5.25 p.m. on January 11, at Fort William, a ball of light, shaped like a pear, with the broad end downwards, was seen as if suspended midway between Ben Nevis and the Caledonian Valley. It descended till near the surface of the earth, and then it burst, lighting the whole valley. In colour it resembled the electric light. Mr. W. Gunn writes from Berwick-on-Tweed:—"On January 11, at 5.33-34 p.m., I saw a remarkably brilliant white meteor—certainly as bright as Venus—rather low down in the sky to north-north-west. Apparent motion about in a line from Vega towards a point in the horizon nearly vertically below the end of the tail in Ursa Major; seen for two or three seconds moving slowly; seemed to largely and suddenly increase in size and brightness just as it was lost to view behind some trees. Perhaps this was the bursting seen at Fort William."

THE list of lectures to be delivered before the Association Scientifique de France has been published. They will be delivered as usual at the Sorbonne, under the control of M. Milne Edwards, president of this association. Some of them will be delivered by members of the council of the Association Française, a rival institution, and it is pretty certain that the two societies will be incorporated into one single body. The Association Scientifique is the older of the two, and was created by Leverrier about twenty years ago.

WE learn from *Science* that Mr. H. M. Wilson, in charge of one of the topographical parties in Prof. A. H. Thompson's Wingate division of the U.S. Geological Survey, surveyed, during the season of 1883, about ten thousand square miles in North-Western New Mexico and North-Eastern Arizona. The area covered by his work lies between parallels of latitude 36° and 37°, and extends from meridian 109° to 111°. He also worked some smaller detached areas outside of the limits thus indicated. This region has hitherto remained a *terra incognita*, partly on account of its aridity and barren condition, and partly on account of the difficulty of traversing it. So little has been known of it that within the area surveyed by Mr. Wilson a small mountain range has been indicated as occupying two places on the same map. On the engineer's map of 1879 it is called Calabesa Mountains in the northern place, and Squash Mountains in the southern; and on the Land-Office Map for 1882 both are indicated without names. Mr. Wilson's work proves that they are one and the same, occupying a position very close to that assigned to the Squash Mountains.

NEWS has been received in Berlin from the African traveller, Dr. Richard Böhm, dated July, 1883, from Qua Mpara, on the western shore of Lake Tanganyika, near the estuary of the Lufuku River. Dr. Böhm and his companion, Paul Reichardt, seem to have settled there for some time. Before reaching Qua Mpara they met with considerable difficulties, having to combat the natives, by whom Dr. Böhm was seriously wounded. He left the Belgian station Karema at the end of June, and reached Qua Mpara on July 8. There he was seized by a fever, yet he retained sufficient energy to complete his zoological investigations (principally ornithological) and to forward the results to Europe. All his collections and his scientific instruments were unfortunately destroyed by fire on the Mto ja Ugalla. Dr. Böhm, however, set to work again and commenced making new collections, which he left at Karema in safe keeping. Amongst other things he is reported to have discovered a beautiful freshwater Medusa, with a broad, umbrella-shaped body and numerous long and short prehensile filaments; he found it in Lake Tanganyika. At the same time a report from Herr Paul Reichardt was received describing in detail the Soko so well known to readers of Livingstone. The animals live together in herds of from six to twenty individuals, and build nests on trees at an elevation of 8–19 m., the nests measuring from 1–1·2 m. in diameter. Reichardt found groups of nests in which he counted over fifty separate nests. Up to the time of sending the report Reichardt had not succeeded in securing a specimen.

IN the *Bolletino of the Italian Geographical Society* for December, 1883, Sig. Colini continues his valuable notes on the information supplied by Cavaliere Luciòli on the topography and ethnography of the Upper Amazons regions. The paper is accompanied by a large map of the Huallaga and Ucayali river basins, based on Petermann's South America, but corrected and supplemented by fresh data furnished by Luciòli. The position of a large number of tribes, many hitherto unknown, is determined along the banks of the head waters of the Amazons, and to these is added a list of about sixty others, supplied by Dr. Colini from the old records and the writings of recent explorers. But it is obvious that many of these are mere duplicates or even triplicates of the same tribes due to careless transcription, ignorance, change of tribal designations, and other sources of confusion. Thus Carapacho and Picambio are only older names of the present Caribes and Remos of the Middle Ucayali. So with the Amalmacas, Chuntagurus, and Tambas of the older writers, who may be safely identified with the modern Amahuacs, Chontaguiros, and Campas respectively. Nor, as Colini rightly remarks, are these names always distinctly tribal, but the designations of mere clans, or small family groups, or members of larger divisions. These are continually shifting their locality, disappearing, or becoming absorbed in more powerful groups, another fruitful source of perplexity in the ethnical terminology of the Amazons regions. But, after making all due allowance for this uncertain nomenclature, there still remains a surprising number of really distinct tribal groups scattered along the banks of the Huallaga, Napo, Ucayali, and other Amazonian streams, groups differing from each other always in speech and frequently in habits, usages, and physical type.

ON January 26 the Berlin Wissenschaftliche Central Verein and Humboldt Academy will celebrate the fiftieth anniversary of its foundation.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. C. S. Norman; two Great Kangaroos (*Macropus giganteus* ♂ ♀) from New South Wales, presented by the Zoological and Acclimatisation Society of Melbourne; a Dorsal Squirrel (*Sciurus hypopyrrhus*) from Central America, a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, twenty-five Indian Crocodiles (*Crocodilus palustris*) from India, deposited.

OUR ASTRONOMICAL COLUMN

PARALLAXES OF SOUTHERN STARS.—We learn from Mr. Gill, H.M. Astronomer at the Cape, that he has completed a memoir on the parallax of some of the principal southern stars, founded upon observations by himself and Dr. Elkin; the memoir contains investigations on parallax of

By Gill: α Centauri (two series with different comparison-stars); Sirius; ε Indi; Lacaille 9352 (Gould's star with proper motion of 7″); o^2 Eridani, and β Centauri.

By Elkin: α Centauri (two series with different comparison-stars from Gill's); Sirius; ε Indi (also with different stars); ζ Tucani; ε Eridani and Canopus.

Mr. Gill's important memoir has been communicated to the Royal Astronomical Society, and its publication will doubtless be awaited with much interest by astronomers.

The large proper motion of Lacaille 9352 was detected by Dr. Gould, and announced in No. 2377 of the *Astronomische Nachrichten*. The annual P.M. in arc of great circle is 6″·96 in the direction 79°·2. It is a star of 7·5 m. in Piscis Austrinus: Mr. Stone's place for 1880·0 is in

R.A. 22h. 58m. 5·43s., N.P.D. 126° 32′ 40″·0.

In only one instance has the existence of a larger proper motion been discovered, viz. in that of the well known 6·7 m. Groombridge 1830 in Ursa Major, where the amount is 7″·05. ε Eridani, 4·4 m., is in R.A. 3h. 15m. 8·16s., N.P.D. 133° 31′ 46″·8 for 1880, according to Stone, who attributes to it an annual proper motion of 3″·0 in the direction 75°·5. ζ Tucani, a fourth magnitude, is in R.A. oh. 13m. 48·60s., N.P.D. 155° 34′ 49″·0 for 1880, with an annual proper motion of 4″·35 on an angle of 74°·8, by Stone's values.

Mr. Gill expects to be in England early in February, to superintend a large amount of official printing, for which he brings copy with him.

PONS' COMET.—For a few evenings this comet will form a pretty conspicuous object as it descends in the south-western sky; after it ceases to be visible in Europe observations may be continued at the observatories of the other hemisphere for several months. On March 26 the theoretical intensity of light will be ten times, and a month later, five times, greater than at the beginning of September, when the comet was discovered through the diligent scrutiny of the heavens, followed up by Mr. Brooks, who found it considerably beyond the limits of the sweeping ephemerides then in the possession of observers. Mr. S. C. Chandler has conjectured that a meteor-stream may be connected with this comet. MM. Schulhof and Bossert's orbit for 1884 gives the radiant in R.A. 197°·8, Decl. + 67°·3.

THE MINOR PLANETS.—The *Berliner Astronomisches Jahrbuch* for 1886 contains elements and approximate ephemerides for the present year of 231 of the known members of this extensive group, only four therefore being omitted in the absence of the necessary data. In addition there are twenty-six accurate opposition-ephemerides. Four of these small planets approach the earth, within her mean distance from the sun, in 1884. At the end of December No. 132 *Æthra*, situate in the vicinity of α Orionis, will approach the earth within 0·85, and shining as a star of the ninth magnitude, will afford another favourable opportunity for the investigation of solar parallax, on the method advocated by Mr. Gill.

SCIENCE IN RUSSIA[1]

THE *Memoirs* (*Zapiski*) *of the Novorossian Society of Naturalists*, at the University of Odessa, founded only in 1873, have already reached their eighth volume, and contain a good deal of valuable work. Confining our analysis to the last three volumes, we notice in them the following papers:—In the domain of geology Prof. Sintsoff contributes several papers. One of them is an elaborate monograph on the sponges from the chalk of Saratoff. Revising his former work on the same subject, and taking advantage of the well-known work of Prof. Zittel, as well as of new extensive collections, M. Sintsoff creates a number of new species and four new genera: *Mæandroptychium*, which he proposes to substitute for those of *Caloptychium*, *Etheridgia*, and *Tremabolites*; *Labyrintholites*, closely allied to *Plocoscyphia*; *Polyscyphia*, akin to the preceding; and *Zittelispongia*. The author describes (with figures) seven species of the first, four species of the second and the third, and one species of the fourth, as well as the following species:—*Cuculispongia triloba*, Trautschold, *Craticularia cylindrica*, Mischl.; two species of *Ventriculites*, two species of *Coscinopora*, *Leptophragma simplex*, T. Smith, *Actinosiphonia radiata*, Fisch., and the new species *Hallirhoa peskowi* and *Isoraphinia cavata*.—The same author contributes a second paper on Mesozoic fossils from Simbirsk and Saratoff (the first paper having appeared in vol. iv.), and describes the following species:—*Ammonites longispinus* and *caletanus*, *Scalaria dupiniana*, var. *rhodani*, *Astarte beaumontii*, *Panopæa neocomiensis*, and as new species *Aporrhais striata-carinata*, *Nucula subarduennensis*, and *Lucina neutralis*.—A third paper by the same author contains a description of the following Tertiary fossils of Novorossia:—*Dreissena rostriformis*, Desh., *Hydrobia mathildæformis*, Fuchs, *H. dimidiata*, Eichw., *Valvata variabilis*, Fuchs, *Neritina danubialis*, Pfeif., var. *liturata*, Eichw., *N. prevostriana*, Partsch., and *N. capillacea*, Brusina, from the Pliocene; *Trochus rollandianus*, d'Orb., *Phasianella kischinerviæ*, d'Orb., and as new species *Trochus minutus*, *semistriatus*, and *elegantulus*, *Hydrobia substriatula*, *Amnicola cyclostomoides*, and *Valvata pseudo adeorbis*, from the Miocene. All these fossils are represented in the plates.—M. Prendel contributes a paper on the geological structure of the districts of Elizabethgrad and Alexandria, in the government of Kherson. The rocks are granites, mostly as schists, and considered by the late Barbot-de-Marny as a product of metamorphism of sedimentary rocks, and very small patches of Huronian schists, covered with numerous isolated islands of Eocene. The whole is covered with the "White Sands," where M. Prendel has found a stem of *Cupressonoxylum severzovi*, Merklin (Miocene ?), and with loess, which contains, besides the usual fossils, remains of *Arctomys bobac*, which does not now extend in Russia south of 52°–54° N. lat.—The same author contributes (vol. viii.) another paper on the crystalline rocks on the Bazavlouk and Saksagan Rivers, right tributaries of the Lower Dnieper. The paper is accompanied by a map of coloured sections of microscopic specimens of crystalline rocks.

The chief papers in these *Memoirs* are however devoted to comparative anatomy and zoology. Without attempting to summarise their varied contents, we can merely enumerate most of them. All are profusely illustrated with plates. In the sixth volume we notice a preliminary communication by Madame Olga Mechnikoff, on the anatomy of cartilaginous fishes; and a note, by Prof. H. Mechnikoff, on the larva of the *Anisoplia*.—M. Repyakoff contributes an elaborate paper on the morphology of the *Bryozoa*. Without attempting to determine the place that the Bryozoæ ought to occupy in systematic classification, the author devotes his special attention to the relations between the two great subdivisions of the Endoproct and Ectoproct Bryozoæ, and his paper is a valuable contribution to the work undertaken by Nitsche, Hatschek, Joliet, and Barrois.—M. Zabarinsky contributes a paper on the morphology of the Hydra.—In vol. vii. M. Buchinsky publishes a paper on the development of the earthworm, devoting his special attention to the development of its mesoderm and of its nervous system.—In vol. viii. M. Krasilschik contributes an elaborate paper on the development of the *Polytrema*, and the place it occupies with regard to other Flagellatæ; M. Repyakoff publishes a note on the larvæ of the *Polygordius flavocapitatus*; M. Depp, on the life of the Macropodes; and M. A. Kovalevsky, on the development of the Chiton.—In physiology we notice the researches, by M. Spiro, into the development of bile, being the result of various experiments, and accompanied with tables showing the dependence of its amount upon the food.

In botany we find the researches by M. Rishavi on the development of the organs of reproduction in *Dasya elegans* (vol. vi.); a list of lichens collected on Mount Castel in the Crimea, and determined by Dr. Brutann in Dorpat (vol. vii.); and a work, by M. Kojernikoff, on the anatomical structure of the corolla in flowers. The author has extended his researches

[1] *Memoirs of the Novorossian Society of Naturalists* (*Zapiski Novorossiyskago Obschestva Estestvoispytateley*), vols vi., vii., and viii. Odessa.

to a great number of flowers, and has come to the conclusion that, however great the analogy between the petals and the leaves, still the former have a series of well-established anatomical features which enable us to characterise them as well as any other part of the plant. Some of their anatomical features can be explained by the physiological function of the organ, whilst the others have no connection with them, and the explanation of these peculiarities must be sought for elsewhere—says the author—in the yet unknown internal structural form of the plant as also, perhaps, in the position occupied by the flower in the whole of its organic life.

In chemistry and physics we notice two papers, by M. Tanatar, on the fumaric and maleinic acids (vol. vi.), and on their compounds with chlorite (vol. viii.); by M. Klimenko, on the lactic and propionic acids (vol. vi.); by M. Melikov, on the componnds of acrilic acid; and by M. Geritch, on electrical phenomena observed during the diffusion of several liquids.

A paper of general interest, intended to show some relations between animals and plants at their lowest degrees of development, is contributed by M. Shmankevitch (vol. vii.). When the Flagellate, *Anisonema acinus*, Blütochli—having a relatively high organisation—is cultivated for many generations in a medium which is slowly modified, for instance, in sweet water to which a certain amount of lake salt is added, its structure is modified, in proportion as the concentration of the solution of salt is increased. The individuals become less developed, their size diminishes, and the feeding-canal loses its former development. Numberless intermediate forms between the *Anisonema acinus* and its new, less developed representatives, make their appearance, as well as between these and the still lower *Anisonema sulcatum*, which would be thus but a lower organised variety of the former. When the concentration of the medium in which the *Anisonema* lives is carried on side by side with a change of temperature of the medium, the transformation goes further on, and the lowest *Anisonemæ* are transformed on the one side into algæ-like organisms, and in another direction into organisms which seem to belong to the category of fungi. The individuals not only become smaller, but they give rise also to a progeny long before reaching their full size. Under the influence of the sun's rays the uncoloured Flagellatæ acquire a new physiological function, and develop chlorophyll. "We see thus," the author says, "the beginnings of two kingdoms, animal and vegetable, radiating from one common stem. We see the transformation of one of them into the other, not only in its morphological features, but also in its physiological functions, under the direct influence of physical and chemical agencies. The saline solutions, as compared with sweet water, diminish the size of the lower organisms, and at the same time they contribute towards the development of chlorophyll in the sweet-water algæ, thus giving them, so to say, a more vegetable character, together with an increased productivenes." And further: "While descending from the *Anisonema sulcatum* to a unicellular alga, we see the regressive development, a simplification of organisation; we descend towards the plants containing chlorophyll. . . . While descending from the same *Anisonema* on another branch, we enter into the region of such lower organisms which, under the influence of another medium, do not develop chlorophyll, and having no nutrition from the air, find their food from the substratum; they could be described as parasitic Rhizopodæ, and this the more as from the fungoid form we can ascend, under some circumstances, not only towards the Amœba-like uncoloured Flagellata, but also towards the moving Monad. On the contrary, by reversing the physical agencies, we can arrive, from the unicellular alga, as well as from the fungoid form, to an uncoloured form having the structure of the *Anisonema*." The researches of A. Giard, Cienkowsky, and Famintzyn, and some observations by Ray Lankester, seem to be, in the author's opinion, in accordance with the above.

PROFESSOR HAECKEL ON THE ORDERS OF THE RADIOLARIA[1]

[THE following translation of a recent paper of mine, by Miss Nellie Maclagan, has been revised by myself.—ERNST HAECKEL.]

THE "Outline of a Radiolarian System founded on Studies of the *Challenger* Radiolaria," published by me in the *Jenaische Zeitschrift für Naturwissenschaft* (Bd. xv. pp. 418-472), shortly before starting for Ceylon in October, 1881, gave a very short survey of the systematic results of the researches which I had been carrying on since 1876 among the inconceivably rich Radiolarian material of the *Challenger* collection. At that time I distinguished in this Rhizopod class seven different orders (p. 421) and 24 families, containing in all 630 genera ("Prodromus Systematis Radiolarium," *l.c.*, pp. 423-472). I was able even then to distinguish no less than 2000 new species, and this goodly number has since been considerably increased. Further investigations corroborated all the principal essential points of the views then briefly given as to the morphologico-phylogenetic conditions of relation among this Protista class, but I gradually came to simplify my views as to the relation of the principal groups, and have now reduced the seven orders to four, which makes the complicated system much more comprehensible.

The systematic arrangement of the 15 families, given in my "Monographie der Radiolarien," 1862 (following Johann Müller, who first broke ground in his treatise, 1858) was essentially improved by Richard Hertwig, whose admirable work on the "Organismus der Radiolarien," 1879, thoroughly explained for the first time the difficult histology of these Protista, and definitely determined their unicellular nature, despite all peculiar modifications of the cell structure. On the ground of important differences discovered by him in the structure of the membrane of the central capsule, and the consequent varying comportment of the passage of pseudopodia, Hertwig distinguished the following six orders (*l.c.* p. 133):—1. *Thalassicollea*, monozoic uninuclear Radiolarians, having the capsule membrane pierced on all sides: skeleton siliceous, irregular, or wanting. 2 *Sphærozoea*, polyzoic multinuclear Radiolarians, having the capsule membrane pierced on all sides: skeleton siliceous, irregular, or wanting. 3. *Peripylea*, monozoic uninuclear Radiolarians, having the capsule membrane pierced on all sides: skeleton siliceous, consisting of fenestrated spheres or modified fenestrated spheres or disks. 4. *Acanthometrea*, monozoic uninuclear Radiolarians, having the capsule membrane pierced on all sides: skeleton non-siliceous, consisting of twenty spicules arranged according to J. Müller's law. 5. *Monopylea*, monozoic uninuclear Radiolarians, the capsule open on one side, and with a peculiar porous area: skeleton siliceous. 6. *Tripylea*, monozoic uninuclear Radiolarians; capsule membrane double, with one principal and two accessory openings; skeleton siliceous, formed of tubes.

As I found that the important differences in the structure of the membrane of the central capsule and the consequent passage of the pseudopodia, discovered by Hertwig in the comparatively limited material at his disposal, were corroborated in their most essential points by my researches among the wider world of the *Challenger* Radiolaria, I adopted his scheme in my "Conspectus Ordinum Radiolarium Classis," 1881 (*l.c.* p. 421), but with this difference, that I divided Hertwig's *Sphærozoea* into two orders—*Symbelaria* and *Syncollaria*. The latter, *Syncollaria*, includes the families of the *Sphærozoida* in the wider sense, and, from the absence or incompleteness of the skeleton, corresponds as a polyzoic group to the monozoic *Thalassicollea*, whilst the former, *Symbelaria*, includes the family of the *Collospharida* in the wider sense, and by its spherical, reticulate, siliceous skeleton corresponds as a polyzoic group to the monozoic *Peripylea*.

Recent researches, which have brought to light an immense number of new, hitherto unknown Radiolarians belonging to the last-mentioned groups, have, however, convinced me that the distinction between the monozoic (solitary) and the polyzoic (social) Radiolarians is of much less importance than was formerly supposed. They are as insignificant and of as little value in forming a system as the differences between monozoic Hydropolyps (*e.g. Hydra, Myriothela*) and polyzoic Hydropolyps (*Tubularia, Coryne*), or as the differences between solitary Infusoria (*Vorticella, Trichodina*) and social Infusoria (*Carchesium, Epistylis*). According to Hertwig, the essential difference between the two groups is that the solitary *Thalassicollea* are uninuclear, the social *Sphærozoea* (= *Symbelaria*) multinuclear. Nevertheless, the central capsule in all Radiolaria (without exception) is uninuclear at an early stage and multinuclear later on. We would require to be more exact about this distinction, inasmuch as in the *Sphærozoea* (= as in the *Acanthometrea*) the division of the simple nucleus into a number of nuclei (spore nuclei) takes place at a very early period, whilst in the *Thalassicollea* (as in the other Radiolaria) it only takes place later on. This relative modification is, however, of no standard value

[1] "Separat-Abdrück aus den Sitzungsberichten der Jenaischen Gesellschaft für Medicin. und Wissenschaft." Jahrg. 1883. Sitzung. von 16 Februar.

for the systematic distinction of the orders, and is, moreover, subject to various exceptions.

Among the new Radiolaria of the groups above mentioned discovered in the *Challenger* collection, there were, moreover, monozoic and polyzoic species which correspond completely, even in the specific characteristics of the skeletal form. For example, a monozoic *Thalassoxanthium* has precisely the same characteristic spicules as the common cosmopolitan *Sphærozoum punctatum*, but whilst in the latter the small polyzoic central capsule incloses a large central oil globule and numerous small peripheric nuclei, in the former the central capsule, which is three times as large, incloses a single, large central nucleus and numerous small peripheric oil globules. The complete identity of the characteristic skeletal form might even lead us to suppose that a kind of alternation of generation may take place between the two forms. In the same way, a social *Collosphæra* corresponds completely to a solitary *Cenosphæra*, the polyzoic *Acrosphæra* to the monozoic *Conosphæra*, and so forth.

On the ground of these observations—the importance of which I shall explain in detail in my work on the *Challenger* Radiolaria—I consider the distinction between monozoic and polyzoic Radiolarians (which I contrasted in 1862, according to Müller, as *Monocyttaria* and *Polycyttaria*) as practically unimportant, and for the present connect the polyzoic families in the system immediately with the monozoic. In this way the number of the six or seven groups is reduced to four, as I refer all the groups thus formed to Hertwig's Peripylea. As I have already shown (1881, *l.c.* p. 421), these may be again divided in pairs into two principal groups or sub-classes—into *Holotrypasta* and *Merotrypasta*. The *Holotrypasta* (*Acantharia* and *Peripylea*, the latter including the *Collodaria*, *Symbelaria*, and *Syncollaria*) includes all Radiolaria in which the capsule membrane is pierced on all sides by fine pores, and the pseudopodia consequently radiate equally on all sides. The *Merotrypasta* (*Monopylaria* and *Phæodaria*) include all those Radiolaria in which the membrane is pierced at one side either by a single area of pores or by openings confined to a few spots, so that the pseudopodia project from the central capsule as a single bunch or as slightly separated bunches.

The high standard importance of the central capsule for the proper conception of the Radiolaria to which I first drew attention in my monograph, 1862, has since been recognised by Hertwig and most other investigators of these Protista, but recently disputed by Carl Brandt (*Monatsb. Berlin. Akad.* 1881, p. 391). As I reserve the detailed reasons for my opinion for my work on the *Challenger* Radiolaria, I shall now merely remark that my more recent researches have fully corroborated my former views, and that in all true Radiolaria the central capsule is separated by a distinct membrane from the extracapsularium (or external gelatinous soft part). The so-called "freshwater" Radiolaria (which, from absence of the membrane, are not Radiolaria but Helizoa) do not of course furnish any counter-proof. Brandt's erroneous assertion rests upon the extremely limited amount of material investigated by him. Careful investigation enabled me to discover the capsule, even in all species which he regards as "without capsule." In isolated species, however, the capsule membrane is somewhat late in forming a definite boundary between the capsule and the gelatinous sheath (sometimes just before the formation of spores), whilst in other cases it usually takes places at a very early stage. I therefore maintain now, as formerly, that the chief character of the class is the differentiation of the unicellular body into two essential, principal component parts, viz. the inner central capsule with nucleus and membrane, and the outer gelatinous sheath with matrix and forest of pseudopodia. On the other hand, it is immaterial whether "yellow cells" (or "zooxanthella") are present or not. I found them wanting in many cases, though they are usually present. I therefore agree with Cienkorosky, and regard the symbiosis of these unicellular Algæ as an accidental and not an essential phenomenon. They are in no way necessary for the nourishment of the Radiolaria, though they may be important agents in the matter.

Meantime I am convinced that the four orders of the class Radiolaria, *Acantharia*, *Spumellaria*, *Nassellaria*, and *Phæodaria* represent four distinct, perfectly natural, principal divisions. In each of these four orders the numerous forms belonging to it, despite their astonishing variety, may be referred by morphological comparison to a common primitive form, which may therefore be regarded as their ancestral form in a phylogenetic sense. This phylogenetic view of the four orders as distinct monophyletic groups is justified by the fact that the remarkable and extremely complicated relations of all the forms of each common ancestral group have the same natural, strong phylogenetic signification as they have in the comparative anatomy of the Vertebrata or of the Articulata. Bütschli was therefore in the right at the close of his admirable dissertation on the skeletons of the Cyrtida (1881, *l.c.* p. 538), where he lays stress on the fact that the complicated phylogenesis of this section, so rich in specific forms, may be regarded as an excellent argument in favour of the doctrine of descent, and that in this way those painstaking investigations of the microscopic world (which many "exact physiologists" consider mere morphological trifling) come to be of real importance.

I. The Acantharia, which are distinguished from the three other orders by their organic acanthine skeleton—they never have a true siliceous skeleton—correspond on the whole to the *Acanthometræ* of J. Müller (including, however, part of the *Haliomma*), and to the *Acanthometrae* of Hertwig, which he divides into *Acanthometrida* and *Acanthophractida*. I hold the remarkable *Actinelius* to be the ancestral form of this order. It was first described by me in 1865, but I have lately found several forms closely allied to it, partly Astrolophida, partly Litholophida, in the *Challenger* collection. In *Actinelius* the spherical central capsule is pierced by numerous simple, radial spicules (without definite number and arrangement) meeting in the centre of the capsule. *Actinelius* may be held to have arisen immediately from *Actinosphærium* by the hardening of the firmer axial fibres in the radial pseudopodia of the latter into radial spicules. *Actinelius* is the common ancestral form, on the one hand, of the whole *Actinelidæ* (Astrolophida and Litholophida), all with indefinite number and arrangement of the spicules, and, on the other hand, of the remaining *Acantharia*, in which twenty radial spicules are invariably arranged according to J. Müller's law in five four-rayed zones. The oldest of these are the Acanthonida (or Acanthometra in the more limited sense) from which the Dorataspida and Diploconida having shells are derived later on.

II. The Spumellaria, by which I understand Hertwig's *Peripylea*, *Thalassicollea*, and *Sphærozoea*, had been previously united with tolerable accuracy by Ehrenberg, on the ground of observations made by him on the skeletons of the fossil Radiolaria of the Barbadoes, and opposed to the Nassellaria as *Polydictya* or *Polycystina composita*. His *Spyridina* (our *Spyroida*) belongs, however, to the latter, not to the former. All Spumellaria (which may also ultimately be termed Peripylaria or *Peripylea*) have—in contradistinction to the Nassellaria and Phæodaria—a central capsule pierced on all sides by fine pores, and agree in this respect with the Acantharia, from which, however, they are distinguished by the absence of the acanthine skeleton. All Spumellaria may be easily referred to a common ancestral form —to *Actissa*, the simplest form of the Thalassicollida. An interesting species belonging to *Actissa* was accurately described by Hertwig in 1870, under the name *Thalassolampe primordialis* ("Organismus," p. 32, taf. iii. fig. 5). It has neither the extracapsular alveola of *Thalassolampe* nor the intracapsular alveola of *Thalassicolla*. I observed another species of the genus, which I shall describe later in detail, as *Actissa princeps* in Ceylon, 1881. *Actissa* certainly represents the simplest possible Radiolarian form, in a measure the actual embodiment of the simplest ideal type of this whole Rhizopod class. In a phylogenetic sense it may therefore claim to be regarded as the ancestral form not only of all Spumellaria, but perhaps also of all Radiolaria. All *Collodaria* (the solitary Thalassicollida and Thalassosphærida, the social Collozoida and Sphærozoida) are derived immediately from it, then all *Sphærellaria*. The ancestral group of the latter section, which is richest of all in specific forms, is the *Sphæroida* (or *Sphærida*), and, first among them, the Monosphærida, furnished with a simple, fenestrated spherical shell. From the latter all the others, viz. Pylonida, Zygastida, Discoida, and Lithelida, can be derived without difficulty.

III. The Nassellaria, which correspond on the whole to Hertwig's Monopylea, had already been defined by Ehrenberg as *Monodycta* or *Polycystina solitaria*, in contrast to his Spumellaria. His definition was correct on the whole, though the *Spyridina* (our *Spyroida*), which he places among the latter, belong rather to the former. Hertwig was the first to determine correctly the essential characters of this large order, so wonderfully rich in forms, viz. the simple area of pores at one pole of the capsule axis, 1879 (*l.c.*), and I would therefore have retained his name, *Monopylea* or *Monopylaria*, for the entire order, had it not been equally suitable to part of the Phæodaria. I therefore prefer

Ehrenberg's older nomenclature. Like Hertwig, I regard the skeletonless *Cystidium inerme*, discovered by him (*l.c.* pp. 87, 136, taf. vii. fig. 1) as the ancestral form of the order. *Cystidium inerme* is distinguished essentially from *Actissa* by the restriction of the capsule pores to a single area, and the consequent monaxonous fundamental form of the central capsule. All other Nassellaria are derived from *Cystidium* by the development of a characteristic siliceous skeleton. Hertwig assumes that there are at least two or three entirely different original forms for the Nassellaria skeleton, viz. a simple siliceous ring (*Lithocircus*) for the Cricoid skeleton of the Acanthodesmida and Zygocystida, and a triradial siliceous framework consisting of three spicules united at one point (*Plagiacantha*) for the Plagiacanthida and Cystida (*l.c.* p. 126, &c.). I then endeavoured to refer these two fundamental forms to a single form, as I made out the combination of the simple siliceous ring and the triradial framework in many Cystida and Spyroida (or Zygocystida). In my "Prodromus" (October, 1881, *l.c.* pp. 423-444) I divided the Nassellaria order into five families, and placed the *Plectida* (with triradial siliceous framework) as the common ancestral group. From it I derived first all the *Cystida*, from these again the *Botryoida* and *Spyrida* (=Zygocystida), and from the latter the *Stephida* (= Cricoidea). At the same time, and quite independently of my researches, Bütschli was busy with the same morphological problem, and arrived at essentially the same conclusion, except that he reversed the phylogenetic series of the forms. In his admirable treatise on the skeletons of the Cystida (also dated October, 1881, published in the *Zeit. f. wissen. Zoologie*, 1882, bd. 36, p. 485) he tries to prove the morphological connection of all Nassellaria (his *Cricoidea*), but regards the *Stephida* (= *Acanthodesmida*) as the primitive ancestral form, not as the last degenerated scion, an opinion which I myself formerly shared (compare Hertwig, 1879, p. 126). Which of these two opinions is correct cannot be determined at present. Important facts favour my present view, that the triradial siliceous framework may be the common ancestral form of all Nassellaria (*Triplagia*, *Plagiacantha*). Again, other important facts favour Bütschli's view that this ancestral form may be the simple siliceous ring (*Lithocircus*, *Monostephus*). Finally, there are good grounds for supporting Hertwig's opinion, that both these ancestral forms (the triradial and the annular) may have arisen independently from the skeletonless Cystidium. I shall discuss this difficult and interesting question at length in my work on the *Challenger* Radiolaria.

IV. The Phæodaria were only known up to 1876 by three types described by me in 1862 (*Aulacantha*, *Aulosphæra*, *Cœlodendrum*). By the discovery of numerous forms in the *Challenger* collection this has since acquired an importance of which we had no previous idea, as those Radiolarians far surpass all others both in size and singularity of form, as well as in peculiar combinations of structure. In my preliminary paper on the Phæodaria, 1879 (*Jena. Naturwissen. Sitzungsb.*, December 12) I distinguished 10 families with 38 genera, a number which has since been increased considerably by the continuous and astonishing discovery of new forms. As in the majority of these the skeleton is composed of hollow, siliceous tubes (differing therefore from that of all other Radiolarians), I termed the whole order *Pansolenia*, 1878 ("Protistenreich," p. 102). This name, however, suits all members of the family as little as the name *Tripylea*, proposed by Hertwig, 1879. On the other hand, the present name *Phæodaria* indicates the common characteristic of the whole order, the peculiar *phæodium*, a voluminous, dark body of pigment, lying excentrically outside the central capsule. The latter is, moreover, universally distinguished by its double membrane and by the peculiar opening furnished with a radiated operculum, which lies at the pole of the axis, and may therefore be termed the principal opening. In addition to it there are usually (though by no means invariably) two small accessory openings, lying one beside the other at the opposite (aboral) pole. Sometimes there are more than two, whilst at other times they are entirely wanting. Despite the extraordinary diversity of the peculiar, and often very complicated siliceous skeleton, all Phæodaria may likewise be derived from a common ancestral form—the skeletonless *Phæodina*.

The further phylogenetic question, whether all the hypothetic primitive forms already mentioned of the four Radiolarian orders can be referred to a single common primitive form, may now in all probability be decided in the affirmative. From *Actissa* the parent form of the Spumellaria, the ancestral form of the three other orders may be derived without difficulty. *Actinilius*, the ancestral form of the Acantharia, may have arisen from *Actissa* by the thickening of part of the radial pseudopodia into acanthine spicules. *Cystidium*, the probable ancestral form of the Nassellaria, may be derived from *Actissa* by the pores of the capsule membrane, originally developed equally and on all sides, becoming restricted to a single distinct porous area. *Phæodina*, the ancestral form of the Phæodaria may have arisen in a similar way from *Actissa* by the porous area becoming replaced by a single, simple opening, or small, additional, accessory openings, still being left, whilst at the same time the capsule membrane became double, and the pigment mass of the phæodium deposited excentrically round it. Whilst, on the one hand, the simplest Spumellaria form, *Actissa*, may be easily accepted as the ancestral form of all Radiolaria, *Actinosphærium* and *Actinophrys* show, on the other hand, how it may be derived from the simplest Rhizopoda.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Technical Schools in connection with the University College, Nottingham, will be formally opened by Sir Frederick Bramwell on the 24th inst.

MR. J. T. DUNN, M.Sc., Demonstrator in Chemistry at the College of Science, Newcastle, and formerly Demonstrator in Physics, has been appointed Science Master and Director of the Chemical Laboratory in the High School for Boys, Gateshead. In the Gateshead High School, which opened in May 1883, there are already about 175 boys, and it is intended that all the boys shall learn Physics and Chemistry at some period of their school course.

SCIENTIFIC SERIALS

Journal of Franklin Institute, vol. cxvi. No. 696, December, 1883.—The cheapest point of cut off, by W. D. Marks. Partially based on, and in criticism of, a previous paper by Mr. Hill.—Experiments upon non conducting coverings for steam pipes, by Prof. J. M. Ordway. In this research calorimeters are used, consisting of sheet-brass vessels so shaped that they can be clamped together outside the steam pipe, inclosing a known length of it and of its covering. Of more than fifty substances tried, simple hair-felt with a cheap cover of burlap proved best; seventeen other compositions owed their efficiency to hair. Asbestos hard pressed was a very bad material; it was non-conductive only in the downy state when full of air.—Pressure attainable by the use of the "Drop Press," by Prof. R. H. Thurston. These presses appear to be very efficient for forging hot iron.—The theory of turbines, by Prof. R. H. Thurston. This is the first part of an abstract of a most valuable mathematical discussion of the subject.—A new valve-motion, by Carl Angstrom. This is a so-called "radial" valve-motion, resembling those of Brown, Marshall, and Joy.—A simple and sensitive thermostat, by Dr. N. A. Randolph, designed for incubation and other experiments in the physiological laboratory. The adjustment is obtained by the more or less closing of the orifice for the gas by the expansion of alcohol causing mercury to rise toward the orifice.

Annalen der Physik und Chemie, xx. No. 12 (*a*), December, 1883.—On the condensation of carbonic acid on smooth surfaces of glass, by Prof. R. Bunsen. The condensation of the gas goes on for years, in spite of continual changes of density and pressure. In three years each square centimetre absorbs, at standard pressure and temperature, 5·135 cubic centimetres of the gas, about two-thirds of this amount being absorbed during the first year.—Density proportions of normal salt solutions, by C. Bender.—The law of rotational dispersion, by E. Lommel.—A simple method of investigating the thermo-, actino-, and piezo-electricity of crystals, by Prof. A. Kundt: consists in applying Lichtenberg's powder.—On the measurement of electric forces by means of the electric mill, by D. Kaempfer.—On the question whether the condensation of steam produces electrification, by S. Kalischer.—On the influence of the hardness of steel on its magnetisability, by V. Strouhal and C. Barus; also, on the influence of annealing on the retentivity of the magnet, by the same authors. These are two very elaborate and important papers, covering the ground of many previous scattered researches. The first gives the curious result that, to obtain the highest possible degree of magnetisation, short magnets should be tempered glass hard, but long magnets should be at the other extreme of softness. The second research gives the result that the most constant magnets are those which, after fairly hard tempering, are annealed for twenty to thirty hours by heating in a steam bath, then magnetised, finally heated in steam for five hours more.—Correction, by A. Guébhard, relative to his electrochemical figures.—Use of the method of "Schlieren" for investigating intrusions in quartz, by A. Kundt.—On absolute measure, by Prof. C. Bohn.

Journal de Physique, t. ii. No. 23, November, 1883.—A. Potier, on the experiments of Wroblewski and Oltzewski on the liquefaction of oxygen, nitrogen, and carbonic oxide.—B. Elie, electrodynamic and magnetic potentials in elasticity.—A. Terquem, description of a new cathetometer of M. Dumoulin Froment. This cathetometer is divided into two parts—a vertical standard scale mounted on three levelling feet, to be set up near the apparatus, and a levelled observing telescope sliding upon another vertical stem to be set up at a distance, this second part of the apparatus being just an ordinary cathetometer without a scale.—Bichat and Blondlot, influence of pressure on the electric difference between a liquid and a metal in contact.—Krouchkoll, on immersion currents and on those due to the movement of a metal in a liquid, and on currents of emersion.—E. H. Hall, abstracts (by M. Leduc) of papers on so-called rotational coefficient.—Aug. Righi, on Hall's phenomenon. Righi finds this phenomenon to be 5000 times as strong in bismuth as in gold. The process by which his film of bismuth, only 0·079 mm. in thickness, was procured is not stated.—H. Roiti, on Hall's phenomenon in liquids.—H. Koch, on magneto-electric rotations.

Bulletins de la Société d'Anthropologie de Paris, tome vi. fasc. 3, Paris, 1883, contain:—A paper by M. Hamy, on the interpretation of an inscription on the Mexican stone tablet in the Museum of the Trocadéro, supposed by him to refer to the foundation, in 1483, of the temple of the great Aztec divinity, Hiutzilopochtli.—On the special frequency in criminals and in the insane of an anomalous medial occipital fossa, by Prof. Lombroso.—On the significance of the interlaced hearts common in the ornamentation of rings, crosses, &c., in use in La Bretagne and La Vendée, by M. Bonnemère, who regards them as of mediæval origin, and connected with marriage, while Madame Clémence Royer showed that they were of modern design, and religious in character, representing the hearts of Jesus and the Virgin, as symbolised in the convents of the Sacré Cœur.—A communication from Madame Clémence Royer, setting forth her claim to be regarded as the first person who pointed out that Lamarck was the true father of the theory of evolution, she having expounded his doctrines in a course of lectures on philosophy given by her in 1859-60.—On the explorations of the Grotto des Cottés in Poiton, by M. de Rochebrune. The finds exhibit fossil bones in great abundance, well-cut flints, and a human skeleton, which has been submitted to M. de Mortillet.—On the Chelléan deposits of Ternifine, in Algiers, by M. le Dr. Tommasini. These contain remains of so-called *Elephas atlanticus*.—On Prof. Putnam's recent explorations of Kjökkenmöddings, mounds, ash-pits, and stone-graves in Maine, Ohio, and Tennessee, by M. de Nadaillac.—On a more correct mode of classifying the colour of the eyes and hair in reference to the determination of ethnic characteristics, by M. Ikow.—On the "Er Fousen," or pit-graves in St. Pierre-Quiberon, in La Bretagne, by M. Gaillard.—On the anthropomrtric determination of the principal races of France, by M. le Dr. Collignon. A detailed and exhaustive treatise, in which the author, after setting apart a distinct group of Frenchmen, considers the rest of the French nation, somewhat arbitrarily, under four heads—Celts, Cimri, "Lorrainians," and so-called "Mediterranéens." Under the latter term he treats of those south-western races of France, whose chief source of origin is the Eastern Pyrenees, and who designate themselves as Catalans.—On the craniometric study of plagiocephalics, by M. le Dr. Manouvrier, bearing on the question af cerebral asymetry as a characteristic of superior brain-capacity.—On anomalous muscles in man, by M. le Dr. Testut.—Note on the various objects of fetish from Upper Ogooe, by M. Delisle. In the discussion to which the communication gave rise, M. de Mortillet maintained the view, to which he has frequently given expression, that in Africa originated the use of iron for industrial purposes, while the African was the only savage who knew how to extract and work the metal. In the iron projectile arms from the Congo M. de Mortillet believes we have analogous weapons to those seen in the hands of the Assyrian kings when represented as engaged in lion-hunting.—On the decrease of the population in France, by M. Lagneau. This decrease was known to amount to seven for every hundred inhabitants in twenty-six Departments, although there were only eight of these in which the deaths exceeded the births.—On the "Questionnaire de Sociologie et d'Ethnographie" of the Society, drawn up by MM. Hay, Hovelacque, and Vinson, and submitted by them to their *confrères*.—On two crania found in the Department de la Drôme, by M. le Dr. Delisle. One of these is dolichocephalic, and similar to the Cro-Magnon type; the other is brachiocephalic.—On the dangers of premature exercise of the higher intellectual faculties and of the physical powers in relation to the present excessive academic requirements and early term of military service in France, by M. Dally.—On M. Testut's elaborate prehistoric chart of La Dordogne, by M. Hamy.—On the practices and superstitions which prevail in Artois and Picardy in connection with bees, by M. E. T. Hamy. Such practices in no way differ from those described in the "Georgics," excepting in as far as concerns the aspersion of the hive with holy water by the modern peasant bee-cultivator. In Artois, as in Berry, when the master of the house dies his hives must be covered with black, and the fact of his decease whispered to the bees to avert their otherwise inevitable death.—On some cephalometric determinations on the living subject in Greece, by M. Apostolides. He consiners that the people of the Peloponnesus have best preserved the dolichocephalic type of the ancient Greeks, as shown in the crania of tombs belonging to the fourth century B.C.—The first part of a paper by M. de Ujfalvy on the "Kafirs-Siapochs," or "Black-robed" tribe of the Hindoo-Koosh.

Archives of the Physical and Natural Sciences, Geneva, Nov. 15, 1883.—Researches on the absorption of the ultra-violet rays by aqueous and vitreous humours, albuminoids, and other substances, by M. J. L. Soret.—On electrolytic condensers, by Dr. C. E. Guillaume.—Sixty-sixth session of the Helvetic Society of Natural Sciences held at Zurich in August, 1883: Report on the Geological Session, president, Prof. Suess of Vienna. Papers were read on the structure of the Alps, by the President, who rejected the theory of upheaval, denying the existence of any natural motive power capable of raising lofty mountain ranges; on the old glaciers of the northern slopes of the Alps, by M. Alph. Favre; on the climateric zones during the Jurassic and Chalk epochs, by Prof. Neumayr of Vienna; on the Kimmeridge formations of the Vaude Alps, by M. Schardt of Montreux; on the fossils of the same geological area, by M. de Loriol; on the physical and chemical changes undergone by rocks subject to glacial pressure, by Prof. Mühlberg of Aarau; on some specimens of spath fluor recently found in the dolomitic limestones of Trolerengraben, Valais, by M. Ed. de Fellenberg; on the hydrographic system of the Jura range in the canton of Neuchâtel, by M. Jaccard; on the mollasse and glacial formations of Upper Suabia, by M. Probst of Essendorff; on the gypsum formations of Vorarlberg, by M. Chavannes; on a sectional profile of the Schlossberg in the Titlis range, showing the geological dispositions of the limestone rocks of the twelfth sheet in Dufour's map, by Dr. C. Moesch of Zurich; on the fauna of the coal and limestone formations in the Permian system of Bohemia, by Dr. A. Fritsch; on an ancient post-Glacial lacustrine basin in the Soleure district, formed by three concentric frontal moraines, slight traces of which still survive in the Aar valley, by M. Alph. Favre; on the earthquake at Ischia, by Prof. Suess.

Nachrichten of the Royal Society of Sciences and of the University of Göttingen, July 30, 1883.—On some historical documents connected with the history of Bavaria during the fourteenth century, by Ludwig Weiland.—Remarks on Jacobi's theory of elliptical functions, with special reference to his logarithm of theta functions (continued), by A. Enneper.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 20, 1883.—"Note on the Constitution of Chlorophyll." By Edward Schunck, F.R.S.

The author having for some time been engaged in examining the derivatives of chlorophyll, the question of the constitution of that body presented itself. Whatever chlorophyll may be from a physiological point of view, for the chemist it is simply an organic colouring matter. The colouring matters occurring naturally in the organs of plants and animals are of several kinds. The greater number belong to the class of so-called glucosides, *i.e.* bodies which by decomposition with acids or ferments yield some kind of glucose or sugar as one of the products. The author was led to suspect that chlorophyll might turn out to be a glucoside, its general properties being such as characterise that class of compounds. To prove this by direct experiment was almost impossible, on account of the difficulty in preparing chlorophyll in a state of purity; but the author describes some experiments made with solutions of chlorophyll, which tend to show that when decomposed with acids it does behave as a glucoside, splitting up into glucose and other bodies, the phyllocyanin and phylloxanthin of Fremy being products that are formed at the same time.

Mathematical Society, January 10.—S. Roberts, F.R.S., vice-president, in the chair.—Messrs. D. Brockelbank and Asutosh Mukhopadhyay were elected members, and Messrs. Fortey and Heppel admitted into the Society.—The Chairman spoke upon the late Mr. C. W. Merrifield's mathematical work and upon his services to the Society, and concluded his remarks by reading the words of a vote of condolence with the family of the deceased which the Council had requested the President to communicate to them.—Mr. A. Buchheim stated an extension of Pascal's theorem to space of three dimensions, and communicated a paper on the theory of screws in elliptic space. His special object was to show that Grassmann's "Ausdehnungslehre" supplies all the necessary materials for a calculus of screws in elliptic space, and that Clifford was apparently led to construct his theory of biquaternions by the want of such a calculus.—Mr. H. Fortey read a paper on contacts and isolations, a problem in permutations.—Mr. Tucker presented a paper by Prof. H. Lamb on the induction of electric currents in cylindrical and spherical conductors, and spoke on a group of circles which are connected with the "triplicate-ratio" circle.

EDINBURGH

Royal Physical Society, December 19, 1883.—Dr. R. H. Traquair, F.R.S., president, in the chair.—The following office-bearers were elected for the year 1883–84, viz. Presidents, Dr. R. H. Traquair, F.R.S., B. N. Peach, F.R.S.E., F.G.S., J. A. Harvie-Brown, F.R.S.E., F.Z.S.; Secretary, Robert Gray, V.P.R.S.E.; Assistant Secretary, John Gibson; Treasurer, Charles Prentice, C.A., F.R.S.E.; Librarian, J. T. Gray, M.A.—The following papers were read, viz.:—Notes on the genus Gyracanthus, by Dr. H. Traquair, F.R.S.—On a specimen of Pecopteris in circinate vernation with remarks on the genera Spiropteris and Rhizomopteris of Schimper, by Robert Kidston, F.G.S.—On a new species of Schutzia from the calciferous sandstones of Scotland, by R. Kidston, F.G.S.—On the structure of Sarcodictyon, by Prof. W. A. Herdman, F.R.S.E.—Notes on the islands of Sula Sgeir or North Barra and North Rona, with a list of the birds inhabiting them, by Mr. John Swinburne. Specimens of eggs from the islands were also exhibited.—Mr. J. A. Harvie Brown, F.Z.S., exhibited, with remarks, a specimen of the Little Gull (*Larus minutus*), shot in the island of North Uist.—Mr. Hoyle exhibited, with remarks, a skeleton of the extinct Moa (*Dinornis didiformis*).—Dr. Traquair exhibited a specimen of the Osprey (*Pandion haliaetus*), shot in Midlothian.—Prof. Arch. Geikie, F.R.S., was elected an honorary Fellow of the Society.

Mathematical Society, January 11.—Mr. Thomas Muir, F.R.S.E., president, in the chair.—Prof. Chrystal delivered an address on surfaces of the second order, in which he advocated strongly the study of the properties of these surfaces from the surfaces themselves. The address was illustrated by a large number of beautiful models in wood, plaster, cardboard, and thread.—Prof. Tait communicated an analytical note, and one or two geometrical problems were discussed.

DUBLIN

Royal Society, December 17, 1883.—Rev Dr. S. Haughton, F.R.S., in the chair.—On the Ringhals or Cape Cobra, by M. G. R. O'Reilly. The author briefly describes some of the habits of this snake (*Sepedon hæmachates*), called "ipimpi" by the Kafirs. He is peculiarly subject to fear, but, when compelled, fights savagely. Raising one-third of his length perpendicularly, and with expanded hood, he advances, dashing his head repeatedly to the ground and hissing furiously. Should he come close enough, he strikes repeatedly, not open-mouthed, but only with the point of the fangs that protrude lightly downwards over the lower lip. But little poison is introduced into the superficial wound produced in this way, and such wounds are not nearly so often fatal as those produced by the puff-adder. There is, however, a time when the Ringhals is much more to be dreaded. When driven to an extremity, he sometimes subsides into a kind of swoon, and lies as if dead with his mouth somewhat gaping, but woe to the man who should curiously venture his finger therein; it would be instantly locked as in a vice, the fangs would be buried in the flesh, and the poison would flow unceasingly. He will not let go, but, like a bulldog, will allow himself to be beaten to death rather than relinquish his hold. When he finds fatigue coming on, he exerts himself to hold the faster, and each new exertion causes the deadly venom to flow more and more. By degrees fatigue overcomes him, and inch by inch, from the tail upwards, his muscles lose their rigidity, till at last after perhaps a quarter of an hour, finding himself unable to hold on any longer, he lets go. Then if again attacked he fights anew, apparently as fresh as ever; but if allowed a little peace he will lie still a few moments, and then calmly glide away to feast again on the frogs in the sedges, or sun himself once more by the heated rocks on the hillside.—On more convenient equivalents for converting British into metrical measures than those hitherto in use, by G. Johnstone Stoney, D.Sc., F.R.S. Capt. Clarke's determination of the length of the British yard in metrical measure, made at Southampton in 1866 for the Ordnance Survey (see *Philosophical Transactions* for 1867), differs by a small amount from that which had previously been made by Capt. Kater, and it is noteworthy that the small difference between these excessively careful determinations is greater than the difference between Capt. Clarke's determination and the very simple equivalent,

The yard = 914·4 millimetres;

so that the outstanding error which will be incurred if this very convenient number is adopted is of an amount which is inappreciable in ordinary good scientific work. It is less than the expansion produced in iron standards of length by one degree of temperature. Again, the pound avoirdupois differs, according to Prof. Miller's determination (which is the most elaborate we possess), from the simple equivalent,

The pound = 453·6 grammes,

by only one-quarter of a grain avoirdupois in a kilogramme. This is about 1/70 of the correction which would have to be made in weighing water in order to reduce its apparent weight to its weight in vacuo, and is of small account even in carefully conducted scientific work. The value of the gallon, which follows from Capt. Clarke's determination of the metre, is 1·000027 times that adopted in Dowling's Metrical Tables, and differs from the simple equivalent,

The gallon = 4544 cubic centimetres,

by an amount which is less than a cubic centimetre in ten litres, an error which is inappreciable; measures of capacity not admitting of being compared so closely as weights and measures of length. Hence we may take as our fundamental units—

The yard = 914·4 millimetres,

with an error of less than a fifth-metret[1] in the metre, on the authority of Capt. Clarke;

The pound = 453·6 grammes,

with an error of one-quarter of a grain avoirdupois in a kilogramme, on the authority of Prof. Miller;

The gallon = 4544 cubic centimetres,

with an error of less than one cubic centimetre in ten litres, on the authority of the best previous determinations corrected by Capt. Clarke's. It is a truly remarkable circumstance that the first of these numbers happens to be divisible by 3^2 and 2^5, the second by 2^2 and 7, and the third by 2^6. Divisors more convenient could hardly have been chosen for dealing with the disorderly way in which British measures are subdivided. They furnish the following tables, which may be safely recommended:—

[1] By metrets are to be understood decimal subdivisions of the metre. The fifth-metret is the fifth of these, or the hundred-thousandth of a metre. It is about the diameter of one of the red disks in human blood.

TABLE I.—*Measures of Length.*

The yard	= 914·4	millimetres.
The foot	= 304·8	,,
The inch	= 25·4	,,

TABLE II.—*Weights.*

The pound	= 453·6	grammes.
The half-pound	= 226·8	,,
The quarter pound	= 113·4	,,
The ounce	= 28·35	,,
The grain	= ·0648	,,

[This last gives the gramme = 15·43210 grains, a number which it is singularly easy to recollect.]

TABLE III.—*Measures of Capacity*

The gallon	= 4544	cubic centimetres.
The quart	= 1136	,,
The pint	= 568	,,
The half pint	= 284	,,
The noggin	= 142	,,
The fluid ounce	= 28·4	,,

If any person using these tables wishes to carry refinement farther, he may do so by subtracting one in every hundred thousand after using Table I., by subtracting one in sixty thousand after using Table II., and by subtracting one in ten thousand after using Table III. These corrections will carry accuracy to the limit of Prof. Miller's and Capt. Clarke's determinations.—R. J. Moss, F.C.S., showed an experiment illustrating the use of Rohrbach's heavy liquid—a solution of baric and mercuric iodides. Minute garnets occurring in Dublin granite were separated from the roughly pulverised rock in a state of purity, and in quantity quite sufficient for an exhaustive analysis.

SYDNEY

Linnean Society of New South Wales, October 31, 1883.—The President, C. S. Wilkinson, F.G.S., in the chair.—The following papers were read:—Occasional notes on plants indigenous in the immediate neighbourhood of Sydney, No. 5, by Edward Haviland.—Notes on the temperature of the body of the *Echidna hystrix*, by N. de Miklouho Maclay. This is a detailed account of some experiments made by the writer at Brisbane in July, 1879. He found, after observations carefully made on two occasions, that the average temperature of the body of the Echidna is 25° C., equal to 78° F., or very little more than that of fish, and about 25° under that of mammals generally.—On the Plagiostomata of the Pacific, part ii., by N. de Miklouho Maclay and William Macleay, F.L.S. The continuation of a paper by the same authors, written some years back, on the genus Heterodontus. The present paper gives descriptions and illustrations of a new species from Japan, named *Heterodontus japonicus*.—Notes on some reptiles from the Herbert River, Queensland, by William Macleay, F.L.S. In this paper, after enumerating all the Reptilia contained in the collection sent to him by Mr. Boyd from the Herbert River, Mr. Macleay describes as new a lizard, *Tiaris boydii*, and three snakes, *Tropidonotus angusticeps*, *Dendrophis bilorealis*, and *Herbertophis plumbeus*, the latter a new genus allied to Coronella.—Notes on some customs of the aboriginal tribes of the Albert District, New South Wales, by C. S. Wilkinson, F.G.S., president. The President read some notes furnished him by Mr. W. H. J. Slee, the Government Inspector of Mines, regarding a singular ceremony which the aboriginal tribes of the Mount Poole district perform, when, as is often the case in that arid region, they need rain. Occasionally pieces of the fibrous variety of gypsum, Satin-spar, are found by the natives, who highly value them and call them "rain-stones," for they believe that the Great Spirit uses them in producing rain. The President exhibited one of the "rain-stones" which had been secured by Mr. Slee, who witnessed the ceremony when performed two years ago by the Mount Poole and Mokley tribes.—On the brain of Grey's whale (*Kogia greyi*), by William A. Haswell, M.A.—On a new genus of fishes from Port Jackson, by Wm. Macleay, F.L.S. This paper consists of the description of a large fish taken a few days ago in a seine net at Watson's Bay. It is of the family *Cirrhitidæ*, and somewhat allied to the genus *Chilodactylus*. The generic name given to it is *Psilocranium*, from its naked head, and the specific name *Coxii*, in honour of the President of the Commissioners for Fisheries of New South Wales. This fish was exhibited by Mr. Morton, Assistant Curator, Australian Museum.

Royal Society of New South Wales, October 3, 1883.—Hon. Prof. Smith, C.M.G., president, in the chair.—Two new members were elected and thirty-five donations received.—A paper by H. Ling Roth, F.M.S., on the roots of the sugar-cane, was read.—Mr. H. C. Russell exhibited a modification of Faure's bichromate battery.—Mr. Russell exhibited several new photographs of the sun taken by him at the Sydney Observatory.

November 7, 1883.—H. C. Russell, F.R.A.S., in the chair.—One new member was elected and eighty-eight donations received.—A paper, on irrigation in Upper India, was read by H. G. McKinney, M.E.—Prof. Liversidge exhibited portions of a fossil crocodile from the Flinders River in Queensland, and other fossils.

November 14, 1883.—Hon. Prof. Smith, C.M.G., president, in the chair.—An adjourned meeting was held, and a paper, by Mr. A. Pepys Wood, on tanks and wells of New South Wales water supply and irrigation, was communicated by Mr. Warren, C.E.

PARIS

Academy of Sciences, January 7.—M. Rolland, president, in the chair.—M. Bouley was elected vice-president, and MM. H. Milne Edwards and Becquerel added to the Central Committee of Management for the year 1884.—The President reported on the papers, memoirs, and documents of all kinds issued by the Academy and received from various sources during the year 1883. The changes that took place amongst the members and correspondents during the same year were announced.—Report on the hydrographic explorations of the *Romanche* in Tierra del Fuego, by M. F. Martial. The work accomplished comprised three distinct parts—(1) the regular triangulation of a portion of Beagle Passage and of several islands, besides twenty plans of various roadsteads; (2) the survey of the north-western branch and about half of the south-western branch of Beagle Passage and the Ildefonsus Islands; (3) exploration of the north-west extremity of Talbot Passage, of the west side of the archipelago from Cook Bay to Black Head Cape, and of the various channels connecting Brecknock Passage with Whaleboat and Darwin Sounds.—Report on the climate of Cape Horn, by M. J. Lephay. Appended to the report are various meteorological tables showing the temperature, barometric pressure, atmospheric currents, direction and velocity of the winds observed at the station of Orange Bay from September 26, 1882, to August 31, 1883.—On the spectrum of the Pons-Brooks comet, by M. Ch. Trépied.—Spectroscopic observations made at Nice on the Pons-Brooks comet, by M. Thollon.—Observations at Marseilles on the same comet (one illustration), by M. E. L. Trouvelot.—On certain doubly periodical functions of the second species, by M. E. Goursat.—On the application of Vandermonde's notation to the representation of hypergeometrical polynomes in a condensed form, by M. Radau.—Calculus of the contact arc of a flexible, spiral, metallic rod, according to any given conditions, on a circular cylinder, by M. H. Léauté.—Note on the action exercised on polarised light by the cellulose solutions in the Schweizer reagent, by M. A. Levallois.—On the compound heat of the soluble fluorides and the law of substituted thermic constants, by M. D. Tommasi.—Some new sulphuretted salts derived from the trisulphuret of phoshorus, by M.G. Lemoine.—On the law of free surfaces in vegetable anatomy, by M. C. Eg. Bertrand.—On the modifications presented by the muscles after severance of the nerves communicating with them, by M. J. Babinski.—On progressive atrophic myopathy (hereditary myopathy beginning in infancy with the muscles of the face, without change in the nervous system), by MM. L. Landouzy and J. Dejerine.—Researches on some recent pretended infallible specifics against hydrophobia (second note), by M. P. Gibier. Garlic and pilocarpine (active principles of jaborandi), tested on rats and cats, were found to be powerless to prevent the development of rabies.—Note accompanying the photographs of natural size of two children delivered by the operation of paratomy in cases of extra-uterine pregnancy by M. Championnière, of the Tenon Hospital, by M. Just Lucas Championnière.—Observations on the remarkable sunsets and dawns observed at Campan during the month of December, 1883, by M. Soucaze. No solution of the phenomenon is offered; but to the volcanic theory it is objected that the effects should be permanent if due to the permanent presence of minute igneous particles in the atmosphere.

BERLIN

Physical Society, December 14, 1883.—Prof. Börnstein described an apparatus for measuring the momentum of the wind, constructed and set up by him in the High School of Agricultnre. Hitherto, as is well known, in order to compute the momentnm of the wind, people had either registered its velocity by means of the Robinson anemometrical scale, or its pressure by means of the so-called pressure table. The cross-cup instrument laboured, however, nnder this disadvantage, that it was incapable of following a rapid change of the wind's velocity, being neither able, under an increase of velocity, to pass at once to the duly accelerated pace, nor in the case of an abrupt abatement of the wind's speed, to fall back, till after a considerable time, to the commensurately slower rate. The pressure-table, again, was attended with this disadvantage, that on each occasion it had to be placed in the direction of the wind, and in the case of a relief of pressure, performed oscillations of its own, which registered themselves on the writing apparatus. Prof. Börnstein's instrument consisted essentially of a ball, 126 mm. diameter, affixed to a vertical descending rod, which by an axle-system, at four-fifths of its length, was rendered freely movable on all sides. To the lower end of the rod was fastened a long wire, likewise movable on all sides, and snspended inside a tube 4 metres long. At a still greater distance was placed a quadrilateral vertical prism, movable between rollers, so that each lateral movement of the ball became converted into an up and down movement of the prism. To the prism there hung a frame with a pencil, which marked in curves on a passing strip of paper the movements produced by the pressnre of the wind on the ball. At the lower end, again, there was fixed a horizontal plate, by way of a damper. Several of the curves described by this measurer of wind-pressnre were shown by Prof. Börnstein, among others that of December 4, a day distinguished by a very low minimnm (730 mm.), which passed over Europe from west to east. The observer perceives in this curve a very great rise of the wind's momentum during the day, then at about seven to nine in the evening he sees the curve descend almost to the line of zero, remounting thence in the later hours of the night to its maximum. This showed that the centre of the barometric minimum had passed exactly over Berlin, two periods of intense wind-momentum being separated by a lull of considerable duration.—Dr. König added some supplementary notes to the address recently delivered by him before the Society, setting forth the results of his investigations into the state of the colour-blind (see NATURE, vol. xxix. p. 168). Among other things he read a passage in Goethe's "Theory of Colours," showing that Goethe had already examined a colour-blind person, regarding whom he was of opinion that he was blue-blind, or *akyanoblept*. From Goethe's statements, however, it was plain that the individnal in question was red-blind, and it would accordingly appear that this was the first real observation of a case of colour-blindness.

Physiological Society, December 21, 1883.—Prof. Fritsch gave a demonstration of the model of a brain, prepared according to the directions of Prof. Aeby in Znrich, and acquired by the Physiological Institute. By means of differently coloured wires and of coloured balls of different sizes, it shows the situation of the cerebral ganglia, and the course of the nerve-fibres in connection with them. The nerve-cords and the ganglia pertaining to them are withont exception of the same colour. The connections between the spine and the separate sections of the cerebrum and cerebellnm, the cerebral cavities and fissures, come out very clearly in the skilfully fashioned model.—Dr. Falk spoke of the transference from mother to fœtus of corpuscular and chemical poisons, and brought prominently to notice the different results yielded by observations on man and experiments made on animals with a view to obtaining knowledge on this subject. Infectious diseases, such as small-pox, syphilis, &c., were conveyed from the mother. Other diseases, such as inflammation of the spleen, were not so conveyed. With respect to chemical poisons, the case was likewise various. The statements of different authors respecting the oxide of carbon did not agree. Dr. Falk had quite recently had occasion to dissect a woman who died from the poison of oxide of carbon. Her body displayed all the symptoms characterising this form of death, showing in a singularly perfect manner the bright colour of the skin, of the muscles, and of the blood. The dead fœtus of the deceased woman, which was of eight months' growth, had, on the other hand, normally coloured muscles and dark blood, in which neither chemical reagents nor spectral analysis discovered a trace of the oxide of carbon. A case having, however, been elsewhere observed of the passage of the oxide of carbon into the blood of a fœtus six months old, Dr. Falk conjectured that the age of the embryo, more particularly the greater or less thickness of the partition dividing the mother's system of blood-vessels from that of the child, formed a considerable item in the account. This point he would study by experiments on the osmosis of gases.—Dr. Blaschko communicated the results of his investigations into the structure and embryological development of the outer skin in the palm of the hand of man and apes. On the under side of the epidermis he not only found protuberances corresponding with the regular furrows visible on the surface, but, answering to the prominences of the surface, were also found protuberances on the under side connected with the former by transverse swellings. The study of the histological development of the outer skin further taught Dr. Blaschko that the epidermis, with its protnberances and depressions, was first fully formed before the cutis came into shape, attaching itself to the epidermis.—Dr. Salomon has endeavoured to fill a gap which was yet perceptible in our knowledge of the urine of domestic mammalia. In particular there existed but four analyses of the urine of the pig, which, as an omnivorous animal, stood specially near to man, and of these four, three were of earlier date than 1845. These four analyses, moreover, all concurred in denying that the urine of swine contained any uric acid, a circumstance very remarkable in face of the fact of the universal diffusion of this substance among all the other higher animals that had yet been examined. Its place was supposed to be supplied in the pig by guanine. As the result of his examinations, Dr. Salomon found that in all cases the urine of swine contained uric acid, and that in no inconsiderable qnantities. The proportion of uric acid in the urine was, in swine, as 1 to 150; in man, 1 to 50. Guanine, on the other hand, could not be indisputably proved to be present in the urine of swine; but a crystalline substance, very closely related to guanine, and showing similar reactions, was fonnd; lactic acid, the presence of which in swine had been maintained, could not be discovered, although succinic acid, which comes near to it, was found. Creatine and creatinine, as also other xanthine substances, were likewise searched for in the nrine of swine.—In connection with this subject, Dr. A. Baginski stated that in the urine of a diptheritic child suffering from nephritis he had found a substance very nearly related to guanine, as also xanthine, both in perfectly perceptible quantities. Both these substances, however, decreased in quantity with the abatement of the disease.

CONTENTS

THURSDAY, JANUARY 24, 1884

THE ALPS OF NEW ZEALAND

The High Alps of New Zealand; or, A Trip to the Glaciers of the Antipodes, with an Ascent of Mount Cook. By William Spotswood Green. (Macmillan, 1883.)

THE laborious explorations of Dr. Julius von Haast and his associates, undertaken in 1862 and subsequent years, had, as their results, an excellent sketch map of the New Zealand Alps, and a general knowledge of their topography and geology. It was also made evident that, although the summits did not attain the elevation of many in the Swiss Alps, yet, as they were steep and precipitous, as they rose from valleys comparatively low, and as the snow line descended far below its ordinary level in the Northern Alps, there would be considerable difficulty in scaling the higher peaks. No real attempt on these was made till the year 1881, when Mr. Green decided to try his hand at mountaineering in New Zealand.

It was of course necessary for any one contemplating glacier excursions to take guides from Europe. Mr. Green was fortunate enough to secure the services of Emil Boss and Ulrich Kaufmann, both well known guides from Grindelwald. His narrative shows that he could not have made a better choice—the two men proved to be not only first rate mountaineers, but also pleasant and trustworthy companions, always uncomplaining and unselfish.

Mr. Green must have begun his journey under an unlucky star. Small-pox broke out on board among the forecastle passengers before they reached Table Bay. On arriving in Australia, all were put in quarantine for some three weeks, where, we may add, the arrangements for the reception of the unfortunates appear to have been disgracefully bad. Then, when Mr. Green escaped from this bondage just in time to catch the New Zealand steamer, it happened to be full, so that altogether more than a month of valuable time was lost.

At last, after touching at one or two spots on the western coast of the Southern Island, Mr. Green landed at Christchurch, and, after a brief consultation with Dr. von Haast, hastened to push up the country towards Mount Cook. The physical structure of the Southern Island is comparatively simple. A map of it bears some resemblance, except for the smallness of the scale, and the greater height of the mountains, both relative and absolute, to the southern part of the Scandinavian peninsula. The watershed—that of the Southern Alps—lies comparatively near to the western coast, and runs roughly parallel with it; between these is a mountain land, pierced with beautiful fjords, especially towards the south, and covered with dense and generally impenetrable forest; on the eastern side, between the main range and the sea, is a comparatively level district; a zone of lakes borders the mountain region, similar to that on the southern flank of the European Alps; and the lowlands extend far into the recesses of the peaks. The Tasman valley, for example, which runs up to the glacier of the same name in the very heart of the chain beneath the peak of Mount Cook, is described by Mr. Green as an immense flat, from which the mountains rise as from a shore. The end of the glacier being 2400 feet above the sea, the average fall of the river is about 25 feet to a mile. Mount Cook, which attains an elevation of 12,349 feet above the sea, is the culminating point of the Southern Alps, but there are several fine peaks near it which are not very much lower. A grand group of glaciers descends from these, of the beauty of which Mr. Green speaks in enthusiastic terms.

The mountains of New Zealand are of great interest to the student of physical geography. The latitude of Mount Cook corresponds with that of Florence in the northern hemisphere, but the mean annual temperature of the Southern Island is 10° lower than that of corresponding latitudes in Western Europe. There is, however, much less difference between the extremes. For instance, the mean summer temperature of Dunedin (lat. 45° 50′) is 57°·2, the mean winter 50°·7 F. The rainfall on the eastern coast is much the same as on the English lowlands, being 33 inches at Dunedin and 25 inches at Christchurch; but on the western coast, at Hokitaka, it is 118 inches. Thus the snowfall on the mountains is heavy, and the line of permanent snow is full three thousand feet lower than on the Alps. Hence the glaciers descend far below the level of those in Switzerland, coming down on the western side at one place to within 670 feet of the sea-level, while on the eastern they terminate at about 2000 feet; on this side, however, the limit of perpetual snow is about 750 feet lower than on the western. On the whole the area covered permanently by ice and snow in the Southern Alps is about 160 square miles, or 20 more than that in the Bernese Oberland. The Great Tasman Glacier is eighteen miles long, thus exceeding the Great Aletsch by three miles; further it is two miles wide at the end, while the other does not exceed a mile in any part.

The Southern Alps present another very singular feature. To the south of Mount Cook the chain is severed by a singular flat-topped pass—named after Dr. von Haast—the ill-marked summit of which is only about 1600 feet above the sea; yet to the south of it again the mountains rise rapidly, and attain elevations of full ten thousand feet. Thus a depression of a couple of thousand feet would convert the Southern Island of New Zealand into two mountainous islands, divided by a narrow channel, just as the Raftsund parts Hindö and Vaagö in the Lofotens.

The Alps of New Zealand are more ancient than those of Europe, as they were probably uplifted in Jurassic times. The oldest rocks—granites (or possibly in part granitoid gneisses) appear on the western side; these are overlain by crystalline schists, to which succeed slates, grits, &c., of Silurian and later ages. Probably when this district is fully surveyed the New Zealand Alps will be found to consist of a series of Archæan rocks overlain by sedimentary deposits of considerably later date. The highest rock on Mount Cook appears to be a quartzite, and Mr. Green mentions the occurrence, lower down the mountain, of some volcanic tuffs.

For Mr. Green's adventures during the ascent of Mount Cook we must refer readers to his volume. Suffice it to say that this proved to be no easy task. The difficulties were twofold: those of conveying the necessary supplies of food and covering to a sufficiently elevated bivouac, and those presented by the mountain itself. The former of course will be overcome as the country is opened up, but it is evident that Mount Cook is equal in difficulty to most of the first class Alpine peaks. Mr. Green first attacked it by the southern ridge, but, after reaching a height of 7500 feet, found that route impracticable. An attempt was then made to reach the north-eastern face of the mountain by a route which also had to be abandoned. Mr. Green then mounted by a ridge on the left bank of the Hochstetter Glacier, and, after bivouacking at a height of about 7000 feet, succeeded in attaining the summit by a circuitous and difficult climb near the ridge connecting Mount Cook with Mount Tasman. His usual ill-fortune pursued him. The weather was bad, as it seems often to be in these parts—and the approach of night compelled him to return without actually setting his foot on the very highest point. The ascent however was practically accomplished, only a slight detour to avoid a crevasse and a little more plodding along a snow ridge remained; but even the quarter of an hour or twenty minutes which this would have added to the expedition could not be spared. The summit of Mount Cook is not the place on which to spend a night in bad weather, nor is it a peak which can be descended in the dark. As it was, notwithstanding their utmost exertions, the travellers were compelled to halt for the night at an elevation of some 10,000 feet above the sea, on a ledge so dangerous that they dared not sleep —even one at a time!

Mr. Green afterwards visited the neighbourhood of Mount Earnslaw, a high peak south of Haast Pass, but his usual ill-fortune pursued him, and the weather prevented him from doing more than make a reconnaissance.

We lay down this volume with regret that the Fates were not kinder to Mr. Green in giving him the opportunity of writing a longer tale of adventure. He tells his story so well and pleasantly that we regret he could not carry further his explorations of New Zealand peaks and glaciers. He is evidently a close observer and devoted student of nature, so that without any attempt at book-making he has contrived to incorporate with his narrative many interesting facts relating to the natural history and physiography of these remarkable islands, which raises his work far above the level of an ordinary book of travel.

T. G. BONNEY

DOBSON'S "MONOGRAPH OF THE INSECTIVORA"

A Monograph of the Insectivora, Systematic and Anatomical. By G. E. Dobson, M.A., F.R.S. Parts I. and II. 4to. Pp. 1-172, 22 Plates. (London: Van Voorst, 1882-83.)

THE Insectivora constitute an order of Mammals at the same time but little known and of great scientific interest. Until recently they were not considered an attractive group. Small in size, shy and retiring in habits, difficult of capture, none of them of commercial value or capable of domestication, they have received little notice even from professed zoologists, and to the general public their existence, except in the case of two or three of the commonest species, has been almost unknown. The fact, however, on which Prof. Huxley insisted many years ago, in his lectures at the College of Surgeons, that in this order we find some of the most generalised members of the Eutherian or placental Mammals, little-modified representatives of what appear to be ancestral forms, whose study is an excellent introduction to a knowledge of the more modified or specialised members of the class, has done much to elevate them in the eyes of naturalists who are seeking the key to unlock the history of the evolution of the Mammalia. Mr Dobson, whose excellent work in the Chiroptera is familiar to all zoologists, has done well then to take up the Insectivora, and to give us, for the first time, a thoroughly reliable and exhaustive monograph upon them.

Aided by wisely-bestowed grants from the Government Fund administered by a committee of the Royal Society, and with the assistance of numerous scientific friends, he has been enabled to collect abundant materials, and publish the results of his investigations in a copiously illustrated form. To facilitate comparison and avoid repetition, Mr. Dobson commences with a detailed account of the anatomy, paying especial attention to the myology, of two species, *Gymnura rafflesi* and *Erinaceus europæus*, which have been selected, the former as the nearest representative of an undifferentiated Eutherian, and the latter as being a well-known species, easily obtainable for examination. With these the anatomy of the species subsequently described is compared and contrasted. With regard to the general classification of the group, a knowledge of which can of course only be obtained from a thorough examination of their structure, Mr. Dobson has wisely reserved his views until the work is completed, adopting provisionally that which has been gradually elaborated by Peters, Mivart, and Gill.

The two first parts of the work already issued contain the families *Erinaceidæ*, *Centetidæ*, *Solenodontidæ*, *Potamogalidæ*, *Chrysochloridæ*, and *Talpidæ*, each family, genus, and species being treated of fully, both anatomically and zoologically. The difficult group *Soricidæ*, as well as the *Macroscelidæ*, *Tupaiidæ*, and the aberrant *Galeopithecidæ*, will form the subject of the third and concluding part. If this part should be, as we have every reason to believe it will, equal to its predecessors in thoroughness of detail and beauty of illustration, we shall have a work which will do great credit to its author, and rank among those solid contributions to knowledge which form landmarks in the progress of science.

W. H. FLOWER

OUR BOOK SHELF

Manual of Mathematical Tables. By the Rev. J. A. Galbraith and the Rev. S. Haughton, F.R.S. (London: Cassell, Petter, and Galpin.)

"Now what so pleasing can there be, if a man be mathematically given, as to calculate or peruse, Napier's logarithms, or those tables of artificial sines and tangents, not long since set out by mine old collegiate, good friend, and late fellow-student of Christchurch in Oxford, Mr. Edmund Gunter, which will perform that by addition and subtraction only which heretofore Regiomontanus's tables did by multiplication and division?" We shall not take up the cudgels against quaint old Burton, but will simply say that, for those to whom the subject is a "pleasing" one, here is an exceedingly handy and neatly got up manual, whose *raison d'être* is justified by its having reached a fourth edition. If our readers are "philosophers," they will not require an account of what logarithms are (see Mr. Glaisher's excellent description in the "Encyclopædia Britannica," vol. xiv.); if they are not, with Mr. Squeers we say, "Then I am sorry for you, for I sha'n't be able to explain them."

The tables, are in the main, five-figure tables, except that the logarithms of 1001 to 1100 are given to seven places, and in the case of the logarithms of numbers extend to the logarithm of 10000. The other tables are logarithms of sines and tangents to every minute of the quadrant, and Gauss's sum and difference logarithms. Besides, there are a capital introduction, tables of useful constants with their logarithms, and solutions, by trigonometrical tables, of quadratic and cubic ($x^3 \pm px \pm q = 0$) equations. There are no tables of natural sines and tangents. We have no hesitation in commending these tables to a still wider public than they have already reached. R. T.

Principles of Theoretical Chemistry. By Ira Remsen. (Philadelphia: H. C. Lea's Son and Co., 1883.)

UNFORTUNATELY for some years past we have been treated with an immense number of "books" on chemistry in England of a most mechanical type: books in which no reasoning theory is apparent. A dry epitome of facts in a most unpalatable shape, embellished here and there with formulæ of various kinds, graphic, symbolic, empiric, or glyptic, but in very rare cases any attempt at showing the learner, easily, how these ideas of chemical constitution, represented by formulæ, are clearly arrived at. If a student is unable to see, in his mind, how the formula H_2SO_4 represents *a* knowledge of the constitution of sulphuric acid, he had much better only know its percentage composition, as it may otherwise lead him wrongly.

From the style of the present work, and some others we have recently seen from the other side, our cousins are taking up chemistry in a more philosophic manner than ourselves. And it is easy to see whence this view comes. Considering that we own a Dalton it is strange that the development of chemical theories is so lightly treated in English text-books. Are English students so superficial or so under the domination of *Exams.* that a work like Kopp's "Entwickelung" is too much for them?

This very condensed little work, just over 200 pages, is intended for somewhat advanced students who have a basement of facts to build upon. It commences with a general discussion of atoms and molecules, which is continued in a very simple and clear manner, with the exception of a few *newish* words like *chemism.* The chapters on atoms and molecules and on valency are about as clear and simple as they can be made, and the same may be said in regard to the opening chapter on carbon compounds. The author has evidently a reasonable notion of the value and permanence of a chemical theory, and no exception can be taken to the manner of discussion or expression. Speaking, for instance, of Avogadro's hypothesis, the author says: "It is at present almost universally accepted by chemists, some, indeed, going so far as to speak of it as a *law.*" It is certainly one of the best additions to the list of *small* chemical books that has been made for some time.

Studies in Micrographic Petrography. (Ady and Hensoldt, 7, Muchell Road, Nunhead, S.E.)

THE growing interest taken in this country in the study of petrography is well shown by the rapidly increasing facilities offered for the prosecution of this branch of science. The most recent of these has just appeared under the foregoing title. It is to consist of the issue of two dozen microscopic slides of characteristic minerals and rocks prepared by Mr. Hensoldt of Wetzlar, with illustrative drawings and descriptive text by Mr. J. E. Ady, who is already favourably known for his microscopic preparations of British rocks. The first number of the "Studies" is devoted to "*Eozoon*, Led Beg, Sutherland." It contains two lithographic plates illustrative of the so-called eozoonal structure of a limestone in the north of Scotland, and four pages of descriptive text. The author gives a brief reference to the literature of the subject, and an account of the microscopic structure of some portions of the limestone in question, which he regards as akin to that of the Canadian *Eozoon*, but as being of inorganic origin. We are afraid his sketch is too slight to have much weight in the controversy regarding *Eozoon*. His effort to extend the opportunities of petrographical investigation, however, and to popularise this fascinating but difficult branch of geology is praiseworthy, and we hope that his "Studies" may meet with such success as may induce him to continue them.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Remarkable Sunsets

THE numbers of NATURE for October, which are the latest to be seen here at this date, contain in the correspondence accounts of the green appearance of the sun in India. Some solar phenomena observable at present and during the whole of the past month are probably related to these, and yet are sufficiently distinct to deserve a separate description. They have, indeed, attracted the attention of everybody here by their novelty and spectacular magnificence, and to some have an ominous significance in connection with recent seismic disturbances.

In November and December we have in this part of Japan a remarkably clear atmosphere, and this year has proved no exception. The great snow-capped mountain, Fujii, some ninety miles away to the west, is beautifully defined to view both at sunrise and sunset on most days, although during the greater part of the year—the warmer part that is—it is rare to catch a glimpse of it.

The phenomena of which I wish to record a description occur every day before and after sunset and sunrise, and serve to materially lengthen our day. In this latitude, although not in the tropics, the shortness of the twilight is very noticeable as compared with that of England, but at present at least an hour and a half elapses between the moment of sunset and that of the disappearance of the last of its rays, and this, with the same time between dawn and sunrise, causes our day to be very appreciably lengthened.

On some days there is round the sun, even while it is still high, a considerable area of silvery glare, 40° to 50° in diameter, and bordered by a lurid reddish-brown or purplish-brown halo. A similar lurid turbidity lies in the horizon, and as the sun descends the halo blends with this below, while above the sun it attenuates and disappears, the silvery glare remaining undiminished. When the sun sets there is still a nearly circular area of this intense glare with a diameter of about 12°. On other days there is before sunset only a thin silvery light round the sun diffusing away from it, and only about and after the setting is the more defined area of strong light strikingly visible, and on these days the horizon also shows little of the dull redness mentioned above. Besides the above peculiarities, the sun preserves its whiteness much more than usual, so as to be only golden orange when setting.

Now follow the more remarkable phenomena. The white glare, or patch of silvery light, gradually sets, spreading out along the horizon as it does so, and passing through the sunset colours until little more than a red line one or two degrees deep remains. This happens at about twenty minutes after sunset. At this moment, on the gray curtain of twilight appears a white luminosity, which rapidly intensifies over the sunset, and shades away over almost half the visible hemisphere. The brightness over the sunset becomes vividly brilliant, and at the same time delicately coloured. Over a somewhat depressed circular area, about 12° high and 15° broad, it assumes a pale green tint. Above this comes an equally dazzling pale yellow-orange, and again above this a soft rose colour melts away to the zenith. The revival of the light, or return from commencing twilight, is peculiarly striking. Buildings become brilliantly illuminated, and strong shadows are cast. All this outglow occurs in no more than five minutes, and now continues for about a quarter of an hour, but the brilliancy gradually contracts in area and sets with a magnificent display of sunset colours reaching some 120° round the horizon, until, by fifty minutes after sunset, this light has also gone down to a red line of about 2° elevation. I should not have omitted to say that the green light passes to yellow.

By this time night has fairly well come in the eastern half of the heavens, but already another but more delicate silvery whitening begins to show itself on the western curtain, and this also diffuses very rapidly up to the zenith and round to north and south. It also then goes through a process of contracting, intensifying to considerable brightness, and gradually passing through the sunset colours. Night is now full—with or without moonlight, according to date—and from the west, or rather from a point well to the north of it, spreads a delicate but brilliant light, having an almost perfect resemblance to the burning of a vast distant city. The last crimson light of this reflection does not disappear till an hour and a half after sunset.

The phenomena I have attempted to describe cannot possibly, I think, be explained otherwise than as being the effects of reflection, and that from a canopy many miles above the earth's surface. The matter of this canopy is highly transparent, for not only are moon and stars brilliantly clear, but in the crescent moon the dark surface of its sphere was on some nights in both months visible and so distinct as to have been noticed independently by several persons. (It has been suggested that this greater visibility of the dark surface of the moon may be due to a stronger reflection from the present atmosphere of the earth.) The reflecting matter must, I suppose be water, but in what form and under what conditions it is there so high up day after day in varying weather, it is difficult to me to conceive. We have had wet days intervening, cloudy days, and very windy days, but on all occasions, except during rain, the phenomena have been visible with strange uniformity.

Not counting the setting of the silvery glare twenty minutes after sunset, which ought perhaps to be done, there are, it will be seen, two reflected sunsets following the true one. In the morning before sunrise the same phenomena in inverse order are perhaps still more remarkable to see. Indeed the whole phenomena, night and morning, have a most unnatural and magical appearance, very different from those of the ordinary sunset and sunrise.

One other phenomenon, also of reflection, has yet to be mentioned. Rarely with much distinctness, but always to be noticed, there appears high up in the *east*, just after the silvery glare following the sun has set, and lasting only a few minutes, a dim image of the white glare and the western horizon just after sunset. It is of a delicate rosy light, with a grayish central part.

I am informed that somewhat similar appearances are being seen in Shanghai. EDWARD DIVERS

Imperial Japanese College of Engineering, Tokio,
December 12, 1883

IF the red sunsets are to be attributed to smoke and dust in the atmosphere from volcanic eruptions, as seems likely from the contributions in the last number of NATURE at hand (December 20), then it becomes important to take into account other eruptions which may have happened simultaneously with or since that of Krakatoa on August 27, 1883. In any discussion of atmospheric currents as fixing the dates of the appearance of these sunset phenomena at different places this is of special importance, in order that no confusion may arise in trying to reconcile places and dates that may refer to dust and ashes brought from entirely distinct eruptions. For this reason I send you the following extracts.

The first is from the U.S. Signal Service *Monthly Weather Review* for October, 1883, and is as follows :—

"*Unalaska, Alaska, October* 22, 1883

"*Executive Officer, Signal Service, U.S.A., Washington, D.C.*

"SIR,—I forward by this mail a sample bottle of sand that fell during the storm of October 20, 1883.

"At 2.30 p.m. the air became suddenly darkened like night, and soon after a shower of mixed sand and water fell for about ten minutes, covering the ground with a thin layer. The windows were so covered that it was impossible to see through them.

"This sand is supposed to have come either from the Menkushin or the new volcano adjacent to Bogoslov. The former is at a distance of about nineteen miles south-west, but for years has only issued forth smoke or steam. The latter is a new one, which made its appearance this summer, and burst out from the bottom of Behring Sea. It has been exceedingly active, as it has already formed an island from 800 to 1200 feet high.

"According to the report of Capt. Anderson, the discoverer, who sails one of the company's vessels, and who went within 2000 yards of it, it presents a most magnificent sight. The fire, smoke, and lava are coming out at many crevices, even under the water line. Large boulders are shot high in the air, which, striking the water, send forth steam and a hissing sound.

"Bogoslov is about sixty miles from here, in a westerly direction. The new volcano is about one-eighth of a mile north-west of it. "I am, Sir, very respectfully,

"S. APPLEGATE,
"Sergt. Sig. Corps, U.S.A."

The other extract is from a recent paper as follows :—

"*San Francisco, Cal., December* 28, 1883

"Prof. Davidson received from Alaska to-day the particulars of the volcanic disturbances there in October last, near the entrance to Cook's Inlet. On the morning of October 6 a settlement of fishermen on English Bay heard a heavy report, and, looking in the direction from whence the sound came, immense volumes of smoke and flame were seen to burst forth from the summit of Mount Augustine. The sky became obscured, and a few hours later great quantities of pumice dust began to fall, some of it being fine and smooth, and some gritty. At half-past three o'clock on the same day an earthquake wave thirty feet high came rushing in over the hamlet, sweeping away all the boats and deluging the houses. The tide at the time being low saved the settlement from utter destruction. This wave was followed by two other waves eighteen feet high, which were succeeded at irregular intervals by others. The pumice ashes fell to a depth of five inches, making the day so dark that lamps had to be lit. At night the surrounding country was illuminated by flames from the crater. Ordinarily Mount Augustine is covered with snow, but this year it is completely bare. Upon examination after the disturbances had subsided, it was found that the mountain had been split in two from base to summit, and that the northern slope had fallen to the level of the surrounding cliffs. Simultaneously with the eruption, a new island made its appearance in the passage between Chernabonra Island and the mainland. It was seventy-five feet high, and a mile and a half long. So violent was the volcanic action that two extinct volcanoes of the Peninsula of Alaska, lying to the westward of the active volcano Iliamua, 12,000 feet high, burst into activity, and emitted immense quantities of smoke and dust. Flames were visible at night. It is stated that the wives of a party of Aleut Indians, who were engaged in otter-hunting in that locality, became afraid of the subterranean noises, and refused to stay, returning to their homes. None of those who remained can be found."

The approximate positions of some of the points mentioned in these reports are as follows :—

	Lat.		Long.
Iliamua...	60·1 N.	...	153·1 W.
Mount Augustine...	59·5 N.	...	153·5 W.
Unalaska	53·9 N.	...	166·5 W.
Bogoslov	54·0 N.	...	168·0 W.

Here we have the record of (1) a new volcano which appeared near Bogoslov some time during the summer, and had been continuously active and thrown up an island 1000 feet high up to some time in October ; (2) an explosive eruption of Mount Augustine on October 6, which split off the whole side of the volcano and distributed ashes to a depth of five inches many miles away, and started a wave in the ocean about thirty feet high ; and (3) of a shower of sand and water on October 20 at Unalaska, which probably arose from some fresh or renewed eruption of a neighbouring volcano.

Many of these phenomena resemble those reported from Krakatoa, though on a smaller scale. It is not necessary to point out that a continuous eruption of a new volcano for weeks or months would probably eject as much or more dust and ashes than accompanied the Krakatoa convulsion, though not to so great a height. If, however, Mr. Preece's theory of electric repulsion of the dust particles be true, then the finest of them, if highly electrified, might rise to great heights, independent of the force of ejectment from the volcano.

In this connection it is well to remember that there may have been many other volcanic outbursts during the last few months, of which we have not yet heard, and perhaps never may. The whole chain of islands from Java to Alaska, including the Philippines and Japan, is full of volcanoes, and seems to be a sensitive seam in the earth's crust. A convulsion like that of Krakatoa is likely to be accompanied or followed by others along this line, the northern portion of which is only visited by otter-hunters.

Without presuming to question the theory as to the rapid transmission of Krakatoa dust by the upper currents of the atmosphere until we see the evidence on which it rests, it occurred to me that the above considerations might possibly modify or supplement it in some degree.

Referring to the remarkable results deduced by General Strachey, showing an atmospheric wave travelling three times round the globe from the Krakatoa eruption, which seems to be of even more scientific interest from a physical point of view than the transmission of the dust and ashes, and which deserves a thorough and careful re-examination when the data are in from all available barometric records, I would say that I have been kindly allowed to examine the barometric records of the Signal Office here at Washington, and I find no trace of any such disturbance following the reported Alaskan eruptions of October 6 and October 20. In connection with the record of the waves following the Krakatoa catastrophe there are some interesting points which I wish to examine more carefully before discussing them. H. M. PAUL

Washington, January 8

REFERRING to Mr. Burder's letter in NATURE of January 10 (p. 251), is it so certain that, if there be no resisting medium in interplanetary space, the whole of the earth's atmosphere must "rotate with the earth as if it were part and parcel of it"? Take a stratum of the atmosphere at, say, forty-five miles in altitude at the equator. According to the received theory, this ought of course to move with a velocity greater than that of the surface of the earth immediately below. But each successive inferior stratum moves with less velocity. And thus they must tend to retard the superior strata with which they may be assumed to be in contact. Of course the merging of stratum into stratum is gradual, but this does not affect the amount of friction and retardation.

In like manner, imagine a section of the atmosphere taken along the equator. Sections taken along successive parallels of declination north and south would tend to retard the velocity of this central layer.

These two causes combined might have a considerable effect in retarding the velocity of the upper atmosphere in equatorial regions. And it seems to me doubtful whether the upper atmosphere near the poles would be actually carried round with each terrestrial rotation. The rarity of the upper regions of the atmosphere and the lessened force of gravity would both help towards the result indicated, inasmuch as they would tend to make the atmosphere less rigid.

As I am writing, I venture to make another suggestion. Gilbert White mentions that in the summer of 1783, when, as at present, the atmosphere was filled with dust consequent on volcanic eruptions, and "a peculiar haze or smoky fog prevailed for many weeks in this island and in every part of Europe, and even beyond its limits," "all the time the heat was so intense that butchers' meat could hardly be eaten the day after it was killed, and the flies swarmed so in the lanes and hedges that they rendered the horses half frantic, and riding irksome." May not the present May-like weather be due to a like cause? Sweet violets, primroses, wallflowers, roses, and several other flowers are now blooming in my garden under the Cleveland Hills.

Had the halos round the moon seen here last and the previous night any possible connection with the dust in the atmosphere? I computed the diameter of the inner dirty white to be twice, the dirty orange one and three-quarters, and the outer green three and a quarter times the moon's apparent diameter.

JOHN HAWELL

Ingleby Greenhow Vicarage, Yorks, January 15

I THINK a few notes relating to the recent sunsets may still have an interest for some readers of NATURE. Notwithstanding the length of time these remarkable phenomena have been apparent, the sunsets of January 11 and 12 were as brilliant as regards the *second* after-glow as any that have preceded them, the final glow having lasted on the 12th till 5.55; while the sun set that evening at 4.12.

The pink halo so often seen of late could not be discerned that day though the sky was cloudless; but it has been often visible when clouds partly obscured the sun, or portions of the sky, and could then be recognised between them, separating the blue of the remoter sky from the whitish light surrounding the sun, as a ring-formed glow of a strong pink colour.

These broad pink halos have been less commented on than the splendid sunsets which have invariably succeeded them, but they have been nearly as persistent in their presence. You have had so many accounts of the succession of colours and effects of the two after-glows, that I will not allude further to them here; but as I have retained a record of many remarkable sunsets and sunrises which I observed in Wales in former days (possibly the very same mentioned by Prof. Piazzi Smyth in NATURE, December 13, 1883, p. 149, as observed by him thirty years ago), and as I carefully noted in them the time and hour of the changes in the sky down to that of the complete extinction of the after light, it may interest others than myself to compare displays of that date with those of this winter.

What is worthy of especial interest is the great difference between the periods of prolongation then and now of the illumination of the western sky, showing that the second after-glow of recent sunsets is a phenomenon distinct from and additional to those belonging to normal sunsets.

The following table exhibits the two series of observations made in 1855, 1856, 1857, and in 1883–84 respectively:—

Date	Sunset at	First after-glow or cone of pink light: Appears as sunset colours are fading	First after-glow: Brightest at	First after-glow: Sets, 1st series, 1855-56-57	First after-glow: Sets, 2nd series, 1883-84	Second after-glow in 1883-84, which begins as the first after-glow sets
Nov. 11, 1856 ...	4.13	4.50	4.57	5.10		
,, 12, ,, ...	4.14					
,, 23, 1855 ...	...	...	...	4.55		
Dec. 7, ,, ...	3.50	...	...	4.20		
,, 8, ,, ...	...	...	...	4.20		
,, 10, ,, ...	...	...	...	4.20		
,, 11, 1883 ...	...	...	...	...	about 4.45	5.45
,, 14, ,, ...	...	...	...	...	...	5.45
,, 15, 1856 ...	...	4.15	4.21	4.35		
,, 18, ,, ...	...	...	4.20	4.30		
,, 19, ,, ...	3.50	...	...	4.30		
,, 24, 1883 ...	3.53	...	...	...	about 5.0	5.45
Jan. 11, 1884 ...	4.13	...	...	...	,, 5.0	5.40
,, 12, ,, ...	...	...	...	...	,, 5.0	5.55
,, 15, 1857 ...	...	...	...	4.55		
,, 16, ,, ...	...	4.50	5.10	5.0		
,, 19, ,, ...	...	...	5.20	5.18		
,, 26, ,, ...	...	...		5.25		
Feb. 8, ,, ...	5	...	...	...		

The colours associated with the actual sunset are quite in accord in both.

The first after-glow, or pink cone or dome of light appearing after the sunset colours have nearly faded, is also similar in both series, but its time of setting has been apparently somewhat prolonged in the recent observations.

It is the 1883-84 series alone, however, that shows the *second* after-glow, and the duration of this strange phenomenon, which I have the advantage of observing over a wide bird's-eye view in North Wiltshire, has extended on evenings when it could be well observed to about one hour after the first after-glow had disappeared below the horizon. The exact moment of this disappearance has been more difficult to determine than in the earlier observations where darkness followed; as recently the heavens and the earth have been reilluminated just as the natural night would have begun. T. STORY-MASKELYNE

Salthrop, January 13

As the "halo" exactly opposite the sun, reported by Mr. T. W. Backhouse in NATURE, January 10 (p. 251) may prove to be of considerable importance, I beg to add my observations of it on the 12th. I had noticed a mass of ruddy colour under the given conditions, previously, but had not detected its strange nature. The sunset on the 11th was very fine. The 12th, until after sunset, was cloudless, except for the hazy masses which seem to precede every sunrise, and, more especially, sunset, at present. Our sunshine record is an unbroken scorch from 9.15 a.m. to 2.52 p.m. (sun seen clear of horizon at 8.26, and touched at 4.0); I doubt if, previously, we have recorded even five hours in early January. At 7.45 a.m. on the 12th (sun rose at 8.22) the cloud-glow had turned to silvery green below, and rose from 15° to 30° in the south east. At 7.47 the rose reached 60°, but was fainter. I first noticed the "halo" at 7.52. It was then so well defined that, calling a lady's attention by asking what she saw there, she spoke of it as "a broad rainbow." Position, by compass, 30° north of west. It was a semicircle situated 10° above the horizon, standing on the dark gray arch of dawn, Jupiter being on a line with the base of the left end of the rosy arch. The inner arc of this measured 10°, and the outer 24° in radius, but it spread out to 30° at the base. The centre was of the same blue as the sky to the right and left of the rosy semicircle, above the gray. The base, sinking faster than Jupiter, spread out so that, at 8 o'clock, the arch having now broken above, its outline was rather like a railway chair. The base now reached from west-north-west to north-north-west by north. After sunset there were signs of a similar phenomenon, but clouds prevented certainty.

Is not *fifty* miles an underestimate for the altitudes of the light-reflecting material? If Mr. Symons is nearer the mark in his suggestion (100 to 200 miles), then more than half of the eastward velocity of the original erupted dust is accounted for by retardation, due to matter having velocity belonging to an earth radius of 4000 miles, revolving in a circle of 4100 to 4200 miles radius. Would it need an eruptive force of more than two to four miles per second (six to twelve times greater than a cannon ball) to attain such altitudes? The constant uprush would minimise the air-resistance enormously.

York, January 14 J. EDMUND CLARK

P.S.—January 15.—This morning, at 7.47, the "halo" began to form, but was not nearly as perfect as on the 12th. The arch (upper part only) was *rayed*, as if it were the opposite point of sight for rays from the sun. All over before 8, or fully twenty minutes before sunrise.—J. E. C.

WITH reference to Herr Wetterhan's inquiry as to the absence of the sky-glow in a clear sky at other places than Freiburg on the morning of January 11, I find that at San Remo, in Northern Italy, where I spent the week ending on that day, a similar falling off of effect occurred at the same time. The sunrise was "very fine, but nothing to compare with the sunset of yesterday," and "the filmy streaks were very thin, and stretched this morning from south-west by south to north-east by north." Nevertheless there was the strange bluish-white glare above the eastern horizon, casting shadows, and a thin pink film up to about 75° at 28 min. before sunrise. The sunset glow of this day and of the day before was magnificent, the procession of colours beginning about 15 min. after sunset, and lasting a full hour. I see that your Constantinople correspondent also mentions the sunset of the 11th as a remarkably fine one. The air on the 10th, not the 11th, as at Freiburg, was wonderfully transparent at San Remo, the whole range of Corsican mountains, over eighty miles distant, standing out sharply for 15 min. before and after sunrise, and the sun himself bursting forth in great splendour from below the sea line.

London, January 19 F. A. R. RUSSELL

Unconscious Bias in Walking

SOME ten or twelve years ago I made some experiments upon the subject of Mr. Larden's letter in NATURE (Jan. 17, p. 262), namely, unconscious bias in walking. The experiments were not numerous, but they left no doubt in my mind as to the cause of divergence from a straight path. My notes were sent, at my father's suggestion, to the late Mr. Douglas Spalding, who was about to undertake experiments on the curious power which animals have of finding their way. I rather think he made some trials with pigs, but I believe he never published anything on the subject. In stating my results I am compelled therefore to rely on memory only.

I began with walking myself, and getting various friends to walk, with eyes shut in a grass field. We all walked with amazing crookedness in paths which were not far removed from circles. I myself and Mr. Galton on the first trial described circles of not more than fifty yards in diameter, although we thought we were going straight, and afterwards I was generally unable to impose a sufficiently strong conscious bias in one direction to annul the unconscious bias in the other. I believe we all diverged to the right excepting one of us who was strongly left-handed.

I then got eight village schoolboys, from ten to twelve years of age, and offered a shilling to the boy who should walk straightest blindfold. Before the contest, however, I dusted some sawdust on the ground, and after making each of the boys walk over it, measured their strides from right to left and left to right. They were also made to hop, and the foot on which they hopped was noted; they were then made to jump over a stick, and the foot from which they sprang was entered; lastly, they were instructed to throw a stone, and the hand with which they threw was noted. Each of these tests was applied twice over.

I think they were all right-handed in throwing a stone, but I believe that two of them exhibited some mark of being partly left-handed. The six who were totally right-handed strode longer from left to right than from right to left, hopped on the left leg, and rose in jumping from that leg. One boy pursued the opposite course, and the last walked irregularly, but with no average difference between his strides. When told to hop, he hopped on one leg, and in the repetition on the other, and I could not clearly make up my mind which leg he used most in jumping. When I took them into the field, I made the boys successively take a good look at a stick at about forty yards distance, and then blindfolded them, and started them to walk, guiding them straight for the first three or four paces. The result was that the left-legged boys all diverged to the right, the right-legged boys diverged to the left, and the one who would not reveal himself won the prize. The trial was repeated a second time with closely similar results, although the prize-winner did not walk nearly so straight on a second trial.

I also measured the strides of myself and of some of my friends, and found the same connection between divergence and comparative length of stride. My own step from left to right is about a quarter of an inch longer than from right to left, and I am strongly right-handed.

Comment on these experiments seems needless, and they entirely confirm Mr. Larden in his view.

It seems to be generally held that right-leggedness is commoner than the reverse; this I maintain to be incorrect. I believe that nine out of ten strongly right-handed persons are left-legged. Every active effort with the right hand is almost necessarily accompanied by an effort with the left leg, and a right-handed man is almost compelled to use his left leg more than the other. I believe that Sir Charles Bell considered that men were generally right-legged, and sought to derive the custom of mounting a horse from the left side from the fact that the right leg is stronger than the other. I suggest as almost certain that we mount on that side because the long sword is necessarily worn on the left, and would get between our legs if we went to the off-side of the horse. Some of your readers may perhaps be able to tell us whether the Chinese do not wear their short swords on the right and mount their horses from the right.

I will not hazard a conjecture as to why the rule of the road in Great Britain, and inside of the towns of Florence and of Salzburg (?), is different from that adopted by the rest of the world. For an armed horseman the English rule is, I presume, more advantageous, both for attack and defence.

January 20 G. H. DARWIN

THE question whether a man will walk to the right or left in a mist, in darkness, or if blindfolded, has led to no little controversy and dispute. Almost every conceivable reason has had its advocates for the fact that some men persistently turn to the left, and others to the right, when walking without the aid of sight. I am familiar with some ambidextrous men, and about the same number of left-handed men, but I cannot recall a single instance of a left-legged man, and think they must be somewhat rare. In the present question it might, perhaps, be well to put aside peculiarities of the arms—as occupation and education enter very largely into the method of their use—and confine observations to the legs alone. Mr. Larden has, I think, very nearly arrived at the solution of the problem with his definition of right or left strong-legged men circling to the right or left respectively. I take exception, however, to his referring the peculiarity to the *strength* of the limb, and think the following suggestion may afford help in the matter, being founded upon observations, and providing a reason for circling in walking in either right- or left-legged men:—It has been frequently remarked of late years that short-leggedness on one side or the other is of common occurrence—the cause is doubtless attributable to a retardation in the growth of the limb caused by one or more of the many illnesses to which we are subject in the earlier years of our life. Excepting when the retardation in the growth of the limb is considerable, it produces no inconvenience, and the possessor of a limb shorter than its fellow by some tenths of an inch may never be aware of the deficiency. To apply this fact to the question (it is another matter why the left leg is more frequently the short one), Mr. Larden's strong leg should correspond to my long leg. The long leg makes a longer step in proportion to the difference in its length over its fellow. If the right be the longer leg, as is oftener the case, the walker will circle to the left, and *vice versâ*. In my experiments I fixed a drawing-pin into the sole of each boot, selected a hard, level, untrodden piece of sand on the seashore, about 250 yards in length, and used a measuring-tape which would take ten or twenty paces in one measurement for obtaining the difference in length of the paces; the drawing-pins afford a definite and precise mark in the sand. To insure a good and regular start I always allowed my man a few yards start with his eyes open and fixed on the distant mark. He then, without stopping, put over his head and face a cardboard cylinder open at the top. This allows the eyes to be open, whilst effectually preventing any lateral vision. I think this, small detail as it is, important, as a bandage tied round the head across the eyes is sometimes unpleasant and often confusing.

97, Adelaide Road THOS. HAWKSLEY

Diffusion of Scientific Memoirs

PROF. TAIT's letter in your issue of December 27 (p. 196) raises two questions of interest to the Cambridge Philosophical Society. Prof. Tait states that during the last thirty years he has received very few of the publications of the Society. I cannot find from the records of the Society that Prof. Tait has ever expressed the wish to have the publications sent to him. The Cambridge Philosophical Society, like the Royal Society of London, the Royal Astronomical Society, and, I believe, other scientific societies, sends its publications to all Fellows who claim them within a reasonable time from the date of issue. Any Fellow requesting that *all publications* may in the future be sent to him receives them as they appear. The second point is the free distribution of copies. I find that at the present date the *Transactions* or *Proceedings* of the Society, or both, are sent either gratis or in exchange for other publications to the following number of centres:—

Home		Foreign	
London	16	Germany	22
Rest of England	16	France	9
Scotland	8	United States	12
Ireland	6	British Colonies	8
		Other foreign countries ...	23
Total	46	Total	74

Honorary Fellows... ... ... about 40
Total number distributed ... ... ,, 160

Of this 160 about 40 have been added since the year 1869.

In Edinburgh at present there are three centres receiving the publications of the Society. I doubt very greatly if there are many societies which do as much as the Cambridge Philosophical Society towards spreading their publications.

R. T. GLAZEBROOK,
Secretary Cambridge Philosophical Society

Cambridge, January 19

Recent Low Temperatures in America

ON or about December 19 some very low temperatures are reported to have been registered in Manitoba. At Emerson, in lat. 49°, a cold of 46° below zero, and in Dakota (United States) $-49°$ are recorded.

I do not presume to say that these temperatures are incorrectly given, but they must be received with some distrust, arising from possible, I may almost say probable, defect in the thermometers used.

These sources of error are two, and by no means uncommon. First, the construction of the instrument may be defective. Second, it is not unusual during the heat of summer for a portion of the spirit to become vaporised, and afterwards condensed in the upper end of the tube. If the spirit is colourless, and if the detached fluid extends down to the metal band which keeps the tube in its place, the error, which may amount to 8° or more, is not readily noticed, unless specially looked for. I had several examples of this error in thermometers used by me in Canada, and one not long ago at the house of an English gentleman, who had perfect faith in the correctness of his thermometer.

Of the errors arising from defective construction there were two notable examples among some twenty thermometers which were tested by freezing mercury at Great Bear Lake in the winter of 1848-49. Eighteen of these thermometers agreed very closely with each other, indicating $-36°\cdot5$, or about 2° too high. Two others, beautifully finished, and made by a London maker of high repute, showed at the same time, and under similar circumstances, 57° below zero, or about 19° of error.

JOHN RAE

Meteors—Unpublished Notes of November 30, &c.

ON November 30, at 8.27 p.m., a large meteor passed from Dubhe, in the Plough, through the lower part of Auriga, exploding in sparkling reddish light; and at 9 another described nearly the same line, but without explosion. The latter left a very vivid bluish light in its path, which lasted about ten seconds. At 10.55 a very large meteor dropped right down from Psi Ursæ Majoris, and disappeared in a black cloud a few degrees above the horizon. At 11.10 one sped rapidly from Beta Ursæ Minoris through between Epsilon and Zeta (Mizar) Ursæ Majoris, and exploded in very brilliant white light. At 11.20 one proceeded from a point about 1° below Benetnasch, and disappeared in the right shoulder of Hercules without explosion. At 11.25 one blazed out from a point 2° above Etanin, and disappeared near Beta Cygni. At 11.30 a large and brilliant but a transient meteor went from Omicron Ursæ Majoris, and disappeared in the tail of the Dragon. At 11.35 one dashed out from a point about 1° above Pi Ursæ Majoris, and I thought that it would go through Merak, but just before it reached Merak it curved suddenly from it and exploded. About 12 a number of small ones were seen. December 1—Meteors seen at 0·13 a.m., 0.18, 1.12, 1.23, 1.45, 3.30, 3.40, 4, 4.23, 4.40, 4.55, 5.7, 5.10, 5.18. December 4—At 2.15 a.m., 2.20, 2.25, 2.28; and a number of meteors were observed between 5 and 6 p.m. December 5—A goodly number of meteors seen from 1 a.m. to 6, and from 8 p.m. to 10. December 6—1.12 a.m., 1.15, 1.22, 2.10, 2.30, 3.40, 5.21, 5.25. December 7—Three meteors seen. December 8, 9, 10, and 12—Only a few meteors were observed here; and from the unfavourable state of the weather, not a meteor could I manage to see since. I have ascertained the paths of all the above meteors, but to give them all would encroach too much on your space. I will supply particulars if required. On November 30 and December 1 last there was a brilliant display of meteors. A few Leonids, Leo Minorids, Taurids, and Geminids were seen. Six Andromedes made their appearance from December 4 to 8. On December 8 a beautiful bolide rushed through the clouds from south-west to south-east, at 6 p.m. Not a star in that part of the heavens could be seen at the time, but the moon shone dimly a little to the left of it. The point at which it appeared was a few degrees higher than the moon, and it disappeared a few degrees above the earth. It blazed in and out three different times on its way through the black clouds, and a little before the end of its journey it swelled out into a huge magnificent ball of red fire, and by its explosion it illumined the western heavens and earth with its bright crimson light. A few of the spectators were alarmed at the unusual apparition. No intonation. Left in its wake a red belt of fire. The light of most of the meteors was blue, or the colour of electric light. A number of the meteors curved suddenly round just before disappearing. Numbers of meteors were seen dropping into black clouds, others seen dropping out of them down to the horizon.

Mossvale, Paisley, January 14 DONALD CAMERON

BRITISH APHIDES[1]

ENTOMOLOGISTS are fond of attaching themselves to some special group of insects—bees, beetles, or butterflies; but there are very few, we believe, who take an interest in collecting the winged or wingless forms of the Aphides. One is very apt to overlook the value of the work of a mere collector, but it comes home to us when amid a group so large, and so important from an economic point of view, as this of the plant lice is, we find only some half a dozen of our British naturalists collecting specimens of the species or making observations on the marvellously strange habits of their heterogeneous forms. Under these circumstances it was most fortunate that a society like the Ray Society was in existence, for the number of those interested in the subject of the history of British Aphides would have been too miserably small to have justified any publisher, no matter how energetic, from publishing an account of these insects; but, thanks to the Ray Society, we have, as the works published by them for their subscribers for the years 1875, 1877, 1880, and 1883, four handsome octavo volumes by Mr. G. Bowdler Buckton, F.R.S., which seem well entitled to their designation of a "Monograph of the British Aphides." These volumes, besides the text, contain over 140 plates, of which ten are devoted to anatomical details, and the rest to coloured portraits of the species both in their immature and various mature forms, and in some few instances there are representations of the various parasites which feed on them. It is to be specially noted that these figures are both drawn and lithographed by the author, and certainly a more interesting series of life-like figures of Aphides is nowhere to be found.

While it seems true that the Aphides are not general favourites of the collector, it is also true that no group of insects has attracted more attention. For nearly a century and a half the mysteries of their growth and development have been laboriously inquired into, and the researches of Réaumur and Charles Bonnet in the eighteenth, and those of Huxley in this our nineteeth century, have not exhausted all the marvels of these strange forms. Their history makes them in many ways attractive. Thus, to those interested in the details of embryology, these Aphides present questions for solution of the greatest importance, and concerning which there is still no absolutely settled opinion. Even the brilliant investigations as to this branch of the subject by Huxley still left work to be done. To the general naturalist they present a source for abundant study—not only their varied and often strange forms, but their curious habitations and the defences which they seem to have against hosts of different insect foes; while to the practical economist they have an immense interest when he thinks that by their success in the struggle for life they cause distress to human nations, often bringing about decrease in the amount of our food material and an increase in the amount of our taxation. To name the Hop Fly or the Vine Aphis is to at once illustrate our meaning.

It is not our intention to write a criticism on Mr. Buckton's learned monograph; it pleases us better to introduce it to our readers as a scientific work full of many easily read and wonderful histories of our native species of plant lice—one that the reader will not lay down in a hurry when he once takes it up; one in which, open where he will, he shall find something in it to interest and attract him. In order that we may in some measure prove this we will give a brief sketch of the chief subject-matter of these volumes. Passing over the disquisition as to the origin and meaning of the word "aphis," we have a general history of the group; included under this heading we find a sketch of their anatomy, an account of the most noteworthy contributions to their history by the early writers, and a sketch of what is known as to their metamorphoses and their very strange reproduction. This is followed by the classificatory portion, in which full diagnoses are given of the genera and species.

Mr. Buckton would account for the want of activity in our entomologists in their study of this group by the confusion into which the group has fallen with reference to its synonomy. One species of Aphis possesses no less than thirty synonyms, while in another case the same name has been given to no less than six different species of the group. There is this further difficulty in their study, that the distinctive characters are far less marked than in most other insects. As to colour, not only are the young sometimes in this respect quite unlike their parents, but their hues vary with the hour, and even the adult forms may undergo as great a change in their tints as the autumn leaves amongst which they nestle.

The family itself belongs to the order of the Hemiptera and to the sub-order Homoptera, where it is located between the families Coccidæ and Psyllidæ. Among the anatomical peculiarities it may be noted that the winged forms are provided with no less than three different kinds of eyes—ocelli, compound eyes, and supplementary eyes. The larvæ of some have eyes; in others the eyes are quite rudimentary; while in some subterranean forms they are absent. Though all the winged forms have ocelli, yet their nocturnal habits are not marked. All the Aphides are suctorial in their habits; as the source of their food varies so does the structure of the mouth parts, especially the rostrum and setæ. In *Stomaphis quercis*, feeding in the alburnum of the oak, the rostrum is nearly twice the length of the insect, and the setæ are much longer; and in the genera Lachnus and Schizoneura, in the young forms, the rostrum projects beyond the end of the abdomen, and is carried as if it were the tail of the insect; while in the young of *Chermes laricis* the long and delicate setæ are coiled into a spiral, which would seem to act as a kind of spring cable by which the insect moors itself so to its feeding ground that it is not easily dislodged by the rough winds of early spring as they play among the larch branches. The punctures are not made by the rostrum, which seems only to act as a sheath, but by the setæ, which can be seen to lance open a number of the parenchymatous cells, and so cause a plentiful flow of cell-contents.

On the question as to the function of the cornicles, the author does not agree with Kaltenbach that they are organs connected with the respiratory apparatus, but rather regards them as the external terminations of excretory ducts. As to honey-dew, the remarks of Kirby and Spence, ascribing it to a secretion of Aphides, is accepted as true by almost all who have written on the subject—including the author—though others, among whom may be mentioned Liebig, Sir J. Hooker (1873), Boussingault (1872), still combat this view.

The chapter on the bibliography begins by alluding to the work of the celebrated anatomist and philosophical lens grinder, Leuwenhoek, in 1690, glances at that of Réaumur (1737), Charles Bonnet (1779), De Geer (1778); the more modern writings of Schrank, Hausmann, Burmeister, Harting, Kaltenbach, Kyber, Morren, Leuckart, von Siebold, Ratzeburg, and Koch among the Germans; Passerini among the Italians; Signoret, Balbiani and Claparède among the French writers; Newport, F. Walker, Haliday, and Huxley among the English writers on the subject.

Aphides are to be found almost everywhere throughout Britain. Some are hardy enough to thrive on the stony

[1] "Monograph of the British Aphides." By George Bowdler Buckton, F.R.S., &c. Four volumes; being the volumes issued by the Ray Society of London to their subscribers for the years 1875, 1877, 1880 and 1883.

heaths of Scotland and Northumberland, whilst others will live almost in the reach of the spray on the sea-shore; terrestrial and aquatic plants are alike subject to their attacks. Some feed on succulent herbs, others on hard timber trees; others again on the roots of flowering plants. Sometimes the white water lily (*Nymphæa alba*) is almost destroyed by the myriads of *Rhopalosiphum nymphææ* which crowd on its leaves and flowers. While certain trees and shrubs appear to be attacked exclusively by their own peculiar Aphis, other trees give nourishment indiscriminately to numerous species. Thus the oak is attacked by at least six, the willow and birch by eight, and the conifers by the same number. Some families of plants are free or almost free from them, such as the Gentian and Irid families. But one species of the large group of the ferns is as yet known to be attacked by them; indeed the cryptogams are as a general rule very free from Aphides; but we have known a species of Marsilea to swarm with them.

The migration of the Aphides is still involved in some mystery, and we seem to have as yet no certain knowledge of the winter habitats of numerous species which seem to occur only during a few weeks of midsummer, such as *Siphonophora millefolii*, which may be found from July to September, and then entirely eludes our notice for the rest of the year.

The peculiar habits of the species opens an immensely interesting subject: some are almost sedentary, others are fairly active; some form receptacles which strangely mimic fruits; some if disturbed drop to the ground, others run to the opposite side of a leaf or twig; some throw up their hind legs when alarmed, which action gives a signal to the rest of the colony, which responds by going through the same performance; some assimilate their colours to their food plants, so as to be difficult to perceive. An interesting phenomenon in connection with these insects is their dimorphism. Thus the early spring form of *Chermes laricis* is different from that of all her progeny till the last, and the same is the case with *Aphis mali*. These variations often relate to size and colour, but often also to considerable change in form and modification of parts. The most extraordinary instance occurs in *Chaitophorus aceris*, "the early spring forms of which occasionally are so diverse that they have been described as belonging to not only different genera but even to distinct families. Thus Mr. Thornton, the original discoverer of this strange insect, gives it the name of *Phyllophorus testudinatus;* afterwards Mr. L. Clark called it *Chelymorpha testudo*, placing it between the Aphididæ and the Coccidæ." But a nearly equally striking example occurs in the dreaded *Phylloxera vitis*, which has two entirely different habits of life and form. In one it is active and winged; in the other it is apterous and subterranean.

We would have liked more ample information as to the geographical distribution of the group. We read that "it is confined to the more temperate regions of the globe," and "that as we approach the tropics it appears to give way to such forms as Coccus." Over the whole continent of Europe they are spread, and across Europe into the Amur district of China. They abound in North America; seem not to be indigenous in New Zealand, though in this country, according to Prof. Hutton, imported species were often very destructive to the crops; and nothing is said as to their occurrence in Australia or the Cape of Good Hope district.

Mr. Buckton divides the family into four sub-families: Aphidinæ, Schizoneurinæ, Pemphaginæ, and Chermesinæ.

Volume i. is taken up with an account of the first half-dozen genera of the first sub-family, and is illustrated with three plates of anatomical details, and forty-two coloured plates of species. Among the more familiar species whose life-histories are given are the Rose Aphis (*Siphonophora rosæ*), the Wheat Aphis (*S. granaria*), the destructive Hop Fly (*Phorodon humuli*), the Cherry Aphis (*Myzus cerasi*), and the Peach Aphis (*M. persicæ*), this last one of the most beautifully coloured of our native species.

Volume ii., with forty-eight plates, concludes the descriptive details of the genera and species of the sub-family Aphidinæ with seven-jointed antennæ, including the type-genus Aphis. Full details are given of that troublesome insect *Rhopalosiphum dianthe*, the *Aphis vastator* of Smee, which feeds on almost every cultivated plant, often swarming on the potato, turnips, pinks, not to mention hyacinths, tulips, and oleanders, but which the author agrees has nothing to do with the production of either the potato disease or clubbing in crucifers. Forty-five species of the genus Aphis are enumerated, and a very useful analytical table of these is appended. No less than seven synonyms are quoted to *A. rumicis*, Lin., which commits such destruction often on the bean and turnip crop, and which is not very particular as to its food plants. Seven species of the genus Chaitophorus are described, and a full account is given of the very extraordinary dimorphism existing in *C. aceris*. In this volume we have accounts of the aphidivorous Hemerobiidæ and Hymenoptera.

Volume iii., with twenty-seven plates, contains the description of the forms of the sub-family Aphidinæ with six-jointed antennæ, of the sub-family Schizoneurinæ, and of some of the forms of the sub-family Pemphiginæ. Among the more familiar species we have here the Aphis (*Pterocallis tiliæ*) which abounds on the lime tree, and so bedews it with its sweet secretion; the Beech Aphis (*Phyllaphis fagi*), so well known as often covering the leaves of the beech tree with its white cottony or rather waxy fluff; the Sallow Aphis (*Lachnus viminalis*), which sometimes swarms on our willows. The "Amerieań blight" (*Schizoneura lanigera*) on our apple trees is an introduced species, apparently from America. It appears that they descend into the soil in winter and attack the roots of the apple trees. *S. lanuginosa* is the aphis which produces the wonderful fig-like galls on the elm tree. These galls are about the size of small green figs, with a small opening at their summits; they contain thousands of the plant lice. In 1866 Mr. McLachlan, travelling in the south of France, gathered a number of these galls, which were in extreme profusion—elm trees twenty feet high being one mass of galls—with the intention of bringing them home; but they made such an awful mess from the viscid liquid in the galls, that he was compelled at last to throw them away. *Pemphigus lactucarius* is the species found living in little earth cavities in the vicinity of the roots of various plants. If a stump of lettuce be pulled up in spring, these "downy flocks" will be very often detected.

The last volume, with twenty-four plates, concludes the account of the species of Pemphiginæ, and gives descriptions of those of the sub-families Chermesinæ and Rhizobiinæ. Mr. Buckton agrees with Passerini, and retains Chermes among the Aphididæ. The Greek verse on the title-page of this volume having caught our eye, we are reminded how little the families treated of in it are the subjects of parasitism; the reason why seems obscure: with these forms the big and little fleas seem to lie down together, not causing each the other any alarm. The Fir Aphis (*Chermes abietis*) is the maker of the curious cone-like galls of the spruce, and a closely related species is often very destructive to larch plantations. Of the genus Phylloxera two native species are described, and a full account of the Vine Aphis (*P. vitis*) now introduced into our hothouses is also given. In this account we have a very interesting and important communication from that eminent entomologist, Jules Lichtenstein, in which he gives a summary of his views on the metamorphoses of the plant lice. This volume has appended to it chapters on Aphides in their economical relations to ants; on the reproduction of Aphides; on the biology and morphology of Aphides; on the antiquity of the Hemiptera, and particularly with regard to the Aphidinæ as represented in the sedimentary rocks and in amber; diagnoses of the Aphides found in amber are given, with figures; and we have also an account of those known to occur in a fossil state in America. Directions for the mounting and preservation of Aphides are given, and we find a very complete bibliography of authors who have treated about Aphides, and a very excellent general index.

In conclusion it only remains for us to congratulate the author on the very successful accomplishment of this important work, which is certain to excite an interest in this marvellous group of insects, and the Ray Society on being the medium of publishing the most beautifully illustrated work on the Aphides that has as yet appeared.

EARTHQUAKES AND BUILDINGS

A COMPLETE discussion of the effects which earthquakes produce upon buildings would form a treatise as useful as it would be interesting. Not only would it involve a discussion of the practical lessons to be derived from the actual effects of earthquakes, but it would include deductions based on our present knowledge of the nature of earthquake motion. Such knowledge is obtained from the records of seismographs.

In the following few notes I intentionally overlook this latter portion of the subject, and confine myself to a few of the more important practical conclusions respecting the effect of earthquakes on buildings, which may be of value to those whose mission it is to erect buildings in earthquake countries.

With regard to the situation of a building, it is sometimes observed that after an earthquake it is the portion of a town situated on low ground which has principally suffered, whilst adjoining portions on hills may have practically withstood the disturbance. In 1855 this was the rule governing the distribution of ruin in Tokio. The reverse, however, has been the rule in Yokohama. Speaking generally on this point it may be said that there is no universal rule,—each small area in an earthquake region having its special rule. As a site for a building, theory seems to indicate that soft earth or marshy ground, which would absorb much of the momentum communicated to it, and therefore act as a buffer between a building and a shock approaching through other strata, would prove a safe foundation. This seems also to have been an old opinion, for we read that the temple of Diana was built on the edge of a marsh to ward off the effects of earthquakes, but experience has repeatedly shown us, as in the case of Tokio and Manila, that swamp-like ground, as an earthquake palliative, has but little effect. On the other hand, hard rocky strata, where the amplitude of motion is small, but the period quick as compared with the motion in the inelastic material of the plains, has, as was markedly illustrated in 1755 at Lisbon, and in 1692 at Jamaica, proved the better foundation. Places to be avoided are the edges of cliffs, scarps, and cuttings. For emergent waves, these are free surfaces, and from their faces materials are invariably shot off, much in the same way that the last car in an uncoupled train of carriages may be shot forward by an engine bumping at the opposite end.

As foundations for a building there are two types. In one, which is the European method of building, the structure is firmly attached to the ground by beds of concrete, brick, and stone. In the other, which is illustrated in the Japanese system of building, the structure rests loosely on the upper surface of stones or boulders. As an indication of the relative value of these two forms of building, it may be mentioned that in Yokohama, in 1880, many of the European buildings were more or less shattered, whilst in the Japanese portion of the town there was no evidence of disturbance.

The houses, like the foundations, are also of two types. In the European house built to withstand earthquakes, of which there are examples in Tokio and San Francisco, and for which in America patents have been granted, we have a building of brick and cement bound together with hoop iron and numerous tie rods. A building like this, which from time to time is jerked backwards and forwards by the moving earth, to which it is secured by the firmest of foundations, is expected to resist the suddenly-applied and varying stresses to which it is exposed by the strength of its parts. This type of structure may be compared to a steel box, and if its construction involves any principle, we should call it that of strength opposing strength. Some of the buildings in Caraccas, which are low, slightly pyramidal, have flat roofs, and which are bound along their faces with iron, belong to this order. These so-called earthquake-proof buildings, with the exception of their chimneys, have certainly satisfactorily withstood small earthquakes in Japan. As to how they would withstand a disturbance like that at Casamicciola is yet problematical. Unfortunately these structures are very expensive.

The second type of building may be compared to a wicker basket. This is certainly as difficult to shake asunder as the steel box type, and at the same time is not so expensive. The Japanese house belongs to this type. It is largely used on the west coast of South America; and in Manila, since the disaster of 1880, it has rapidly been replacing the heavy stone form of structure. Briefly, it is a frame house with a light roof of shingle, felt, or iron. As put up in Japan, its stability chiefly appears to depend on the fact that it is *not* firmly attached to the earth on which it rests, and that its numerous joints admit of considerable yielding. The consequence is that, whilst the ground is rapidly moving backwards and forwards, the main portions of the building, by their inertia and the viscous yielding of their joints, remain comparatively at rest.

A house that my experience suggests as being aseismic, and at the same time cheap, would be a low frame building, with iron roof and chimneys supported by a number of slightly concave surfaces resting on segments of stone or metal spheres, these latter being in connection with the ground. Earthquake lamps, which are extinguished on being overturned, would lessen the risk of fire, while strong tables and bedsteads would form a refuge in case of sudden disturbances.

In earthquake towns the streets ought to be wide, and open spaces should be left, so that the inhabitants might readily find a refuge from falling buildings. Brick chimneys running through a wooden building, unless they have considerable play and are free from the various portions of the building, are exceedingly dangerous. In consequence of the vibrational period of the house not coinciding with that of the chimney, the former by its sudden contact with the latter when in an opposite phase of motion almost invariably causes an overthrow. In 1880 nearly every chimney in the foreign settlement in Yokohama was overthrown in this manner, and the first alarm inside the houses was created by a shower of bricks falling on beds and tables. Since this occurrence the chimneys in Yokohama have had more or less play given to them where they pass through the roofs.

Chimneys with heavy tops, like heavy roofs, must be avoided. Another point requiring attention is the pitch of a roof. If this is too great, tiles or slates will be readily shot off. Archways over openings should curve into their abutments, otherwise, if they meet them at an angle, fractures are likely to be produced.

If for architectural reasons, or as a precaution against fire, it is necessary to have buildings which are substantial, their upper portions ought [to be as light as is consistent with the requisite strength. Hollow bricks, light tiles, with *papier-maché* for internal decorations, have been recommended as materials suitable for superstructures. At the present time the city of Manila, partly through Government interference, and partly through the desire of the inhabitants to reduce the chances of farther disasters, presents a singular appearance of light superstructures rising from old foundations. Iron roofs are visible in all directions, whilst on the massive basements of old cathedrals and churches upper stories of wood, with cupolas and spires of corrugated iron, have been erected.

Although the suggestions embodied in the above notes are few in number, it is hoped that they may be of some practical value. Without extending them, they show us that, even though we may not be in the position to escape from earthquakes by forewarning ourselves of their approach, we can at least mitigate the effects of these disasters by proper construction. JOHN MILNE

Tokio

THE LATE ERUPTION OF VESUVIUS

OUR visit to the crater of Vesuvius on January 11, 1884, was a most interesting one. In my former letter I gave the rough details of this new eruption as well as could be ascertained from the base of the cone. The lava that issued on Tuesday night continued to flow till Wednesday evening, but seemed to have arrested its progress about 10 o'clock that night, when I was in the Atrio del Cavallo. This stream proved to have welled out at the base of the little cone of eruption and to have flowed across the solid lava plain in the crater of 1872, and then to have poured down the north-north-west slope of the cone till it reached the Atrio, across which it extended but little. Within the crater of 1872 we have a somewhat convex plain of lava, which is continuous with, or, more properly, overlaps, the crater edges, except for a short distance on the south-south-west side. The north-east part of this is covered by the remnants of the crater of January, 1882. Within this were a series of crater rings that have since filled up to a certain extent the cavity of 1882. For some time the vent has travelled south, so that the present cone of eruption overlaps the crater ring of January, 1882, on its south side, whereas there is a deep crescentic fossa between the present cone and the north crater ring of two years since. The vent was giving forth great volumes of vapour, and there was an almost continuous fountain of fragments of molten lava, which often attained the height of one or two hundred yards. As a consequence much filamentous lava, often as fine as cotton, was raining around the crater, and as we sat there eating our lunch, it was so covered with these rock fragments, that it required a long climb on foot to make such a gritty meal palatable. The ejectamenta are composed solely of lava in detached pieces, ejected in a plastic state with a few bombs, consisting of older solid lava fragments partially fused and rounded on the surface, which is varnished irregularly by the fluid magma that enveloped them. This indicates that the lava is very near the top of the chimney, which must be full, as it has been for some time. Photography was no easy matter amidst this fiery bombardment, for such was the abundance of the ejectamenta that we could see how rapidly the cone of the eruption was growing. I made a rough calculation of the quantity of new material expelled, and I think six cartloads in four seconds as quite a fair estimate. The lava that had flowed was solid and cold enough to allow my dog to cross it with ease, though through a few cracks it was seen to be still incandescent, and a green staff thrust in immediately blazed. The lava that was flowing in the direction of Pompeii is still doing so in one or two points, apparently at the same rate and place as two weeks since.

Altogether this eruption seems to be of very little importance, and during the last four years there have been many similar ones. Prof. Palmieri, in the *Corriere del Mattino* of January 11, prophesies a great eruption, but on what grounds it seems difficult to make out. No one would deny that such could occur and is not improbable; but there seems to be no more reason now than two months since.

The smoke or vapour yesterday had, when seen by reflected light, the same colour as usual, namely, a salmon tint. The sky was very clear, and I looked at the sun through this vapour, bearing in mind the recent remarkable sunsets and green suns. The transmitted light ranged from a *burnt sienna* brown to a dirty orange, having much the same colour as when we look through a dark London fog. I noticed that the light that traversed the vapour column and fell on the opposite escarpment of Monte Somma was of a colour that would be obtained by mixing a mauve with about equal quantities of brown.

Naples, January 13 H. J. JOHNSTON-LAVIS

THE EGYPTIAN SUDAN AND ITS INHABITANTS

AS some degree of vagueness seems still attached to the term Sudan, it may be well to state at once that it is simply the Arabic equivalent of the older and more intelligible expressions, Nigritia, Negroland, which have in recent times somewhat unaccountably dropped out of use. In its widest sense it comprises the more or less fertile zone lying between the Atlantic on the one hand and the Red Sea and Abyssinian Highlands on the other, and stretching from the Sahara and Egypt Proper southwards to the Gulf of Guinea, the still unexplored Central Equatorial regions, and further east to Lakes Albert and Victoria Nyanza. This vast tract, which may on the whole be regarded as the true domain of the African Negro race, is commonly and conveniently divided into three great sections:—(1) *Western Sudan*, comprising roughly the basins of the Senegal and Quorra-Binue (Niger) with all the intervening lands draining to the Atlantic; (2) *Central Sudan*, comprising the basins of the Komadugu and Shari with all the lands (Kanem, Bornu, Baghirmi, Wadai) draining to Lake Chad; (3) *Eastern Sudan*, comprising everything east of Wadai, that is mainly the Upper and Middle Nile basin.

Politically, this third section, with which alone we are here concerned, has for some years formed part of the Khedive's possessions, hence is now more generally known as *Egyptian Sudan*. Until 1882 it formed a single administrative division under a Governor-General resident at Khartum. But in that year a sort of Colonial Office was created for this region, which was placed under a Cabinet Minister and broken up into four separate departments or divisions, each under a Hukumdar, or Governor-General, directly responsible to the Minister for Sudan at Cairo. The various provinces hitherto forming the single administration of Egyptian Sudan thus became distributed as under:—

WEST SUDAN, comprising Darfur, Kordofan, Bahr-el-Ghazal, and Dongola, with capital Fasher.

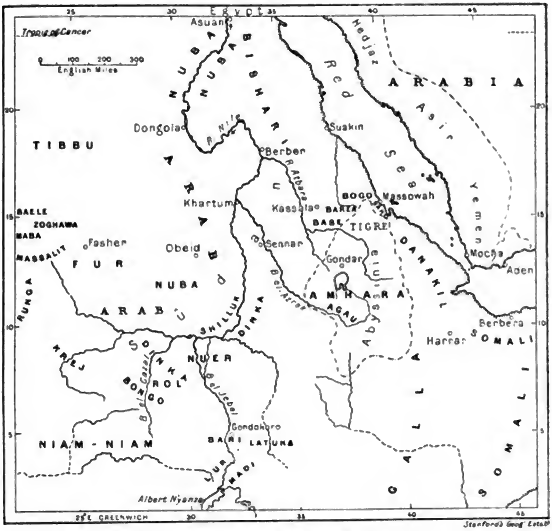
CENTRAL SUDAN, comprising Khartum, Senaar, Berber, Fashoda, and the Equator (Hat-el-Istwa), with capital Khartum.

EAST SUDAN, comprising Taka, Suakin, and Massowah, with capital Massowah.

HARRAR, comprising Zeyla, Berbera, and Harrar, with capital Harrar.

The complete development of this scheme has been somewhat rudely interrupted by the successful revolt of the "Mahdi," who has for the moment wrested the greater part of the country from Egyptian control. But should this arrangement be carried out after the restoration of order, a further element of confusion will be introduced into African geographical nomenclature, for we shall then have three political subdivisions of Egyptian Sudan bearing the same names as the three above described physical subdivisions of the whole region.

These however are matters of detail, with which statesmen do not usually concern themselves, and apart from the terminology the projected arrangement in this instance really recommends itself both on geographical and ethnological grounds. Thus the provinces of Darfur, Kordofan, and Dongola, forming the bulk of "Central Sudan," present a certain physical uniformity in the somewhat steppe-like character of the land, destitute of forest timber and covered mostly with prickly grass, scrub, gum trees, mimosas, and other thorny plants. It is intersected by no large streams, and generally open except towards the west, where the Marrah range forms a water-parting between the few rivers and intermittent torrents flowing south-east to the Nile and south-west through the Bahr-es-Salamat to the Shari. The inhabitants also are of a somewhat homogeneous character, the aborigines belonging mainly to the old Nuba stock almost everywhere interspersed with nomad and slave-hunting Arab tribes. This region communicates with the Nile through two historical caravan routes, one running from El Obeid north-north-east to Khartum, the other from Fasher north-east to El Dabbeh above Old Dongola. Through these outlets the produce of the land—gums, ivory, ostrich-feathers, and slaves—have for ages been forwarded down the Nile to Egypt, the natural emporium of East Central Africa.



Ethnological Map of the Eastern Sudan.

The Nile itself imparts a distinct geographical unity to the more fertile and better watered provinces of Khartum, Senaar, Berber, Fashoda, and the Equator, forming the second division of "Central Sudan." Here the great artery forms a broad, somewhat sluggish stream, often choked with "sudd," or floating masses of tangled vegetable matter, but nevertheless generally navigable from the confluence of the White and Blue Niles at Khartum nearly to Lake Albert Nyanza. The Bahr-el-Jebel, as its upper course is called from the lake to the Sobat junction, is thickly peopled on both sides and along the tributary valleys by numerous tribes and even great nations (Dinka, Shilluk, Mittu, &c.) of pure Negro and Negroid stock. Lower down the White Nile, that is, the section from the Sobat to the Azrek confluence, is held mainly by intruding "Baggara" and other cattle-breeding Arab tribes, interspersed with isolated groups of Nuba, Funj, and other peoples now mostly assimilated to them in speech, usages, and religion.

Although more varied in aspect, the third division of "Eastern Sudan" enjoys a certain unity at least in its outlines, its three provinces of Suakin, Taka, and Massowah being comprised between the middle course of the Nile and the Red Sea, and stretching from the Egyptian frontier southwards to Abyssinia. Here the main stream from Khartum to Asuan (Syene), where it enters Egypt, is essentially a mountain torrent, describing great bends to the right and left while forcing its way over six cataracts and other obstacles through the sandstone and granitic ridges intersecting the Nubian wilderness on the

Race	Main Divisions	Locality	Remarks
Hamite	*Tibbu:* Baele; Zoghawa; Wanyanga	N. and N.W. Darfur	*Hamite* is here equivalent to the *Kushite* of some writers; but is taken in a wider sense, answering to the African Division of the Mediterranean or Caucasic anthropological type of mankind. For the removal of the Tibbu from the Negro to this connection, see NATURE, March 1, 1883 ("North African Ethnology"). Most of these are zealous Muhammadans.
	Bishari (Beja): Hadendoa; Hallenga; Ababdeh; Beni-Amer	Between Red Sea and Nile, 15°–25° N.	
	Danakil: Adaiel; Dahimela, &c.	Between Abyssinia and the coast, 10°–15° N.	
	Saho; Bogos; Habab	Massowah district	
	Somali: Idur; Isa; Mijarten, &c.	Gulf of Aden Coast	
	Galla (Orma): Yeju; Wollo; Mecha, &c.	E. and S. of Gojam	
Semite	*Arab:* Kababish; Sheygieh; Robabat, &c.	W. from Nile between Dongola and Khartum	The *Arab Semites* are recent intruders, mainly *viâ* Isthmus of Suez and Egypt; the *Himyarites* are intruders from prehistoric times from South Arabia *viâ* Strait of Bab-el-Mandeb. The former are all fierce Muhammadans, the latter mostly monophysite Christians.
	Arab: Homran; Rekhabin; Alawin	Senaar	
	Arab: Homran; Hamr, El-Homr; Habanieh, &c.	Kordofan and Darfur	
	Arab: Ziaieh; Bahemid	N. Darfur	
	Himyaritic: Tigré; Dembela; Lasta	N. and E. Abyssinia	
	Himyaritic: Harrari	E. from Shoa	
Nuba	*Barabra* (mixed): Kenus; Mahasi; Dongolawi	Nile Valley from Egypt to Old Dongola	The Nubas hold an intermediate position between the Negro and Hamite; but the speech is distinctly Negro, and has no connection with the Fulah of West Sudan, as has been supposed by Fr. Müller and others. The Kordofan Nubas represent the original stock and are mainly pagans; those of the Nile are Negroid and a historical people, Christians from the sixth to the fourteenth century, since then Muhammadans of a mild type. They represent the Uaua of the Old Egyptian records, the *Nubæ* of Strabo, and the *Nubatæ* of later times.
	True Nuba: Kargo; Kulfan; Kolaji; Jebel Nuba; Tumali	Kordofan	
	Fur: Fur; Konjara; Fongoro, &c.	Darfur	
	Sub-Nuba: Takruri	Gallibat	
	Sub-Nuba: Barea; Basé (Kunama)	Taka (Mareb Valley)	
	Sub-Nuba: Funj; Hamagh	Senaar	
Negro	*Sudanese:* Birkit; Masalit; Abu-Sarib, &c.	Darfur	Most of these Negroes have been reduced in recent years, and are still virtually pagans. Some, such as the Mittu, Krej, and Bongo, are of a red-brown rather than a black complexion, but the type is Negro, although the speech of all except the Dinka shows grammatical gender. They are very brave and fierce, but easily controlled by firmness and kindness.
	Nilotic: Shilluk; Dinka; Nuer	White Nile and B. el Arab	
	Nilotic: Fallaugh; Kumkung; Ninak, &c.	Sobat basin	
	Nilotic: Krej; Bongo (Dor); Mittu (Moro)	About W. tributaries White Nile	
	Nilotic: Bari; Madi; Lur; Latuka	B. el Jebel, N. of Lake Albert Nyanza	
Bantu	Waganda; Wanyoro; Wasoga; Wagamba	Extreme S. frontier, N. side Lake Victoria Nyanza	The Bantus have not been reduced, although included in the Moudirié de l'Equateur of Messedaglia's official "Carte du Sudan" (Khartum, 1883).

east and the Libyan desert on the west. It is thus practically useless for navigation, and the communications with the upper provinces have to be maintained by difficult caravan routes subtended like arcs to the curves of the stream, or radiating from Berber near the Atbara confluence to Suakin on the Red Sea. But south of these dreary solitudes the Atbara basin itself, comprising parts of the Berber and Taka provinces, is a magnificent subtropical land, the flower of the Khedive's possessions, diversified with a varied succession of dense woodlands, rich pastures, and well-watered arable tracts. Hence the route traversing this region from the Nile, through Kassala to the Red Sea at Massowah, although much longer, will be found far more practicable than the more northern highway to Suakin. Like the land itself, the inhabitants of this division present a great diversity of type, the narrow valley of the Nile being occupied by Nubas from the Egyptian frontier to the Old Dongola, and thence on the left bank by Kababish Arabs to Khartum, while the whole region between the Nile and Red Sea, and from Egypt southwards to Abyssinia, is the almost exclusive domain of the great Hamitic Bishari nation. Along the northern frontier of Abyssinia these come in contact at various points with Arab, Amhara, and Tigré peoples, and in one instance even with an isolated Negroid or Nuba tribe, the Basé (Kunama) of the Khor-el-Gash (Mareb) Valley.

The fourth division of Harrar, with its three provinces of Zeyla, Berbera, and Harrar stretching along the northern verge of Somaliland eastwards to Cape Gardafui, is practically separated from the rest of Egyptian Sudan by the intervening "Empire" of Abyssinia, and will be totally severed whenever that state resumes possession of its natural outport of Massowah. It is mainly an arid strip of coastlands fringing the Red Sea and Gulf of Aden, and inclosing the recently-founded Italian and French settlements on Assab Bay and at Obokh on the Gulf of Tajurrah. With the exception of the small Ambaric inclave at Harrar, the whole of this division is inhabited by peoples of Hamitic stock and speech—Saho and Danakil, between the Red Sea and Abyssinia, Idur, and other Somali tribes along the Gulf of Aden.

Egyptian Sudan thus stretches north and south across nearly twenty-four degrees of latitude from Egypt to the equator, or about 1650 miles, and west and east across twenty-two degrees of longitude from Wadai to the Red Sea at Massowah, or from 1200 to 1400. Within these limits it has a total area of at least 2,500,000 square miles, with a population that cannot be estimated at less than 12,000,000. Of these probably three-fourths are of pure or mixed Negro descent, and mostly pagans or nominal Muhammadans. The rest belong to various branches of the Semitic and Hamitic stocks, and are nearly all Muhammadans of a more or less fanatical type. In his valuable "Report on the Sudan for 1883" Lieut.-Col. Stewart remarks: "Besides the main division of the people into Arab and Negro, they are again subdivided into a number of tribes and sub-tribes, some sedentary and others nomad. Of the Negro tribes all are sedentary and cultivators, but the Arabs are for the most part nomads or wanderers, each tribe within certain well-known limits. All these Arab tribes are large owners of cattle, camels, horses, and slaves. These last, along with the Arab women, generally cultivate some fields of doora (a kind of millet) or corn, sufficient for the wants of the tribe. The Arab himself would consider it a disgrace to practise any manual labour. He is essentially a hunter, a robber, and a warrior, and, after caring for his cattle, devotes all his energies to slave-hunting and war" (p. 8).

This presents a fairly accurate picture of the natural relations of the people in all respects except as regards the main division into two ethnical groups—Arab and Negro. From what has been already stated it is obvious that this is a totally inadequate distribution. It is another and signal instance of that official ignorance or disregard of the racial conditions that has ever been such a fruitful source of political troubles and disasters in lands governed or controlled by foreign administrators. As a matter of fact, Egyptian Sudan is a region of great ethnical complexity, and so far from being occupied by Arabs and Negroes alone, there are scarcely any Arabs or Negroes at all anywhere east of the Nile between Khartum and Egypt. To designate as Arabs the tribes at present blocking the Suakin-Berber route, as is currently done, betrays a depth of ethnological ignorance analogous to that of the writer who should group Basques, for instance, and Slavs in the same category. The Arabs themselves are comparatively recent intruders, although it is possible that some, such as the Beni-Omr, now fused with the Funj and Hamagh Negroid peoples of Senaar, may have found their way across the Red Sea into the Nile basin in pre-Muhammadan times. But the Bishari tribes about Suakin are the true autochthonous element, lineal descendants of the Blemmyes and other historic peoples whose names are enrolled in Greek, Roman, and Axumite records. But these and other points will be made clear by the above synoptical table, with accompanying map, of the East Sudanese races and tribes.

Khartum, the centre of administration for all these discordant elements, has been brought within the sphere of civilisation since 1819, when it was occupied by the Egyptian troops under Ismael Pasha. At that time it was a mere outpost of the Hamagh kingdom, Senaar; but, thanks to its convenient position at the confluence of the two Niles midway between the Mediterranean and the equator, it soon rose to importance under the strong government of Mehemet Ali. Under Khurshid Pasha (1826–37) its skin and reed hovels were replaced by substantial brick houses, and at present it is by far the largest and most flourishing place in Central Africa, with a motey population of over 40,000, including the garrison roops. Here considerable quantities of goods in transit are always in deposit; here are resident many Europeans interested in the African trade, and in the more philanthropic work of African culture and exploration. Khartum has thus become inseparably associated with all the work done during the last half century towards developing the material resources of the land and raising the moral status of its inhabitants. At its mention, the names of Petherick, Beltrami, Schweinfurth, Baker, Gordon, Marno, Junker, Linant de Bellefonds, Emin Bey, Gessi, and many other heroic pioneers in the cause of African progress, are irresistibly conjured up. Such names plead silently but eloquently for its preservation to civilisation in the better sense of the word, and make us feel how great a crime against humanity would be its abandonment to barbarism and the villainous Arab slave-dealers of Central Africa.

A. H. KEANE

NOTES

WE understand that subscriptions to a memorial to the late Mr. F. Hatton are being asked for in a paper in which the name of Prof. Huxley is mentioned as one of the committee and an intending subscriber. We are authorised to state that the name of Prof. Huxley has been employed without his knowledge.

WE have received the following subscriptions on behalf of the Hermann Müller Fund:—Prof. W. H. Flower, F.R.S., 1*l.*; Mr. W. E. Hart, 1*l.*; K., 10*s.*

MR. FRANK E. BEDDARD, M.A., of the University of Oxford, Naturalist to the *Challenger* Commission, has been selected out of thirteen candidates for the post of Prosector to the Zoological Society of London, in succession to the late Mr. W. A. Forbes. Mr. Beddard was a pupil of the late Prof. Rolleston, and for the past year has been employed on editorial and other work connected with the issue of the official reports on the scientific results of the *Challenger* Expedition. He has also been intrusted with the examination and description of the *Isopoda* collected by the Expedition, and has the reputation of being a most promising and enthusiastic naturalist.

AMONG other legacies in the will of the late Sir William Siemens are 1000*l.* each to the Scientific Relief Fund of the Royal Society and the Benevolent Fund of the Institution of Civil Engineers.

THE Cunningham Medal of the Royal Irish Society was presented on the 15th inst. to Mr. John Birmingham of Tuam, for his "Contributions to the Advancement of Knowledge in Astronomy."

MR. ARCHIBALD GEIKIE, F.R.S., Director-General of the Geological Survey of the United Kingdom, will give the first of a course of five lectures on the Origin of the Scenery of the British Isles, on Tuesday next (January 29), at the Royal Institution of Great Britain.

IN January, 1883, one of the officers of the Geological Survey of Ireland, Mr. E. T. Hardman, was selected to proceed to Western Australia for the purpose of taking part in an exploration of the Kimberley district of that colony. He took the field in April last, and continued on active service in the bush until near the end of September, having in this interval travelled at least 1500 miles, and having obtained materials for a first geological sketch-map of about 12,800 square miles of country. He has determined the sequence of formations which begin with certain quartzites, schists, and other metamorphic rocks, which he classes provisionally as altered Lower Silurian, but which may be of Archæan age. These are succeeded by limestones and sandstones with gypsum, &c., which are referred to Upper Carboniferous horizons. Certain basalts and felstones occur, the age of which is uncertain. The youngest deposits are Pliocene sands, gravels, conglomerates, and marly limestones ("pindar" of the natives) overlaid by river gravels, extensive plains of alluvium, and, along the sea-coast, by raised beaches.

MR. BARNUM's so-called white elephant arrived safely last week at the Zoological Gardens from Burmah, and has already attracted many visitors. Prof. Flower, writing to the *Times*, says:—"The Burmese elephant now deposited in the Zoological

Society's Gardens, Regent's Park, is apparently not quite full grown, being between 7 feet and 8 feet in height, and has a well-formed pair of tusks about 18 inches in length. It has a remarkably long tail, the stiff bristly hairs at the end of which almost touch the ground. The ears are somewhat larger than in the ordinary Indian elephant, and are curiously jagged or festooned at the edges, whether as a natural formation or the result of early injuries it is difficult to say. It is chiefly remarkable, however, for a peculiarity of coloration which is quite unlike that of any elephant hitherto brought to this country. In this elephant the general surface of the integument is quite as dark as, if not darker than, that usually seen in its kind, being, perhaps, of rather a more bluish or slaty hue. There are, however, certain definite patches, disposed with perfect bilateral symmetry, in which the pigment is entirely absent, and the skin is of a pale reddish brown or 'flesh colour.' These patches are of various sizes, sometimes minute and clustered together, producing only an indistinct mottling of the surface, sometimes in large clear spaces, but which are mostly, especially at their edges, dotted over with circular pigmented spots of the prevailing dark colour about half an inch or more in diameter, which give a remarkable and even beautiful effect. The largest and clearest light-coloured tract is on the face, extending from the level of the eyes to the base of the trunk. . . . The animal is not a pale variety of the ordinary elephant, as some have supposed the so-called 'White Elephant' to be, but one characterised by a local deficiency of the epidermic pigment, in symmetrically disposed patches, and chiefly affecting the head and anterior parts of the body. It does not result from any disease of the skin, as has been suggested, but is doubtless an individual congenital condition or defect."

In *Cosmos les Mondes* for January 19 Prof. P. Guy describes the remarkable sunrise witnessed by him at Perpignan on January 8. From his bedroom window, looking southwards, he noticed a sudden flash, which lit up the whole room, and which was followed by a lovely pale light diffused throughout the southern sky from horizon to zenith. This was at 4 a.m., and consequently could not have been produced by the clouds reflecting the light of the moon, which had set at 2.42 a.m. The luminous matter presented a milk-white appearance, not unlike that of the Milky Way, and scarcely more intense. So transparent was it that the stars remained perfectly visible without any diminution of their brightness through the vapours which seemed to cause the effulgence. Mars and Jupiter, visible near the zenith, were encircled by a halo like that often visible round the moon. Along the southern horizon there stretched a dark band formed by clouds at an elevation of about 15°, the upper edge of which was lit up intermittently by the action of successive waves of light resembling the sheet lightning so often seen in summer. About 4.45 a.m. the light gradually faded away, after which the sky became overcast and quite dark. The local and intermittent light, Prof. Guy thinks, was obviously due to electricity, to which with less certainty may also be attributed the more general manifestation. The upper regions of the atmosphere contain a large quantity of electricity, as shown by the potential increasing with the increased altitude. To its presence are probably due such faint and phosphorescent diffusions of light as are here described, and have often been observed elsewhere.

After more than a fortnight's working without the slightest hitch of any kind, the experiment of the direct electric lighting of one of the District Railway trains between Kensington and Putney may, it is stated, be fairly looked upon as a distinct success. The fitting of the Putney train is of a rather heterogeneous character, being a collection of plant procurable without special manufacture, the whole consisting of a launch boiler, a small Willan's three-cylinder steam-engine, running at 500 revolutions, and driving direct off its own shaft, a Siemens' shunt-wound dynamo supplying current for 50 Swan 20-candle power incandescent lights. In addition there are two water-tanks, and a coal-box, the whole being placed in a separate van, and this tentative arrangement has this advantage—that by the removal of the van to other lines more extended trials can be made on longer trains, as in the present case only 30 of the lamps are employed for the actual service of the train, the remaining 20 being kept lighted in the van itself. The effect on the train is very brilliant, although the arrangements are not what are ultimately proposed—namely, to place a small high-speed engine and the dynamo on the tender and take steam from the locomotive itself, and so dispense with the attendant now required in the special van.

The fiftieth anniversary of the birth of Philipp Reis, the inventor of the telephone which bears his name, was celebrated by the Elektrotechnische Gesellschaft of Frankfort on January 7 by a special meeting in the afternoon, followed by a banquet, to which the son of the deceased inventor and a number of his surviving scientific friends and comrades were invited. A memorial discourse was pronounced by Herr Postrath Grawinkel, dwelling on the inventions of Reis and his now generally admitted claims. At the banquet a speech was made by Dr. Petersen, president of the Physical Society of Frankfort, on behalf of that body, at whose session in 1861 the telephone first saw the light. The speeches and toasts lasted till after midnight.

We mentioned last week that the Scottish Fishery Board on the recommendation of Prof. Cossar Ewart had taken steps to utilise the abundant machinery at their disposal for collecting material that will assist in solving some of the important fish problems. As a firstfruit of this organisation a splendid specimen of a torpedo was forwarded to the University of Edinburgh by the fishery officer at Wick on Saturday last. Prof. Ewart exhibited this, apparently the only torpedo ever found off the Scottish coast, at the last meeting of the Royal Physical Society of Edinburgh (January 16). After giving a short account of the torpedo group, Prof. Ewart mentioned that the specimen exhibited was taken about five miles off Lybster, that it was 28 inches in length and 19½ inches across the pectoral fins, and that it belonged to the species *hebetans*, several specimens of which have been found in the English Channel. This torpedo will in all probability be presented by the Fishery Board to the Edinburgh Museum of Science and Art.

The members of several scientific societies in the east of Scotland having had under consideration the advantages that would result from a federation of the various societies, believing that thereby the value of their scientific work would be greatly increased and their objects promoted, have determined to call a meeting of delegates from the various scientific bodies in the east of Scotland, to be held at the Perthshire Natural History Museum, Perth, on Saturday, February 9 next. At this meeting it is purposed to consider the question of federation, and how it may best be carried out, and also to adopt a constitution, and to arrange for a first general meeting. Some of the advantages of such an association are thus briefly stated :—(1) Increased value of work by having an aim in common ; (2) Increased zeal amongst members by definite work being put before them ; (3) Improvements in method of carrying out excursions ; (4) Increased facilities for intercourse amongst members of the different societies. The idea of a federation of societies is not a new one. In England the societies of three large districts have formed associations, with excellent results ; and though in Scotland no unions of a similar nature have yet been formed, the joint meetings (inaugurated by the Inverness Scientific Society) of some of the northern societies, which have taken place annually during the past two or three years, have been a step in the same direction.

THE Geographical Society at Antwerp has given a reception to the distinguished geographer, Dr. Chavanne, editor of the *Mittheilungen* of the Vienna Geographical Society. He has undertaken the task of drawing up a complete map of the Congo territory, showing the stations of the African Association. He will leave for the Congo at the beginning of next month.

THE first maps of the Algerian survey have been published and presented to the Paris Academy by Col. Perrier.

THE largest ice cavern in Carniola has lately been discovered by Prof. Linhart of Laibach, having hitherto been known only to a small circle of woodcutters and hunters. It is now called the Friedrichstein Cavern, and can be reached in about two to three hours from Gottschee. The upper aperture is large and rectangular, the back is formed by a limestone rock rising some 80 metres perpendicularly; there is also a colossal gate fringed by icicles some metres in length. The sides are very steep. The area of the cave is about 450 square metres, nearly circular in shape, the level ground being covered with ice several feet deep. Altogether the cave seems to offer one of the grandest aspects imaginable.

NEWS about the Russian expedition to Western Africa under Herr Schulz von Rogosinski was communicated at a recent meeting of the Berlin Geographical Society. The expedition has investigated the district north and east of the Cameroon Mountains, and discovered a large native settlement or town, Kumba by name, on the Mungo River east of the mountains mentioned. They intend to penetrate still further to the east. Dr. Pauli and Dr. Passavant of Basle have started also for the same districts on an exploring tour. A letter was also read, dated Ibi, September 30, in which Robert Flegel makes some official business communications.

THE additions to the Zoological Society's Gardens during the past week include a Black-handed Spider Monkey (*Ateles geoffroyi*) from Central America, presented by Mr. Colin Wm. Scott; two Yellow-bellied Liothrix (*Liothrix luteus*) from India, a Goldfinch (*Carduelis elegans*), British, presented by Mrs. Edwards; an Indian Elephant (Mottled Variety) (*Elephas indicus* ♂) from Burmah, a Slow Loris (*Nycticebus tardigradus*) from Sumatra, a Gray Ichneumon (*Herpestes griseus*) from India, deposited; a Rufous-necked Wallaby (*Halmaturus ruficollis*) from New South Wales, a Brush Bronze-wing Pigeon (*Phaps elegans*) from Australia, received on approval; an Axis Deer (*Cervus axis*), three Brown-tailed Gerbilles (*Gerbillus erythrurus*), a Babirussa (*Babirussa alfurus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

A SOUTHERN COMET.—A telegram from Melbourne addressed to Prof. Krueger of Kiel, editor of the *Astronomische Nachrichten*, notifies the discovery of a small comet on January 12 in R.A. 22h. 40m., and N.P.D. 130° 8', and consequently in the constellation Grus. It is stated to be moving quickly to the south-east.

Possibly this comet may add to the very small number of cases where one of these bodies has been telescopically discovered in the other hemisphere, and the elements of the orbit have wholly depended upon southern observations. We can call to mind only two such instances: (1) the comet of 1824 detected by the late Carl Rümker at Parramatta, and observed there by him and by Sir Thomas Brisbane, the founder of that observatory, and Governor of the Colony. The orbit was first calculated by Rümker, and has lately been more completely investigated from the Parramatta observations by Dr. Doberck; (2) the comet of 1833, discovered by Dunlop (Rümker's successor) at Parramatta at the end of September, and observed there from October 1 to 16: orbits by Henderson, Peters, and Hartwig.

PONS' COMET.—For the convenience of readers who are observing in the southern hemisphere we subjoin an ephemeris of this comet, deduced from the provisionally corrected ellipse of MM. Schulhof and Bossert. The positions are for Greenwich mean noon:—

1884		R.A. h. m. s.	Decl. ° '	Log. distance from Earth	Log. distance from Sun
Feb.	5	0 44 33	−31 38·8	9·9506	9·9024
	9	0 55 27	35 10·7		
	13	1 5 10	38 14 2	0·0019	9.9284
	17	1 14 0	40 54·4		
	21	1 22 14	43 15·8	0·0440	9 9628
	25	1 30 7	45 22·4		
	29	1 37 52	47 17·2	0·0772	0·0011
March	4	1 45 40	49 2·8		
	8	1 53 40	50 41·4	0·1029	0·0401
	12	2 2 0	52 14·9		
	16	2 10 50	53 44·6	0·1225	0·0781
	20	2 20 19	55 11·3		
	24	2 30 34	56 36·0	0·1374	0·1143
	28	2 41 44	57 59·4		
April	1	2 53 58	59 22·0	0·1489	0·1483
	5	3 7 27	60 43·6		
	9	3 22 23	62 4·1	0·1583	0·1800
	13	3 38 59	63 22·5		
	17	3 57 27	−64 37·4	0·1668	0·2095

The theoretical intensity of light on February 5 is sixty-nine times that on the day of discovery; on April 17 only six times the same. Probably the comet may be discernible with the naked eye until the end of February.

Dr. G. Müller of the Astro-physical Observatory at Potsdam records a second remarkably sudden increase in the brightness of this comet. On January 1 at 5h. 47m. M.T. its appearance was very similar to that of the preceding days, the nucleus large and diffused; photometric comparisons showed that it was following pretty nearly in the calculated light-curve, and harmonised with the measures on December 29 and 30. At 7h. 20m. he was astonished at the altered aspect of the comet. In place of the previously diffused nucleus, there was now an almost stellar point, equal in brightness to a star of the seventh magnitude, so that he was at first under the impression that a bright star was seen through the comet. By comparisons with two neighbouring stars, estimated in the *Durchmusterung* 7·0 and 6·8, the following magnitudes were determined:—

	h. m.				h. m.	
At	7 28	7·53 m.		At	8 27	7·03 m.
	7 41	7·35			8 38	7·00
	7 58	6 97			9 0	7·13
	8 7	6·89			9 7	7·33

With the help of a curve the observations appeared to fix the maximum of the development of light to 8h. 12m. M.T. at Potsdam corresponding to 7h. 20m. Greenwich M.T. At 9h. 30m. the comet's aspect had again changed and resembled that presented at the previous day's observations. The whole variation amounted to about 1·3 mag. On that evening the comet's distance from the sun was 0·90, and that from the earth 0·665.

Attention will be no doubt directed in the other hemisphere to these abnormal variations in the light of the comet. It will be remembered that the first remarkable change occurred about September 22, three weeks after the discovery by Mr. Brooks, when the distance from the sun was 2·18, and from the earth 2·14.

PROFESSOR HAECKEL ON THE ORDERS OF THE RADIOLARIA[1]

II.

[THE following translation of a recent paper of mine, by Miss Nellie Maclagan, has been revised by myself.—ERNST HAECKEL.]

Systematic Survey of the 4 *Orders*, 10 *Sub-orders, and* 32 *Families of the Class Radiolaria*. (Compare the former survey of the families in my Monograph, 1862, and in "Prodromus," *l.c.* 1881).

1. Order I. ACANTHARIA, Hkl. (*Acantharia*, Hkl., 1881 = *Acanthometreæ*, Hertwig, 1879 = *Panacantha*, Hkl., 1878).

Central capsule originally (and usually permanently) spherical; nucleus usually early divided into numerous small nuclei. Cap-

[1] "Separat-Abdrück aus den Sitzungsberichten der Jenaischen Gesellschaft für Medicin. und Wissenschaft." Jahrg. 1883. Sitzung. v. n 16 Februar. Concluded from p. 276.

sule membrane spherical, pierced on all sides by innumerable fine pores. Extracapsularium, a voluminous gelatinous sheath, without phæodium, usually without zooauthella. Skeleton always intracapsular, consisting of acauthine spicules, which meet in the centre of the central capsule, and pierce the membrane.

1A. Sub-order I. Acanthometræ, J. Müller, 1858. Acautharia, in which the acanthine skeleton is composed merely of radial spicules, but does not form a fenestrated shell.

Family 1. Actinelida, Hkl., 1865. Skeleton composed of a varying number of spicules, not distributed according to J. Müller's law (*Astrolophida, Litholophida*).

Family 2. Acanthonida, Hkl., 1881. Skeleton composed of twenty radial spicules, distributed regularly according to J. Müller's law, in five quadriradiate zones (*Acanthometrida, Acanthostaurida, Acantholonchida*).

1B. Sub-order II. Acanthophractæ, Hertwig. Acantharia, in which the skeleton is composed of twenty radial spicules regularly distributed according to J. Müller's law, and forming a fenestrated or solid shell round the central capsule by means of connected transverse processes.

Family 3. Dorataspida, Hkl., 1862. Fenestrated shell, spherical, spheroidal, or ellipsoidal, simple or double (*Phractaspida, Sphærocapsida, Phractopelmida*.

Family 4. Diploconida, H., 1862. Shell shaped like an hour-glass or a double cone, having in its axis a pair of strong spicules running in opposite directions (*Diploconus*).

2. Order II. Spumellaria, Ehrenberg (= *Peripylea* + *Thalassicollea* + *Sphærozoea*, Hertwig, 1879 = *Sphærellaria* + *Collodaria* + *Polycyttaria*, Hkl., 1881).

Central capsule originally (and usually permanently) spherical, more rarely discoid or polymorphous. Nucleus usually divided only immediately before the formation of spores into a number of small nuclei. Capsule membrane simple, pierced on all sides by innumerable fine pores. Extracapsularium a voluminous gelatinous sheath, without phæodium, usually with zooxanthella. Skeleton consisting of silicium, or of a silicate, originally usually forming a central reticulate sphere, later extremely polymorphous, more rarely rudimentary or entirely wanting.

2A. Sub-order III., Collodaria, H., 1881 (*sensu ampliori*). Spumellaria without skeleton, or with a rudimentary skeleton composed mainly of detached siliceous spicules scattered outside the central capsule.

Family 5. Thalassicollida, H., 1862. Skeleton entirely wanting. Central capsules living solitary, monozoic (*Actissa, Thalassolampe, Thalassicolla*, &c.

Family 6. Collozoida, H., 1862. Skeleton entirely wanting. Central capsules social, thickly embedded in a common gelatinous body, polyzoic (*Collozoum*).

Family 7. Thalassosphærida, H., 1862. Skeleton composed of numerous detached spicules, scattered round the solitary central capsule. Monozoic (*Thalassosphæra, Thalassoxanthium*, &c.).

Family 8. Sphærozoida. Skeleton composed of numerous detached spicules, scattered round the social central capsules, or embedded in their common gelatinous body (*Sphærozoum, Rhapidozoum*).

2B. Sub-order IV. Sphærellaria, Hkl., 1881. Spumellaria having a reticulate or spongiose siliceous skeleton, forming a single connected plexus of siliceous fibre, originally evolved from a simple fenestrated sphere.

Family 9. Sphæroida (vel *Sphæridea*, H., 1879. "Protistenreich," p. 103; "Prodromus," 1881, pp. 448, 449). Skeleton either a simple fenestrated sphere, or composed of several concentric fenestrated spheres, with or without radial spicules. Central capsule solitary, monozoic. The family of Spumellaria richest in specific forms (*Monosphæria, Diosphæria, Triosphæria, Tetrasphæria, Polysphæria, Spongosphæria*).

Family 10. Collosphærida, H., 1862. Skeleton either simple reticulate spheres, or composed of two concentric reticulate spheres, severally inclosing the spherical, social, central capsules. Polyzoic (*Acrosphærida, Clathrosphærida*).

Family 11. Pylonida, Hkl., 1881 ("Prodromus," p. 463). Skeleton subspherical, ellipsoid, or polymorphous, distinguished by large fissures or gaps, which break through the originally spherical or ellipsoidal fenestrated shell, at definite points. Fenestrated shell, simple or composed concentrically, with or without spicules. Geometrical fundamental form with three unequal, equipolar axes, perpendicular one to another (*Pylocarpida, Pylophonnida*).

Family 12. Zygartida, Hkl., 1881. Skeleton an ellipsoidal or almost cylindrical fenestrated shell prolonged in the direction of one axis and constricted annularly in the middle, perpendicular to the said axis, often articulated by repeated annular strictures. One or two concentric, small, fenestrated shells, often inclosed in the middle. Both poles of the principal axis equal (*Artiscida, Cyphinida*).

Family 13. *Lithelida*, Hkl. ("Monogr. Prodrom." 1881, p. 464). Skeleton spheroidal or irregular, composed of a small, central, fenestrated sphere, and of series or heaps of chambers piled round it, sometimes spirally or axially according to definite, complicated laws, sometimes quite irregularly (*Phorticida, Soreumida, Spireumida*).

Family 14. Discoida (vel *Discidea*, Hkl., 1879, "Protistenreich," p. 103, "Prodrom." p. 456). Skeleton flattened like a disk, originally circular, lenticular, later often polymorphous by means of peripheric processes; sometimes distinctly composed of rings, sometimes spongiose (*Phæodiscida, Coccodiscida, Porodiscida, Spongodiscida*).

3. Order III. Nassellaria, Ehrenberg (= Monopylea, Hertwig, 1879; *Monopylaria*, Hkl., 1881).

Central capsule originally invariably uniaxial, oval, or conical, with two different poles of the axis; at one pole the characteristic porous area through which the whole of the pseudopodia project like a bush. Nucleus usually divided late, immediately before the formation of spores, into numerous small nuclei. Capsule membrane simple. Extracapsularium, a voluminous gelatinous sheath without phæodium, usually without zooxanthellæ. Skeleton consisting of silicium or of a silicate, originally (it is probable universally) a ring or a triradiate framework of spicules, later extremely polymorphous, usually forming a dipleuric fenestrated shell (wanting only in the simplest form, *Cystidium*).

3A. Sub-order V., Plectellaria, Hkl. Nassellaria, in which the skeleton consists of a simple siliceous ring or of a triradiate framework of spicules, usually furnished with processes forming simple or branched spicules. The branches of the latter may be united into a loose plexus, without, however, forming a chambered fenestrated shell. The skeleton is entirely wanting only in the simplest form (*Cystidium*).

Family 15. Cystidina, Hkl., nov. fam. Skeleton entirely wanting (*Cystidium*).

Family 16. Plectoida (vel *Plagonida*), Hkl., 1881. Skeleton originally composed of three spicules or siliceous rods, radiating from one point (near the mouth of the central capsule), the latter often ramifying into loose plexus (*Plagonida, Plectanida*).

Family 17. Stephoida (vel *Stephanida*), Hkl., 1881. Skeleton originally (?) forming a simple siliceous ring (with or without spicules), later often several connected siliceous rings or a loose plexus, not, however, developed into a regular fenestrated shell *Monostephida, Parastephida, Dyostephida, Triostephida*).

3*b*. Sub-order VI. Cystellaria (Hkl., 1881). Nassellaria, having a chambered (usually dipleuric) fenestrated shell, the primary foundation of which consists either of a simple ring (like the Stephoida), or of a triradiate framework (like the Plectoida), sometimes of a combination of both. Primary foundation sometimes entirely lost.

Family 18. Spyroida (vel *Sphyridina*, Ehrenberg). Skeleton dipleuric, forming a fenestrated twin-shell, the two halves of which (right and left chamber) are connected by a vertical ring, lying in the median plane. At the upper (aboral) pole of the longitudinal axis, usually an occipital apical thorn, at the lower (oral) pole an oscular network, with four (rarely three, five, or more) openings, and three (rarely more) spicules. (*Triospyrida, Diospyrida, Tetraspyrida, Pentaspyrida, Polyspyrida, Perispyrida, Pleurospyrida*) = Zygocystida.

Family 19. Botryoida (Hkl., 1881 = Polycystida, 1862). Skeleton an irregular fenestrated shell, composed of several unequal chambers, piled usually irregularly (rarely in definite order varying from that of the Cyrtida) round a primary capitulum (derivable from the twin shell of the Spyroida), with or without spicules (*Pylobotryida, Cannobotryida*).

Family 20. Cyrtida, Hkl., 1862. Skeleton, dipleuric (at least originally), consisting either of a primary capitulum (derivable from the twin-shell of the Spyroida?) or (usually) of one or more chambers, joined to the oral pole of the said capitulum in the longitudinal axis. Osculum sometimes open, sometimes reticulate. Usually three radial spicules (one median and two lateral), rarely four or more spicules, or none at all (having undergone retrograde formation?). The family most rich in specific forms of all Nassellaria (*Cystocorida, Cystopilida, Cystophonnida, Cystocapsida, Cystoperida, Cystophatuida,* "Prodrom.," 1881, p. 426).

4. Order IV. PHÆODARIA, Hkl., 1879 (= *Pansolenia*, Hkl., 1878 = *Tripylea*, Hertwig, 1879).

Central capsule always uniaxial, sometimes almost spherical, sometimes lenticular or oval, always with two different poles of the axis. At one pole invariably the characteristic principal opening with radiated operculum, from which the bush of pseudopodia project through a tube; at the other pole, frequently (though not invariably) two or more accessory openings. Nucleus usually only late divided into nnmerous small nuclei. Capsnle membrane double. Extracapsularium usually (or always ?) with zooxanthellæ distinguished by the *phæodium*, a voluminous body of pigment lying excentrically in the gelatinous sheath round the principal opening. Skeleton always extracapsular, consisting of silicinm or of a silicate, usually composed of hollow tubes, polymorphous (wanting only in the most simple forms, *Phæodina*, &c.).

4A. Sub-order VII. Phæocystia, Hkl., 1879. Phæodaria, without skeleton, or with a rudimentary skeleton formed merely of detached siliceons tubes (or of reticnlated pieces of silex) scattered outside the central capsule.

Family 21. Phæodinida, Hkl., 1879. Skeleton entirely wanting (*Phæodina, Phæodella*).

Family 22. Cannoraphida, Hkl., 1879. Skeleton consisting of detached hollow tubes or reticnlated pieces of silex, deposited tangentially round the central capsule (*Cannoraphis, Thalassoplaneta, Dictyocha*).

Family 23. Aulacanthida, Hkl., 1862. Skeleton consisting of a superficial pallinm of fine tangential tubes and a number of strong radial spicules (simple or branched) which pierce the mantle (*Aulocantha, Aulospathis, Auloraphis, Aulodendrum*, &c).

4B. Sub-order VIII. Phæogromia, Hkl., 1879. Phæodaria with a dipleuric single-chambered shell having a large opening, usually armed with one or more teeth at the basal pole; besides the primary, often several secondary openings.

Family 24. Lithogonida, Hkl., nov. fam., single-chambered dipleuric shell, with solid wall of peculiar crystalline structure, like porcelain (*Lithogromia*, Tuscarora).

Family 25. Challengerida, John Murray, 1876. Single chambered shells, varying greatly in form, with porous glass-like wall, and very fine, perfectly regular, hexagonal pores (resembling the structure of diatoms) (*Challengeria, Gazelletta, Porcupinia*, &c.).

4C. Sub-order IX. Phæosphæria, Hkl., 1879. Phæodaria having a spherical, or subspherical, fenestrated shell, usually consisting of one single, rarely of two concentric spheres; sometimes with a large principal opening, sometimes without; partly with, partly without, radial spicules. Beams of the reticulum sometimes solid, sometimes hollow.

Family 26. Castanellida, Hkl., 1879. Fenestrated shell, spherical, simple, composed of solid rods, having at one point a large principal opening (often armed with a corona of spicules), with or without radial spicules (*Castanella, Castanidium*, &c.).

Family 27. Circoporida, Hkl., 1879. Fenestrated shell, spherical, subspherical, or polyhedric, composed sometimes of reticulate plates, usually with hollow, radial spicules, always with one large, principal opening, and with several detached porous areæ (*Circoporus, Porostephanus, Porospathis*, &c.).

Family 28. Sagenida, Hkl., nov. fam. Fenestrated shell, sometimes spherical, sometimes subspherical or polymorphous, forming a spongiose plexus of solid beams, without principal opening (*Sagena, Sagenidium*, &c.).

Family 29. Anlosphærida, Hkl., 1862. Fenestrated shell, spherical, more rarely subspherical or polymorphous, composed in a peculiar fashion of hollow tubes, usually with hollow, radial spicules, without principal opening (*Aulosphæra, Auloplegma*, &c.).

Family 30. Cannosphærida, Hkl., 1879. Fenestrated shell, spherical or subspherical, double. The inner (medullar layer) composed simply of solid beams, the outer (cortical layer) of hollow tubes with radial spicules at the nodes of junction; both layers connected by hollow, radial rods (*Cannosphæra, Cœlocantha*, &c.).

4D. Snb-order 10. Phæoconchia, Hkl., 1879. Phæodaria, having a bivalve fenestrated shell, composed like that of a mussel, of two convex, separate, perforated valves, with or without hollow, radial tubes.

Family 31. Concharida, Hkl., 1879. Fenestrated shell, without radial spicules, composed of two smooth, hemispherical or lenticular valves, the edges of which usually catch one another by rows of teeth (*Concharium, Conchidium, Conchopsis*, &c.).

Family 32. Cœlendrida, Hkl., 1862. Fenestrated shell composed of two hemispherical or lenticular valves, having processes in the form of large, hollow, radial spicules, usually dendritically branched at their apical, centre points or at the two poles of the transverse axis of the shell (*Cœlodendrum, Cœlothamna*, &c.).

Differential Characters of the Four Orders of Radiolaria

Holotrypasta

Radiolaria having the capsule membrane pierced on all sides.

I. ACANTHARIA.	II. SPUMELLARIA.
Central capsnle originally spherical. Homaxonous.	Central capsule originally spherical. Homaxonous.
Capsule membrane pierced equally everywhere by innumerable fine pores. (*Peripylea*).	Capsule membrane pierced equally everywhere by innumerable fine pores. (*Peripylea*).
Skeleton acanthine. Zooxanthellæ usually (or invariatly ?) wanting. Without phæodium.	Skeleton siliceous. Zooxanthellæ usually present. Without phæodium.

Merotrypasta

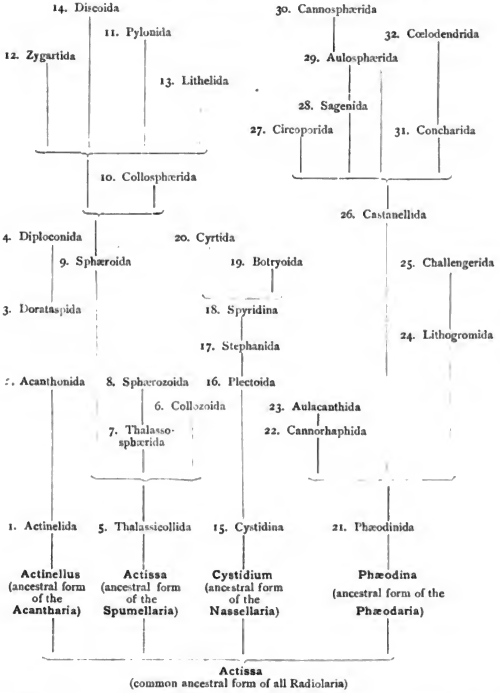
Radiolaria having the capsule membrane partially pierced.

III. NASSELLARIA.	IV. PHÆODARIA.
Central capsule oval or conical. Monaxonous.	Central capsule oval or subspherical. Monaxonous.
Capsule membrane with a single area of pores at the oral pole of the principal axis. (*Monopylea*).	Capsule membrane with a single simple principal opening and often several accessory openings. (*Tripylea*).
Skeleton siliceous. Zooxanthellæ usually present. Without phæodium.	Skeleton siliceous. Zooxanthellæ usually (or invariably ?) wanting. Always with phæodium.

Conspectus Ordinum et Familiarum Radiolarium classis

Ordines	Subordines	Familiæ	Genus typicum
I. Ordo: Acantharia Holotrypasta skeleto acanthinico	I. Acanthometra (sine testa)	1. Actinelida	Actinelius
		2. Acanthonida	Acanthonia
	II. Acanthophracta (testa completa)	3. Dorataspida	Dorataspis
		4. Diploconida	Diploconus
II. Ordo: Spumellaria Holotrypasta skeleto deficiente aut siliceo polymorpho	III. Collodaria (sine testa)	5. Thalassicollida	Actissa
		6. Collozoida	Collozoum
		7. Thalassosphærida	Physematium
		8. Sphærozoida	Sphærozoum
	IV. Sphærellaria (testa completa)	9. Sphærida	Phormosphæra
		10. Collosphærida	Collosphæra
		11. Pylonida	Tetrapyle
		12. Zygartida	Didymocyrtis
		13. Lithelida	Porodiscus
		14. Discoida	Lithelius
III. Ordo: Nassellaria Merotrypasta membrana capsulæ simplici, sine phæodio	V. Plectellaria (sine testa completa)	15. Cystidina	Cystidium
		16. Plectoida	Plagiacantha
		17. Stephanida	Lithocircus
	VI. Cyrtellaria (testa completa)	18. Spyroida	Dictyospyris
		19. Botryoida	Botryocyrtis
		20. Cyrtida	Dictyophimus
IV. Ordo: Phæodaria Merotrypasta membrana capsulæ dupplici, cum phæodio	VII. Phæocystia (sine testa)	21. Phæodinida	Phæodina
		22. Cannorhaphida	Thalassoplancta
		23. Aulacanthida	Aulacantha
	VIII. Phæogromia (testa dipleura)	24. Lithogromida	Lithogromia
		25. Challengerida	Challengeria
	IX. Phæosphæria (testa globosa aut subglobosa)	26. Castanellida	Castanella
		27. Circoporida	Circoporus
		28. Sagenida	Sagena
		29. Aulosphærida	Aulosphæra
		30. Cannosphærida	Cannosphæra
	X. Phæoconchia (testa bivalva)	31. Concharida	Concharium
		32. Cœlodendrida	Cœlodendrum

Hypothetical Ancestral Tree of the Radiolaria (1882)



UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Oxford.—The following courses of lectures and instruction in Natural Science will be held during the present term. In the Department of Physics Prof. Clifton lectures on "The Distribution of Potential in a Circuit," and on the Galvanometer. Mr. Heaton lectures on Elementary Mechanics. Practical instruction in Physics is given daily by Prof. Clifton and Messrs. Heaton and Walker in the Clarendon Laboratory. At Christ Church Mr. Baynes lectures on the Kinetic Theory of Gases, and gives practical instruction in magnetic and electric measurements. At Balliol Mr. Dixon lectures on Elementary Heat and Light.

In the Chemical Department Prof. Odling continues his course on the Naphthalene Compounds. The Courses on Organic and Inorganic Chemistry are continued by Dr. Watts and Mr. Fisher. At Christ Church Mr. Vernon Harcourt has a class for Quantitative Analysis.

Prof. Story-Maskelyne continues his course on Crystallography, and Prof. Prestwich concludes his course on Dynamical Geology, and lectures on Stratigraphical Geology.

In the Department of Morphology practical instruction is given by Prof. Moseley and Messrs. Robertson and Hickson on Human and Comparative Anatomy. Prof. Moseley lectures on the Comparative Anatomy of the Vertebrata, Mr. Hickson on the Elements of Animal Morphology, Mr. Jackson on Mimicry and Parasitism, Mr. Poulton on Descriptive Histology, Mr. Morgan on Odontography, and Mr. Barclay-Thompson on the Anatomy of Amphibia and Reptilia.

In the Department of Physiology (which is much cramped for room pending the erection of new buildings) Prof. Burdon Sanderson lectures on the Nervous System, while practical instruction is given by the Professor and Mr. Gotch on the Elementary Physiology of the Nervous System and of the Sense Organs, and by Mr. Dixey on Histology. At Magdalen Mr. Yule has a class for instruction in Practical Physiology.

The new Reader in Anthropology will give a course of six lectures on the Development of Civilisation and the Arts of Life.

Candidates for the Professorship of Botany are requested to send in their applications to the Registrar of the University on or before January 26. The stipend is 700*l*. a year, and a house rent free in the Botanic Garden.

New College offers an Exhibition in Natural Science (Chemistry or Biology). The examination commences May 6.

CAMBRIDGE.—The following are the principal courses in Natural Science during the present term:—

Mathematics.—Prof. Adams, Lunar Theory, commencing January 31; Mr. Turner (Under Plumian Professor), Instruction in the Use of Astronomical Instruments, January 30; Mr. Mollison, Vibrations and Sound, January 24; Mr. Stearn, Hydrodynamics, January 25; Mr. Hobson, Fourier's Series and Conduction of Heat, January 28; Mr. Thompson, Electromagnetism, January 25; Mr. Glazebrook, Wave Theory of Light, January 24; Mr. Ball, Algebra and Determinants, January 25; Dr. Besant, Analysis, January 23; Mr. Pendlebury, Analytical Optics, January 23.

Chemistry.—Prof. Liveing, General Course, January 24; Prof. Dewar, Organic Chemistry, January 28; Mr. Main, General Course, January 28; Mr. Pattison-Muir, Carbon Compounds, January 25; Non-Metals, January 26; Mr. Scott, Elementary Organic Chemistry, January 25; Mr. Lewis, Catechetical Lectures, January 25; Mr. Heycock, Chemical Philosophy.

Practical Chemistry.—Mr. Sell and Mr. Fenton, Demonstrations in Quantitative Analysis, January 25.

Physics.—Lord Rayleigh, Acoustics, January 26; Mr. Trotter, Electricity and Magnetism, January 24; Physical Optics, January 24; Mr. Atkinson, Heat, January 25; Mr. Glazebrook, Elementary Physics, January 25; Mr. Shaw, Elementary and Advanced Physics, Hydrostatics and Heat, January 25.

Mechanism.—Prof. Stuart, Theory of Structures, January 29; Mr. Lyon, Statics and Hydrostatics, January 29; Rigid Dynamics, January 30; Mr. Ames, Elementary Mathematics for Students of Mechanism, January 30.

Geology.—Principles of Geology and Stratigraphy (advanced), Prof. Hughes, January 24; Dynamical Geology, Mr. Roberts, January 24; Palæontology and Petrology, by Demonstrators, January 26.

Botany.—General Elementary Course, Mr. Vines, January 24; Anatomy of Plants, Mr. Gardiner, January 25; General Biology of Plants (advanced), Mr. F. Darwin, January 26; Morphological Botany, Mr. Hicks, January 26.

Zoology and Comparative Anatomy.—Geographical Distribution of the Vertebrata, by Prof. Newton, January 30; Elementary Biology, Mr. Vines and Mr. Sedgwick, January 25; Practical Morphology, Mr. Sedgwick, January 24; Morphology of Sauropsida, Mr. Gadow, January 23.

Biology.—Elementary, Mr. Vines and Mr. Sedgwick, January 25.

Anatomy and Physiology.—Osteology, Prof. Macalister, January 25; Physiology, Prof. Foster, January 24; Anatomy of the Digestive and Circulatory Organs, Prof. Macalister, January 24; Chemical Physiology, Mr. Lea, January 25; Physiology of the Circulation, Dr. Gaskell, January 24; Practical Work, Dissection, under the supervision of the Professor and Demonstrator, in the Dissecting Room.

SCIENTIFIC SERIALS

Bulletin de la Société des Naturalistes de Moscou, année 1883, No. 2.—Researches into the compounds of the acetylenes, by A. P. Sabanéeff. The author has studied these imperfectly known compounds, namely, di-brom-acetylene, and the double compounds of acetylene with bromine and chlorine, and with chlorine and iodine. He has discovered a new method of preparing larger quantities of the former by acting with zinc on an alcoholic solution of the four-brom-acetylene, and describes its various reactions.—On the periodical changes of level of the ocean, by H. Trautschold (in German). The author, who already in 1869 supported the idea that the geological changes are due, not to the rise of the continents, but to the falling of the level of the ocean, finds in the disposition of the series of deposits of all ages up from the Silurian, on the plains of Russia, new and very interesting arguments for his idea. He maintains that the level of the ocean was falling from the Silurian epoch to the end of the Trias, when the seas had, around the now Russian plains, nearly the same shape as now. The level of the ocean rose, however, during the Jurassic period, retiring again about the end of the Chalk period.—On the bastard of the *Anas crecca* with *Anas boschas*, by Dr. N. Sewertsoff, with a coloured plate (in German). The most interesting bastard of the nearly two extremes of the ducks (relatively to their size) has been shot in the province of Ryazan. The Russian ornithologist describes its features at length, and adds some remarks on the bastards of the ducks generally.—Monopetal plants of Radde, by Ferd. von Herden (continued).—Description (in German) of the Veronicas, Castillejas, *Siphonostegia*, *Phtheirospermum*, and Omphalotrix.—A Mastodon tooth, note by H. Trautschold.—On the photographic photometry of fixed stars, by Ed. Lindemann (in German).—Materials for the fauna of Hemiptera of Russia, by W. Yakovleff, being a description, in Russian, of several new species.

Rivista Scientifico-Industriale, October 31.—A detailed account of the electric exhibition held in September at Lodi, by Prof. Alessandro Volta.—Programme of the anthropological section of the Italian exhibition to be held next year in Turin. Amongst other attractions there will be a large collection of typical Italian skulls of all dates and from every part of the peninsula. Materials will also be brought together for studying the history, ethnography, language, and present condition of all the foreign communities (Albanian, Greek, Catalonian, Slav, German, Rumansch, French) settled in various parts of the country.

Rendiconti del R. Istituto Lombardo di Scienze e Lettere, November 29, 1883.—On Lagrange's general expression of the force necessary to produce a tautocronous motion regarded as a function of space and velocity, by Prof. C. Formenti.—Geological notes on the Alps of the provinces of Reggio and Modena, by D. Pantanelli.—On the first traces of a national debt in the Byzantine Empire, by Z. von Lingenthal.—Unimetalism and bimetalism, by Dr. A. Villa Pernice.—Meteorological observations in the Brera Observatory, Milan, during the month of September, 1883.

Nachrichten of the Royal Society of Sciences and of the University of Göttingen, August 22, 1883.—Contributions to the study of spermatozoa and their evolution (preliminary paper), by Dr. A. von Brunn.—Researches on the action of glycol on orthophenylendiamin, orthodinitrobenzine, and sulphuric acid.

November 7.—On the meteorological relations of Göttingen, by Hugo Meyer.—Optical researches on the substance (calcareous spath) into which crystals of aragonite become decomposed under the action of heat, by C. Klein.—On the age of the iron ores at Hohenkirchen, by A. von Koenen.—On the theory of modular equations, by A. Hurwitz.—On the relations between solar and atmospheric electricity, showing how the latter is referable to the former and allied causes.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, November 22, 1883.—"Some Relations of Heat to Voltaic and Thermo-Electric Action of Metals in Electrolytes," by G. Gore, F.R.S., LL.D.

The experiments described in this paper throw considerable light upon the real cause of the voltaic current. The results of them are contained in twenty tables; and by comparing them with each other, and also by means of additional experiments, the following general conclusions and chief facts were obtained.

When metals in liquids are heated, they are more frequently rendered positive than negative in the proportion of about 2·8 to 1·0; and whilst the proportion in weak solutions was about 2·29 to 1·0, in strong ones it was about 3·27 to 1·0, and this accords with their thermo-electric behaviour as metals alone. The thermo-electric order of metals in liquids was, with nearly every solution, whether strong or weak, widely different from the thermo-electric order of the same metals alone. A conclusion previously arrived at was also confirmed, viz. that the liquids in which the hot metal was thermo-electro-positive in the largest proportion of cases were those containing highly electro-positive bases, such as the alkali metals. The thermo-electric effect of *gradually* heating a metal in a liquid was sometimes different from that of *suddenly* heating it, and was occasionally attended by a reversal of the current.

Degree of strength of liquid greatly affected the thermo-electric order of metals. Increase of strength usually and considerably increased the potential of metals thermo-electro-negative in liquids, and somewhat increased that of those positive in liquids.

The electric potential of metals, thermo-electro-positive in weak liquids, was usually about 3·87 times, and in strong ones 1·87 times, as great as of those which were negative. The potential of the strongest thermo-electric couple, viz. that of aluminium in weak solution of sodic phosphate, was ·66 volt for 100° F. difference of temperature, or about 100 times that of a bismuth and antimony couple.

Heating one of the metals, either the positive or negative, of a voltaic couple, usually increased their electric difference, making most metal more positive, and some more negative; whilst heating the second one also, usually neutralised to a large extent the effect of heating the first one. The electrical effect of heating a voltaic couple is nearly wholly composed of the united effects of heating each of the two metals separately, but is not however exactly the same, because whilst in the former case the metals are dissimilar, and are heated to the same temperature, in the latter they are similar, but heated to different temperatures. Also, when heating a voltaic pair, the heat applied to two metals, both of which are previously electro-polar by contact with each other as well as by contact with the liquid; but when heating one junction of a metal and liquid couple, the metal has not been previously rendered electro-polar by contact with a different one, and is therefore in a somewhat different state. When a voltaic combination, in which the positive metal is thermo-negative, and the negative one is thermo-positive, is heated, the electric potential of the couple diminishes, notwithstanding that the internal resistance is decreased.

Magnesium in particular, also zinc and cadmium, were greatly depressed in electromotive force in electrolytes by elevation of temperature. Reversals of position of two metals of a voltaic couple in the tension series by rise of temperature were chiefly due to one of the two metals increasing in electromotive force faster than the other, and in many cases to one metal increasing and the other decreasing in electromotive force, but only in a few cases was it a result of simultaneous but unequal diminution of potential of the two metals. With eighteen different voltaic couples, by rise of temperature from 60° to 160° F., the electromotive force in twelve cases was increased, and in six decreased, and the average proportions of increase for the eighteen instances was ·10 volt for the 100° F. of elevation.

A great difference in chemical composition of the liquid was attended by a considerable change in the order of the volta-tension series, and the differences of such order in two similar liquids, such as solutions of hydric chloride and potassic chloride, were much greater than those produced in either of those liquids by a difference of 100° F. of temperature. Difference of strength of solution, like difference of composition or of temperature, altered the order of such series with nearly every liquid; and the amount of such alteration by an increase of four or five times in the strength of the liquid was rather less than that caused by a difference of 100° F. of temperature. Whilst also a variation of strength of liquid caused only a moderate amount of change of order in the volta tension series, it produced more than three times that amount of change in the thermo-electric tension series. The usual effect of increasing the strength of the liquid upon the volta-electromotive force was to considerably increase it, but its effect upon the thermo-electromotive force was to largely decrease it. The degree of potential of a metal and liquid thermo-couple was not always exactly the same at the same temperature during a rise as during a fall of temperature; this is analogous to the variations of melting and solidifying points of bodies under such conditions, and also to that of supersaturation of a liquid by a salt, and is probably due to some hindrance to change of molecular movement.

The rate of ordinary chemical corrosion of each metal varied in every different liquid; in each solution also it differed with every different metal. The most chemically positive metals were usually the most quickly corroded, and the corrosion of each metal was usually the fastest with the most acid solutions. The rate of corrosion at any given temperature was dependent both upon the nature of the metal and upon that of the liquid, and was limited by the most feebly active of the two, usually the electrolyte. The order of rate of corrosion of metals also differed in every different liquid. The more dissimilar the chemical characters of two liquids the more diverse usually was the order of rapidity of corrosion of a series of metals in them. The order of rate of simple corrosion in any of the liquids examined differed from that of chemico-electric and still more from that of thermo electric tension. Corrosion is not the cause of thermo-electric action of metals in liquids.

Out of fifty-eight cases of rise of temperature the rate of ordinary corrosion was increased in every instance except one, and that was only a feeble exception—the increase of corrosion from 60° to 160° F. with different metals was extremely variable, and was from 1·5 to 321·6 times. Whether a metal increased or decreased in thermo-electromotive force by being heated, it increased in rapidity of corrosion. The proportions in which the most corroded metal was also the most thermo-electro-positive one was 65·57 per cent. in liquids at 60° F. and 69·12 in the same liquids at 160° F.; and the proportion in which it was the most chemico-electro-positive at 60° F. was 84·44 per cent., and at 160° F. 80·77 per cent. The proportion of cases therefore in which the most chemico-electro-negative metal was the most corroded one increased from 15·56 to 19·23 per cent. by a rise of temperature of 100° F. Comparison of these proportions shows that corrosion usually influenced in a greater degree chemico-electric rather than thermo-electric actions of metals in liquids. Not only was the relative number of cases in which the volta-negative metal was the most corroded increased by rise of temperature, but also the average relative loss by corrosion of the negative to that of the positive one was increased from 3·11 to 6·32.

The explanation most consistent with all the various results and conclusions is a kinetic one:—That metals and electrolytes are throughout their masses in a state of molecular vibration. That the molecules of those substances, being frictionless bodies in a frictionless medium, and their motion not being dissipated by conduction or radiation, continue incessantly in motion until some cause arises to prevent them. That each metal (or electrolyte), when unequally heated, has to a certain extent an unlike class of motions in its differently heated parts, and behaves in those parts somewhat like two metals (or electrolytes), and those unlike motions are enabled, through the intermediate conducting portion of the substance, to render those parts electro-polar. That every different metal and electrolyte has a different class of motions, and in consequence of this they also, by contact alone with each other at the same temperature, become electro-polar. The molecular motion of each different substance also increases at a different rate by rise of temperature.

This theory is equally in agreement with the chemico-electric results. In accordance with it, when in the case of a metal and an electrolyte, the two classes of motions are sufficiently unlike, chemical corrosion of the metal by the liquid takes place, and the voltaic current, originated by inherent molecular motion under the condition of contact, is maintained by the portions of motion lost by the metal and liquid during the act of uniting together. Corrosion therefore is an effect of molecular motion, and is one of the modes by which that motion is converted into and produces electric current.

In accordance with this theory, if we take a thermo-electric pair consisting of a non-corrodible metal and an electrolyte (the two being already electro-polar by mutual contact), and heat one of their points of contact, the molecular motions of the heated end of each substance at the junction are altered; and as thermo-electric energy in such combinations usually increases by rise of temperature, the metal and liquid, each singly, usually becomes more electro-polar. In such a case the unequally heated metal behaves to some extent like two metals, and the unequally heated liquid like two liquids, and so the thermo-electric pair is like a feeble chemico-electric one of two metals in two liquids, but without corrosion of either metal. If the metal and liquid are each, when alone, thermo-electro-positive, and if, when in contact, the metal increases in positive condition faster than the liquid by being heated, the latter appears thermo-electro-negative, but if less rapidly than the liquid, the metal appears thermo-electro-negative.

As also the proportion of cases is small in which metals that are positive in the ordinary thermo-electric series of metals only become negative in the metal and liquid ones (viz. only 73 out of 286 in weak solutions, and 48 out of the same number in strong ones), we may conclude that the metals, more frequently than the liquids, have the greatest thermo-electric influence, and also that the relative largeness of the number of instances of thermo-electro-positive metals in the series of metals and liquids, as in the series of metals only, is partly a consequence of the circumstance that rise of temperature usually makes substance —metals in particular—electro-positive. These statements are also consistent with the view that the elementary substances lose a portion of their molecular activity when they unite to form acids or salts, and that electrolytes therefore have usually a less degree of molecular motion than the metals of which they are partly composed.

The current from a thermo-couple of metal and liquid, therefore, may be viewed as the united result of difference of molecular motion, first, of the two junctions, and second, of the two heated (or cooled) substances; and in all cases, both of thermo- and chemico-electric action, the immediate true cause of the current is the original molecular vibrations of the substances, whilst contact is only a static permitting condition. Also that whilst in the case of thermo-electric action the sustaining cause is molecular motion, supplied by an external source of heat, in the case of chemico-electric action it is the motion lost by the metal and liquid when chemically uniting together. The direction of the current in thermo-electric cases appears to depend upon which of the two substances composing a junction increases in molecular activity the fastest by rise of temperature, or decreases the most rapidly by cooling.

Zoological Society, January 15.—E. W. H. Holdsworth, F.Z.S., in the chair.—The Secretary exhibited, on the part of Mr. H. Whitely, an immature specimen of the Night-Heron (*Nycticorax griseus*), which had been shot in Plumstead Marshes, Kent, in December last.—A communication was read from Mr. J. C. O'Halloran, Chief Commissioner and Police Magistrate for Rodriguez, accompanying a specimen of a large lizard found only in that island, and very rare there. The specimen had been identified by Mr. Boulenger as *Phelsuma newtoni*, belonging to the family Geckotidæ.—Sir Joseph Fayrer exhibited some additional specimens of the horns of deer gnawed by other deer, in confirmation of previous remarks on the subject.—Canon Tristram, F.R.S., exhibited and made remarks upon some specimens of species of the genus *Pachycephala*, which appeared to have been ignored or wrongly united to other species in a recently published volume of the Catalogue of Birds of the British Museum.—Mr. W. F. R. Weldon read a paper in which he gave a description of the placenta in *Tetraceros quadricornis*. The author showed that this placenta is intermediate between that of *Moschus* and that of the typical Bovidæ, having few cotyledons with diffuse vascular ridges between them. Associated with this primitive character is a uniserial psalterium.—A second paper by Mr. Weldon contained some notes on the anatomy of a rare American monkey, *Callithrix gigot*, which had recently died in the Society's Gardens. The author gave a description of the external characters, and the principal viscera were compared with those of *C. moloch* and of *Mycetes*.—A communication was read from Mr. E. J. Miers, F.Z.S., giving an account of a collection of Crustacea from the Mauritius, which had been forwarded to the British Museum by M. V. de Robillard. In the collection was an example of a new species of *Callianassa*, proposed to be called *C. martensi*.—Mr. Francis Day read a paper on races and hybrids among the Salmonidæ, and exhibited a series of specimens of young salmon and hybrid Salmonidæ reared at Sir J. Gibson Maitland's Howie-town Fish Establishment.—Prof. F. Jeffrey Bell read a paper on the generic position and relations of *Echinanthus tumidus* of Tenison-Woods, from the Australian seas, which he showed to belong to a different genus, proposed to be called *Anomalanthus*.

Chemical Society, January 17.—Dr. W. H. Perkin, president, in the chair.—The following gentlemen were elected Fellows:—B. H. Brough, G. Daubeney, C. C. Hutchinson, W. S. Kilpatrick, E. Matthey, H. Peile, J. Pallister, R. Romanis, S. G. Rawson, F. M. Rogers, W. Robinson, T. Stenhouse, W. O. Senier, J. A Voelcker.—The following papers were read:—On camphoric peroxide and barium camphorate, by C. T. Kingzett. In 1863 Brodie described the formation of camphoric peroxide by triturating camphoric anhydride with barium peroxide in the presence of ice-cold water. The author has repeated the above experiments, and concludes that no camphoric peroxide is formed, but that the anhydride is first converted into camphoric acid, which decomposes the barium peroxide, yielding camphorate of barium and peroxide of hydrogen.—On the decomposition of silver fulminate by hydrochloric acid, by E. Divers and Michitada Kawakita. Formic acid and hydroxyammonium chloride are formed, as is the case with mercury fulminate, but the authors have only been able to obtain two-thirds of the calculated quantity of these bodies. Some ammonia and hydrocyanic acid are also formed.—Supplementary note on Liebig's production of fulminating silver without the use of nitric acid, by E. Divers and Michitada Kawakita. The authors have succeeded in preparing the fulminate, but only when the reaction was allowed to proceed for some time. The solution was then warm, and always contained nitric acid.—On hyponitrites, by E. Divers and Tamemasa Haga. The authors criticise the recent paper of Berthelot and Ogier, and give an account of fresh investigations, which confirm the formula originally proposed by Divers, AgNO. They have not been able to obtain hyponitrite, either by the method proposed by Mencke, *i.e.* heating potassium nitrate with iron filings, or the method proposed by Zorn, in which ferrous hydrate is used as the reducing agent.

Royal Meteorological Society, January 16.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—The Secretary read the Report of the Council, which showed that the past few months mark a very important epoch in the history of the Society. In October the Council received the intimation that Her Majesty had been graciously pleased to grant the Society permission to assume the prefix "Royal." In consequence the Society has become, and will henceforth be called, the Royal Meteorological Society. In December the Fellows made certain alterations in the by-laws by which the annual subscription has been increased. The Report also showed that the Society is doing a great deal of practical work, not only by holding meetings and publishing the papers read at the same, but also by the establishment of a large number of observing-stations, which are regularly inspected, so that the results obtained from them may be strictly uniform and comparable. The number of Fellows is 549 and of honorary members 19, thus making a total of 568.—The President then delivered his address, in which he referred to the experiments made by Mr. Saxon Snell, Mr. Bertram, and Mr. Hele Shaw, with the object of determining the coefficients of Biram's anemometers; as yet these can scarcely be considered quite satisfactory, for, though made with the utmost care, they give results differing from each other by nearly 25 per cent. and from the known truth in opposite directions. The reduction of barometric readings to sea-level is another problem of great interest and importance, the solution of which is far from perfect, and, as applied to the converse determination of altitudes, has been pronounced by Mr. Gilbert, of the U.S. Geological Survey, to be beset with difficulties "so numerous and so baffling that there is no reason to hope that they will ever be fully overcome." In many cases, too, the reduction, even if correct, implies an accumulation of air in places where no air exists; and isobars so drawn, traversing mighty mountain ranges such as the Rocky Mountains or the Himalayas, or elevated plateaus such as those of Central or Eastern Asia, convey an impression which may easily lead to serious mistakes. The great achievement of the year is unquestionably the gathering in of the observations taken, by international agreement, at nine Arctic stations, in which, amidst circumstances of more or less discomfort, parties continued through a full period of twelve months. With one station established by the United States on the shores of Lady Franklin Bay, it has been found impossible to communicate; this was established in the summer of 1881, and no trustworthy news has since been received. Preliminary reports have been published from the English station at Fort Rae on the northern shores of the Great Slave Lake; from the German station in Cumberland Sound; from the Austrian at Jan Mayen, and from some of the others; but the principal interest attaches not to the observations taken separately but to the collation and comparison of the whole, which may be expected to lead the way towards problems of the greatest importance to meteorology. In the present day one science is so mixed up with a number of others, and so involved in them, that it is impossible to separate them, or to define the exact limits of each. Many of the problems of meteorology belong as much to geography, or at times even to experimental physics, and an address which speaks of the progress of meteorology is perhaps apt to appear in some degree discursive. It is that the true student of nature, whilst limiting his detailed work to one particular direction, must consider her kingdom as a grand and comprehensive whole, one and indivisible.—The following gentlemen were elected the officers and Council for the ensuing year:—President: Robert Henry Scott, F.R.S.; Vice-Presidents: Hon. Ralph Abercromby, Edmund Douglas Archibald, M.A., John Knox Laughton, F.R.A.S., William Marcet, M.D., F.R.S.; Treasurer: Henry Perigral, F.R.A.S.; Trustees: Hon. Francis Albert Rollo Russell, M.A., Stephen William Silver, F.R.G.S.;

Secretaries: George James Symons, F.R.S., John William Tripe, M.D.; Foreign Secretary: George Mathews Whipple, F.R.A.S.; Council: William Morris Beaufort, F.R.A.S.; George Chatterton, John Sanford Dyason, F.R.G.S., William Ellis, F.R.A.S., Charles Harding, Richard Inwards, F.R.A.S., Baldwin Latham, F.G.S., Robert John Lecky, F.R.A.S., Edward Mawley, F.R.H.S., Cuthbert E. Peek, F.R.G.S., Capt. Henry Toynbee, F.R.A.S., Charles Theodore Williams, M.D.

Anthropological Institute, January 8.—Prof. Flower, F.R.S., president, in the chair.—The election of the following new members was announced:—Rev. E. S. Dewick, M.A., F.G.S., Prof. A. Macalister, M.D., F.R.S., and Mr. Oldfield Thomas as ordinary members, Dr. E. T. Hamy and Dr. Hermann Welcker as honorary members, and Mr. Lucien Carr and Dr. A. B. Meyer as corresponding members.—The President stated that Mr. Francis Galton had offered 500*l*. in prizes to those who should before May 1, 1884, furnish him with the best extracts from their family records according to the form prescribed in his "Record of Family Faculties," published by Macmillan and Co., and he urged all members of the Anthropological Institute to give Mr. Galton every assistance in their power.—Mr. H. H. Johnston read a paper on the races of the Congo and the Portuguese colonies in Western Africa. The author stated that Western Tropical Africa, between Senegambia to the north and the River Cunéné, offered a vast studying ground to the anthropologist, wherein types of nearly every well-marked African race might be observed. After detailing many of the various races, he proceeded to describe the Bushmen north of Cunéné, which he characterised as about the lowest type of men, but, of the five or six specimens which came more particularly under his notice, he remarked that their mental ability was strangely at variance with their low physical characteristics. The Hottentots were much finer men than the Bushmen as regarded height and build, but they exceeded the latter in baboon-like licentiousness. The western slopes of the Shella Mountains were peopled by a tribe called the A-ndombe, a sturdy race of carriers, which extended as far north as Benguela. Referring to the races of the lower Congo, Mr. Johnston observed that they depended almost entirely upon vegetable diet, whilst they were remarkable for their initiation ceremonies. Traces of phallic worship were noticed, especially in the interior, and more particularly in the neighbourhood of Stanley Pool. A Congo market was exceedingly interesting, and was held for about four or eight days. The natives would often go 100 miles to attend one of these markets, the women generally being the keenest traders. Between Stanley Pool and the coast there is only one great leading tongue spoken, though this has several dialects. This is the Congo language, one known to and studied by Europeans probably before any other Bantu tongue. It bears many signs of Portuguese influence.

Geological Society, January 9.—J. W. Hulke, F.R.S., president, in the chair.—Patrick Doyle, Alfred Harker, Rev. Frederick Hastings, Rev. John Milne-Curran, and William Ford Stanley, were elected Fellows; Prof. G. Capellini, of Bologna, a Foreign Member, and M. Alphonse Briart, of Mons, a Foreign Correspondent of the Society.—The following communications were read:—On the volcanic group of St. David's, by the Rev. Prof. J. F. Blake, F.G.S. The result of the author's examination of the rocks in the district of St. David's which have been designated *Dimetian*, *Arvonian*, and *Pebidian*, is that they belong to one volcanic series, whose members are those usually recognised in eruptive areas, and whose age is anterior to and independent of the true Cambrian epoch. The independence of this series and the Cambrian is shown by the nature of the junction at all points of the circuit that have b en seen. The supposed isocline west of the granitic mass cannot be verified on an examination of the coast-section, there being great irregularity and gentle synclinals not far from where the apex of the isocline should be. With regard to the nature of the rocks which thus antedate the Cambrian, the author was unable to recognise any true alternations in the materials of the granitic axis, though the rock is a peculiar one in the arrangement of its constituents. The felsitic rocks are not independent of the granite, as they surround it on all sides, the line along the north and south being specially traced. They are also often intrusive into the ashes, and hence can have no definite strike. Attention was drawn to the highly acid character of the whole series, and to the small size of the centres of eruption, and it was suggested that such centres have continually decreased in number and increased in magnitude during geological time.—On further discoveries of vertebrate remains in the Triassic strata of the south coast of Devonshire, between Budleigh Salterton and Sidmouth, by A. T. Metcalfe, F.G.S. The author gave a brief stratigraphical account of the Triassic rocks of the coast. He then described some vertebrate remains, consisting chiefly of portions of jaw-bones with teeth in line, probably of Labyrinthodonts, found in the upper sandstones (Ussher's classification) at High Peake Hill, near Sidmouth, by H. J. Carter, F.R.S. At numerous places between Budleigh Salterton and Sidmouth, Mr. Carter and the author had found a large number of isolated bone fragments. Such fragments had been submitted to a microscopical examination by Mr. Carter. In some specimens the bone structure was visible throughout; in some the bony portion had been partially removed and replaced by an infiltration of mineral matter; in others the removal of the bony portion was complete. From these facts the author drew the conclusion that a comparative abundance of vertebrate life was maintained during the Triassic period; and that the rareness of Triassic fossils was due not so much to the paucity of animal life during that period as to the fact that Triassic strata afforded no suitable conditions for the *preservation* of organic remains.

EDINBURGH

Royal Physical Society, January 16.—J. A. Harvie-Brown, F.R.S.E., president, in the chair.—The following communications were read:—On intra-epithelial capillaries in Oligochæta, by F. E. Beddard, F.R.S.E.—On the geognosy of the Harz Mountains, part 1, by H. M. Cadell, B.Sc., of the Scottish Geological Survey. The writer stated that there was still some room for original investigation in that quarter, notwithstanding the great attention the German geologists had bestowed on the region. The Germans had not yet learned the art of detailed structural geological mapping and section-drawing as carried out in the British geological surveys, and many of their so-called geological maps were nothing more than mere petrographical pictures. The writer then went over the various formations of the Harz, and noticed the fact that graptolites were found at the top only of the lowest or Hercynian rocks, which he suggested might be cited as an example of one of Barrandes' "colonies." The older or "core rocks" of the Harz terminating in the Kulm were overlaid in violent unconformability by the border rocks, beginning at the coal measures and extending upwards to the Trias and Cretaceous systems. He agreed with those who consider the loess an "æolian" deposit swept as dust into sheltered valleys and nooks by the wind, and thought that water had had nothing directly to do with its origin. The paper was illustrated by the exhibition of rocks and metallic minerals from the region described.—Prof. Cossar Ewart, F.R.S.E., exhibited, with remarks, a large torpedo recently caught in a trawl off Wick, and believed to be the only specimen of the kind ever found north of the English Channel. The specimen exhibited was 28 inches in length and 19½ inches across the pectoral fins, and belonged to the species *hebetans*.

SYDNEY

Linnean Society of New South Wales, November 28, 1883.—C. S. Wilkinson, F.G.S., F.L.S., president, in the chair.—The following papers were read:—Some fishes of New Britain and the adjoining islands, by Charles W. De Vis, B.A. The names of the new specimens described are—*Serranus perguttatus* and *cruentus*, *Mesoprion flavirosea*, *Tetraroge vestita*, *Acanthurus zebra*, *Rynchichthys novæ-britanniæ*, *Harpage rosea* (a new genus of the Berycidæ), *Salarias æquipinnis*, *Amphiprion arion*, *Pomacentrus onyx* and *notatus*, *Nesiotes purpurascens* (a new genus of the Labridæ), *Exocœtus longibarba*, *Arius armiger*, *Herpetichthys cobra*, (a new genus of the Murænidæ), *Tetrodon insularium* and *lævis*.—Some results of trawl fishing outside Port Jackson, by William Macleay, F.L.S. In this paper are given—(1) An account of two trials of a large beam trawl in forty to fifty fathoms water, by the order of the Commissioner of Fisheries; (2) a list of the fishes captured; and (3) descriptions of two new species—a skate, *Raia australis*, and a gurnard, *Lepidotrigla mulhalli*. Mr. Macleay considers the result promising on the whole.—Baron Maclay read a note on the "Barometro Araucano" from the Chiloe Islands. He stated that this remarkable instrument had been shown to him among a number of other curiosities by Capt. C. de Amezaga, of the

Italian corvette *Caraciolo*, who informed him that it was used by the natives of the Chiloe Islands as a kind of barometer to foretell the approach of either dry or wet weather. This "Barometro Araucano," which consisted merely of the shell of a crab, pronounced by Mr. Haswell to be one of the *Anomura*, probably of the genus *Lithodes*, is most peculiarly sensitive to atmospheric changes. In dry weather it remains nearly white, but, with the approach of moisture, small red spots appear on the shell, increasing in number and size with the increase of humidity, until during the wet season it becomes completely red.

Paris

Academy of Sciences, January 14.—M. Rolland in the chair.—On the researches of M. Guntz in the thermo-chemistry of the fluorides, in reply to the strictures of M. Tommasi, by M. Berthelot.—On a process of anæsthesis by the method of titrate mixtures of vapours and air; its application to the human subject in the form of vapours of chloroform, by M. Paul Bert. The chief advantages of this process are stated to be: delirium always slight, sometimes altogether absent, even in adults; absolute and regular insensibility obtained in six to eight minutes; quiet sleep; normal breathing, circulation, and temperature; no symptoms of nausea; normal and perfectly reassuring appearance of the patient while asleep; constant and always very protracted consecutive anæsthesis; great economy in the outlay for chloroform.—Generalisation and strictly mechanical demonstration of Joule's electrical formula, $w = i e T$, by M. A. Ledieu.—On the preparation in large quantities of artificial virus attenuated by rapid heating, by M. A. Chauveau. By this process sufficient virus for the prophylactic inoculation of from 4000 to 8000 sheep may be rapidly prepared in the same reservoir.—Observations of the Pons-Brooks comet made at the bent equatorial of the Paris Observatory, by M. Périgaud.—On the genus of some entire functions in mathematical analysis, by M. Laguerre.—On the geometrical curve known as Pascal's "limaçon," by M. A. Genocchi.—On linear differential equations with doubly periodical coefficients, by M. G. Floquet.—On the adiabatic expansion of the vapour of water, by M. P. Charpentier.—On the agreement of experience with the general theoretic law regulating capillary surfaces, especially in its application to water confined between two moistened plaques, vertical and parallel, by M. Quet.—On a new method of determining the magnetic inclination by means of the induction compass, by M. Wild.—On the observation of earth currents whose intensity is shown to be subject to secondary fluctuations depending on the degree of moisture and temperature of the zone comprised within the circuit, by M. Larroque.—Determination of the intensity of combustion in some acetones and in the two ethers of carbonic acid, by M. W. Louguinine.—On the phenomena of chemical dissociation, by M. Isambert. Here the author endeavours to resume the results of his experimental researches on dissociation in a simple theory based on the thermic data, by means of which alone it is possible to appreciate chemical phenomena.—On the preparation of the sulphate of the sesquioxide of pure chromium, by M. H. Baubigny.—Explanation of a method for determining the density of liquid oxygen, by M. Menges. The author obtains the equation $d = \frac{V_1 d_1}{v - v_1}$, where d = the density of the liquid gas, v = its volume, V = the volume of the gaseous portion, all known quantities.—On colloidal ferric ethylate and ferric hydrate, by M. Ed. Grimaux.—On a chloruretted silicate of manganese, by M. Al. Gorgeu.—On the influence of plastering on the composition and the chemical properties of wine, by M. L. Magnier de la Source. The plastering process with chemically pure sulphate of lime has the effect of decomposing not only the cream of tartar, but also the neutral organic combinations of potassium which are present in a very considerable proportion in the perfectly ripe grape.—On the presence of the diamond in some graphic stone occurring near Bellary, Madras Presidency, by M. Chaper.—On the fossil Echinidæ of the Eocene formations at Saint-Palais (Charente Inférieure), by M. G. Cotteau.

Berlin

Physical Society, January 4.—Prof. Neesen briefly communicated the contents of a paper sent in by Herr Friedrich C. S. Müller, describing three apparatus used in connection with the delivery of lectures: a tangent compass, a galvanometer, and a rheostat. These instruments were intended to take rapid measurements, and to render them visible to a large audience. Following up this subject, Prof. Neesen gave a short account of the contrivance by which in his lectures he measured the mutual attraction of two magnets by means of scales. In conclusion, he reported experiments instituted by him with a view to determining the influence of magnetisation on electrical conducting power. In these experiments he had made use of a magnetic substance of high specific resistance, a solution of chloride of iron. Two equal tubes were filled with the same solution, and inserted as the two branches of a Wheatstone bridge into the circuit of a galvanic battery; the two other branches being so arranged that the galvanometer stood at zero. The electrodes in the two tubes consisted of iron plates, and were exactly alike. The tubes, that is, the fluid conductors, had in the different experiments different shapes and different diameters. The contents of the one tube were then magnetised either by a magnetising spiral or by a powerful electromagnet, and the galvanometer was observed during this process of magnetisation. The result of the experiments was in every case a negative one. Very slight deflexions were indeed observed in the galvanometer needle in the case of the experiments with the magnetising spiral, but these proceeded from the slight heating of the fluid, an effect which, notwithstanding the solution of chloride of iron was surrounded by a casing of circulating water, had not been wholly avoided. In those experiments, on the other hand, in which the magnetisation was made by means of the electromagnet, the needle remained invariably at rest.—Prof. Rœber discussed and explained the principle of experiments made on the Rhone and reported in the *Comptes Rendus*. These experiments had for their object the towing of ships by means of ropes wound round the whole vessel.—Dr. Kœnig gave a short preliminary communication on the experiments, which, in cooperation with Dr. Dietrici, he had made, with a view to determining the precise position of different spectral colours and the sensitiveness of the eye for distinguishing colours. At the next meeting of the Society he would speak at greater length on the subject, illustrating it by numerical data.

CONTENTS

THURSDAY, JANUARY 31, 1884

THE INDIANS OF GUIANA

Among the Indians of Guiana: being Sketches chiefly Anthropologic from the Interior of British Guiana. By Everard F. Im Thurn, M.A. Oxon. (London: Kegan Paul, Trench, and Co., 1883.)

GENERALLY speaking, the books of travel on which anthropologists have to depend for information as to the less cultured tribes of mankind are descriptions of a country and its exploration, with a chapter or two on the natives. Here the plan is reversed, the main book being a treatise on Caribs and Arawaks, to which is prefaced a short but lively description of the forests and savannahs of Guiana, with their plants and animals, forming as it were a frame in which to set the human picture. When Mr. Im Thurn first went to Guiana in 1877, he spent much of his two years' stay in wanderings among the Indians, and before the end of 1881 went back to the colony, where he is now Resident Magistrate of the Pomeroon District. Such appointments are much to be commended, on the one hand as putting the indigenous tribes under the control and protection of an official thoroughly conversant with native character and custom, on the other hand as placing a scientific man in intimate relations with the fast disappearing culture of the lower races.

The question to what races these native tribes of Guiana belong has occupied Mr. Im Thurn, with results which are not only interesting in themselves but have a bearing on larger problems of anthropology. We too readily take it for granted that the lower barbarians have no history beyond two or three generations of old men's memory. In the present district, however, something far beyond this seems to be made out. The native tribes of Guiana fall into two divisions. One group is made up of the Arawaks, Warraus, and Wapianas; and these, though unintelligible and hostile to one another, are united by a common feeling of aversion to the Caribs, who, native tradition says, came from the West India Islands. These Caribs, who form the other group of tribes of Guiana, are in appearance, language, and customs similar to those of the West Indies, so that we have here a case of native tradition asserting that certain tribes of a country were invaders from another region, though the Carib immigration thus remembered took place perhaps three to five hundred years ago. The present author is so convinced of the reality of this event that he calls the Caribs in Guiana "stranger" tribes to distinguish them from the "native" tribes. Long ago as the invasion happened, Mr. Im Thurn points out that the industrial arts of the two races have not yet become blended. The Arawaks and other native tribes continue to make their hammocks of palm fibre, not taking to the use of cotton thread for hammock-weaving, although the Caribs brought this art so long ago with them from their islands, and have practised it in Guiana ever since. What is still more curious is that the rude method of making thread by rolling palm or grass fibre into a twist with the palm of the hand on the thigh, may be commonly seen in Guiana, although the use of the spindle for spinning cotton is also usual. The explanation of this coexistence of a savage and a more civilised art is no doubt that the old native tribes were "thigh-twisters," but the new stranger tribes were spinners, and the descendants of both have more or less kept up their hereditary methods (pp. 171, 287).

Among matters bearing on the history of civilisation which struck Mr. Im Thurn was the custom of building houses on piles. This may be seen in its primary form among the Warraus (p. 202); although quiet times and security from enemies make it no longer worth their while to build actually out in the waters, they still build many pile-huts in the swamps. These miserable huts have been described as standing on a platform of interlaced stems of the manicole palm, supported on tree trunks five or six feet high, with a notched trunk serving as a ladder, to which, when the waters were high, the canoe was made fast. The motive of building in such a situation is intelligible enough as a means of safety from enemies, but next we come to an extension of the practice requiring explanation:—

"A most remarkable fact is that houses on piles are not unfrequently built, for no apparent reason, on the savannah; and this is done not by any special tribe, but occasionally by Arecunas, Macusis, and by other Carib tribes. They stand not in swamps but on dry ground, sometimes on top of a hill. Except that they are much larger, they are exactly like the Warrau houses already described; and it is a noteworthy fact that the platform on which the house stands is, as in the case of the Warrau houses, made of the stems of manicole palms (*Euterpe oleracea*), though this moisture-loving palm is very locally distributed in the savannah region, and the Indians fetch it from long distances, although other apparently equally suitable material is at hand. It is probable that these savannah pile-builders revert to a form of house which they saw—and perhaps used—on the coast land, when they first reached the mainland from the islands."

This explanation of pile-houses on land as due to survival of the once purposeful habit of building them in the water is the more interesting from its correspondence with a theory based on similar facts on the other side of the globe. Prof. Moseley, describing New Guinea ("Notes by a Naturalist on the *Challenger*," p. 396) points out that the pile-dwellings must have been first built in the water for protection and afterwards were continued on land. Pushing the argument further, he suggests that the pile-house on dry ground was converted into a two-story dwelling by filling in the spaces between the poles with leaves or mats, so that the lower part might serve as a storehouse or cowhouse. In this way Prof. Moseley accounts for the Swiss peasant's châlet as derived from the watery home of the ancient lake-dweller, the present balcony representing the old platform to which the lake-men climbed up from their canoes. When the present remarks find their way into Mr. Im Thurn's hands, it is to be hoped that he will test this ingenious view by the evidence within his reach.

Mr. Im Thurn's researches into the religious ideas of the Guiana tribes disclose a remarkable theological condition. To so acute a student of the theory of religion it must have been an exciting occupation to live in daily mental contact with Animistic conceptions at once so primitive and so vivid. In any future discussion of

Animism, the results obtained by him must take a prominent place.[1] Few, if any, Europeans have had such perfect opportunity of seeing the idea of soul originate in the evidence of the senses in dreams, as interpreted by childlike, savage philosophy. Dreams are, to these rude people, events of real life, in which the spirits or phantoms of other men come to them in sleep, or are seen when the sleeper, in like manner, leaves his own body lying and goes forth into the dream-world. Both these conceptions are illustrated in the following stories of what occurred to our traveller :—

"It becomes important, therefore fully to recognise the complete belief of the Indian in the reality of his dream-life, and in the unbroken continuity of this with his working life. It is easy to show this belief by many incidents which came under my notice. For instance, one morning when it was important to me to get away from a camp on the Essequibo River, at which I had been detained for some days by the illness of some of my Indian companions, I found that one of the invalids, a young Macusi, though better in health, was so enraged against me that he refused to stir, for he declared that, with great want of consideration for his weak health, I had taken him out during the night and had made him haul the canoe up a series of difficult cataracts. Nothing could persuade him that this was but a dream, and it was some time before he was so far pacified as to throw himself sulkily into the bottom of the canoe. At that time we were all suffering from a great scarcity of food, and hunger having its usual effect in producing vivid dreams, similar effects frequently occurred. More than once the men declared in the morning that some absent men, whom they named, had come during the night and had beaten or otherwise maltreated them; and they insisted upon much rubbing of the bruised parts of their bodies. Another instance was amusing. In the middle of one night I was awakened by an Arawak named Sam, the captain or head man of the Indians who were with me, only to be told the bewildering words, 'George speak me very bad, boss; you cut his bits!' It was some time before I could collect my senses sufficiently to remember that 'bits' or fourpenny-pieces are the units in which, among Creoles and semi-civilised Indians, calculation of money, and consequently of wages, is made; that to cut bits means to reduce the number of bits or wages given; and to understand that Captain Sam, having dreamed that his subordinate George had spoken insolently to him, the former, with a fine sense of the dignity of his office, now insisted that the culprit should be punished in real life" (p. 344).

Not less clear is the train of native argument by which the notion of soul extends itself from man to the other animals, which in the view of the rude Indian are beings differing indeed from man in bodily form and strength, but comparable with him in ways and cunning, creatures talking among themselves in their own languages, not more unintelligible to him than are the languages of surrounding tribes of men. Indeed the peai-man or magician of his own tribe, carrying into fraudulent effect this real belief, holds converse in his hearing with birds and beasts. What rude men think of the intelligence of animals is well illustrated by a custom which came under Mr. Im Thurn's own notice. "Before leaving a temporary camp in the forest, where they have killed a tapir and dried the meat on a babracot (stage of green sticks for smoking meat over a fire), Indians invariably destroy this babracot, saying that should a tapir passing that way find traces of the slaughter of one of his kind, he would come by night on the next occasion when Indians slept at that place, and taking a man, would babracot him in revenge."

Not to discuss here the spirits of rocks, waterfalls, and objects generally, which animate the Indian's world, mention may be made of those particular phases of Animism which underlie the proceedings of the native magicians, as to which Mr. Im Thurn has brought some picturesque and instructive facts into view. To understand these ideas, it has to be borne in mind that by the native law of vengeance, when an injury has been done (or believed to have been done) to a man, his nearest relative, as his avenger (*kenaima*), sets himself to follow and slay the wrongdoer, or, if he cannot be found, one of his relatives. Thus every Indian lives in constant dread that a kenaima may be following him like a shadow through the forest till he can catch him sleeping or helpless, strike him down, and rub deadly poison into his flesh, or dislocate his limbs. All this really happens, but the Indian extends the idea into his spirit-world, and, with a rude but sufficient philosophy, finds a cause of all sickness and death in attacks by the spirits sent by the imaginary kenaimas, which enter into the bodies of beasts of prey to attack their victims, or poison them, or, embodied in worms or insects, or any other small objects, pass into their bodies, and cause aches and pains. Against these spirit-foes the Indian has a protector, the magician or *peai*-man. This personage's craft is based on the same Animistic theory as that of his dupes, as is plain from the training for the profession which he undergoes, fasting, wandering in the forest, and drinking large draughts of tobacco-water, till he can work himself up into morbid passions of excitement, in which his intercourse with the spirits is carried on, partly no doubt in knavish imposture, but partly also in genuine belief. The methods by which this practitioner drives out disease-spirits from his patients were actually experienced by Mr. Im Thurn, who had the luck of getting a peai-man to operate on him for a slight headache and fever. A company of some thirty people, mostly attracted by the prospect of so novel a performance as peai-ing a white man, were assembled in the house of the doctor, the entrance was closed, the fires put out, and all lay in their hammocks, our traveller being especially warned not to set foot on the ground, for the kenaimas would be on the floor, and would do dreadful things to him if they caught him. Much like his analogue the professional medium at a modern *séance*, the peai-man made the patient promise not to stir out of his hammock, nor look, nor lay hands on anything that might touch him. For a while all was still, till suddenly the silence was broken by a burst of indescribable and really terrible yells and shouts, which filled the house, shaking walls and roof, sometimes rising rhythmically to a roar, which never ceased for six hours. Questions seemed to be thundered out and answers shouted back, with no pause in the sound. A little Macusi boy, who had slung his hammock close to Mr. Im Thurn's, whispered to him that it was the peai-man roaring his questions and commands to the kenaimas, who were yelling and growling and shouting

[1] A paper by Mr. Im Thurn, embodying much of this research, will be found in the *Journal of the Anthropological Institute*, vol. xi., and remarks of mine on it in a lecture on anthropology printed in NATURE, May 3 and 17, 1883.—E. B. T.

their answers. Every now and then, through the mad din, there was a sound, at first low and indistinct, and then gathering in volume, as if some big winged thing came from far toward the house, passed through the roof and then settled heavily on the floor; and again, after an interval, as if the same winged thing rose and passed away as it had come. As each of these mysterious beings came and went, the air, as if displaced by wings, was driven over the patient's face. They were the kenaimas coming and going. As each came, his yells were first indistinctly heard from far off, but grew louder and louder until, as he alighted on the floor of the house, they reached their height. The first thing each did was to lap up some of the tobacco-water, with an ostentatious noise, from the calabash on the floor. But while he lapped the peai-man kept up the shouts, until the kenaima was ready to answer. When each kenaima had given an account of itself, and had promised not to trouble the sick man, it flew rustling away. They came in the form of tigers, deer, monkeys, birds, turtles, snakes, and of Ackawoi and Arecuna Indians. Their voices were slightly different in tone, and they all shouted in voices which were supposed to be appropriate to their forms, but, oddly enough, all hoarsely. It was a clever piece of ventriloquism and acting. The whole long terrific noise came from the throat of the peai-man, or perhaps a little of it from his wife. The only marvel was that the man could sustain so tremendous a strain upon his voice and throat for six long hours. The rustling of the wings of the kenaimas, and the thud which was heard as each alighted on the floor, were produced by the magician skilfully shaking the leafy boughs brought in for the purpose, and then dashing them suddenly against the ground. This Mr. Im Thurn discovered by the boughs accidentally touching his face, when he seized some of the leaves with his teeth. At the crisis he seemed to feel a hand laid on his face. The effect of all this upon him was very strange. Before long he passed into a kind of fitful sleep or stupor, probably akin to mesmeric trance. Incapable of voluntary motion, he seemed to be suspended somewhere in a ceaselessly surging din. Now and then when the noise all but died away, and the peai-man was supposed to have passed out through the roof and to be heard from a great distance, he awoke to half-consciousness, but as the magician came back and the noise grew again he fell back into stupor. At last towards morning, when the noise ended, he awoke thoroughly, and finding the entrance unbarred, rushed out to find relief in the rain and storm. His head was indeed anything but cured of its ache, but the peai-man insisted that he must be cured, and asked for payment, producing a caterpillar, which he declared was the kenaima which had caused the pain, and which he had extracted when he touched the patient's face. Accordingly he received a fourpenny looking-glass as his fee, and was satisfied.

These extracts will give an idea of the goodness of the material contributed by Mr. Im Thurn to the study of the lower phases of human thought. In conclusion, a few words may be said as to his suggestions on the interesting problem how an explorer may reach the plateau-top of the precipice-walled Roraima, and settle the question what ancient and modern animals and plants have survived and developed there, and whether there may be any truth in fancies of strange human tribes dwelling there, cut off for ages from their fellow-men. In the far west of Guiana or over the Brazilian boundary, where the savannah itself rises 5000 feet above the sea, Roraima springs from it in perpendicular sandstone cliffs 2000 feet high, topped by a flat tableland apparently forest-covered, and whence waterfalls pour down. Round the whole circumference the cliff-wall is said to be perpendicular, but this is mere conjecture, for no traveller has ever been round it. The summit may prove accessible from the other side, and at any rate enough is known of the fauna and flora of the district to make it certain that a naturalist who should accomplish the circuit would be well rewarded by discoveries, even if he failed to reach the top. There is a way as yet untried, which Mr. Im Thurn is convinced will prove more practicable than those by which Roraima has been hitherto approached. He recommends going up the Potaro as far as possible by boats, and thence striking across the savannah on foot. The journey is one of difficulty and privation, which Mr. Im Thurn warns any explorer against undertaking without fully weighing the difficulty and cost. Perhaps we may hear some day of himself, as the leader of a well-equipped expedition, making the attempt.

E. B. TYLOR

THE COLLECTION OF DEERS' HORNS AT THE ROYAL CASTLE OF MORITZBURG

Die Hirschgeweih-sammlung im Königlichen Schlosse zu Moritzburg bei Dresden, mit allerhöchster Genehmigung und Unterstützung Seiner Magestät des Königs Albert von Sachsen. Herausgegeben von Dr. Adolf Bernhard Meyer, K.S. Hofrath und Director des K. Zoologischen Museums zu Dresden. (Dresden: Wilhelm Hoffmann, 1883.)

THE King of Saxony's Hunting Lodge of Moritzburg lies some three hours' journey north from Dresden; it is built on an island in a little lake embowered amid the Friedewald. It was built between the years 1542 and 1589, under the Electors Moritz (1541-1553), August (1553-1586), and Christian I. (1586-1591), after the plans of the first of these Electors, apparently by the architect Hans von Dehn-Rothfelser, and it has been enlarged and renovated from time to time chiefly under the Electors John George I. (1611-1656), and John George IV. (1691-1694), and August II. King of Poland (1694-1763). It contains some two hundred rooms and seven halls, in which latter are arranged the series of pictures relating to hunting, and a collection of horns of all sorts. For this latter the Castle may thank the celebrity which it has among all sporting characters and zoologists. The walls of the large Banqueting Hall, which is 20·25 m. long, 10·50 m. wide, and 11·60 m. in height, are adorned with a collection of seventy-one noble horns of deer, of which none are under four-and-twenty points; while in the Audience Hall is preserved a collection of forty-two more or less extraordinary or monstrous horns, amongst which is the celebrated pair with sixty-six points.

It was a happy thought of Dr. A. B. Meyer, the indefatigable Director of the Royal Zoological Museum at Dresden, to publish an illustrated catalogue of this collection, which, with the gracious approval and assistance of the present King Albert of Saxony, has assumed the form of a splendid folio volume, with 30 plates, in which from 1 to 26 contain figures of all the remarkable horns from the Banqueting Hall, and from 27 to 29 represent some of the more interesting of the monstrous horns, while on Plate 30 we have a most extraordinary instance of a pair of horns—one of ten, the other of twelve, points—which had during life got inextricably interlocked with one another. The finest and most characteristic pairs of horns were selected for these photographs, which are by a new process most excellently reproduced on the plates. As a frontispiece to the text we have a photograph of a quaint sketch of the Castle.

About 1861, Dr. Meyer informs us, acting under the direction of Grand Marshall H. von Freisen, a catalogue of the seventy-one horns in the Banqueting Hall, with measurements in inches, was compiled, but unfortunately some of the identifications cannot be regarded as certain. It is strange that, in spite of the great care with which this collection of horns has been kept, there seems to be no record of when and whence the very ancient ones came to Moritzburg. Even the *Archives* of the place are nearly silent about them. Dr. Meyer has in this quite luxurious catalogue done what he could to rescue all that is known about the collection from oblivion, and he promises at some future time to give the history of the remaining two-thirds as a continuation of this work.

OUR BOOK SHELF

Guide to Methods of Insect Life, and Prevention and Remedy of Insect Ravage. By Eleanor A. Ormerod. Pp. 1-167, 8vo. (London: Simpkin, Marshall, and Co., 1884.)

THE text contains the substance of ten lectures delivered for the Institute of Agriculture. At p. 7 there is an italicised remark to the effect that "*insects always begin life by being produced by a female.*" This may be regarded as an indication of the presumably ultra-ignorant class for whose benefit the lectures were prepared. But we prefer to think that far too low an estimate of the knowledge possessed by our agriculturists has been made, and doubt not that, by a majority of them, the remark will be taken as the reverse of complimentary. The book is exceedingly well got up, and in a very attractive style, and will no doubt become popular (on account of the multitude of illustrations. For the agriculturist purely, it seems to us that it goes either not far enough or too far; it is too "showy" for practical purposes, and often, unwittingly, too abstruse. The copious illustrations are mostly excellent, and many of them are original (among the very few very indifferent figures, that of the "Bee-parasite" may be cited). But the necessity for many of the figures in a book apparently intended for the agricultural class may be doubted, and some have evidently been introduced for effect. That American bogey (or "fraud") the "Colorado Beetle," is honoured by the reproduction of his portrait, and the *Phylloxera* is dismissed with only dishonourable mention. The general information is sound, but occasionally vague, as in the definitions of the terms "larva" and "pupa," and in the apparent assumption that respiration is exclusively effected by the external air being conveyed to the tracheæ by means of *spiracles*. The "Glossary" will no doubt be found very useful to the majority of the readers of the book, but some terms (e.g. "*Telum*") appear wonderfully abstruse, as used in a work in which it was necessary to explain that "*insects always begin life by being produced by a female.*"

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Remarkable Sunsets

ON Friday, the 11th inst., the weather was very remarkable; it recalled to our minds, though on a smaller scale, the storm of December 12, 1883. In the afternoon, about three o'clock, the wind arose with violence, and great squalls alternated with relative calms. The movements of the clouds were also very curious. Layers of air of different elevation floated in various directions, and the lower very low-hanging clouds which moved at the same level had, at different points of the sky, an unequal and changing rapidity. The wind beneath was, at 6 p.m., west-south-west; the lower clouds came from the west, the more elevated, on the contrary, from the north-north-west, so there is no doubt that whirlwinds blew that day in the upper air. The sun had set with a very fine after-glow, and in the ensuing night and morning there fell, now and then, showers of rain occasionally accompanied by snow and hail. Besides, the night before a magnificent halo had been observed around the moon, so

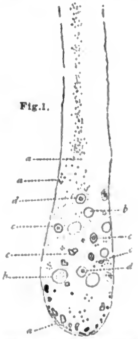


FIG. 1.—Sediment and residue of an evaporated drop of rain, fallen January 12, 1884, on a window-pane. *a a a*, particles of the ash; *b b*, drops of hygroscopic matter; *c c c*, crystals of common salt; and andesitous mineral; *d d*, drops with salt crystals.

that the presence of ice crystals on January 11, in the higher regions of the atmosphere, is certain. In consequence of the low temperature, the air in those regions must have had a great density, and so, apparently, there must have been a great chance that the whirlwinds on Friday had moved the heavy, cold air from above downwards.

That this was really the case seems to proceed from the fact that during the night of January 11 and 12 the rain had brought down on my windows the same sediment as that of December 12, though in smaller quantity. The identity of this sediment with the ashes of Krakatoa will now be beyond doubt to any one who has read the numerous communications in NATURE on the remarkable sunsets. Why I wish to refer to this affair once more is that at the microscopic examination of the dust of January 12 I found in it a relatively great quantity of complete individual crystals, partly soluble, partly insoluble, in water, which had remained unobserved by me in December.

After having scraped the dust off the window-panes and put it on the slide in a drop of oil, I made a drawing of the crystals by means of the camera lucida, magnifying them 400 times, as represented in Fig. 2.

The crystals, as seen in Fig. 2 *a*, evidently exist in common salt; this follows from their solubility in water, their crystalline form, and their reaction in the flame. They are found in so great a number in the residuum of every drop of rain that we come to the conclusion that these little crystals must be found as such in those regions of the atmosphere where the dust is floating, the air containing there hardly anything else but ice, and surely little liquid water.

In Fig. 2 *b* we see the crystals insoluble in water. They are uncoloured and perfectly transparent, and may be considered to be the crystalline form of the ande-itous mineral of which the ashes consist for the greater part.

The residuum of the evaporated rain-drop of January 12 showed itself about in the manner seen in Fig. 1. If the window-pane is used as a slide and the dust examined directly with the microscope, one will find there a great number of little drops (*b b*, Fig. 1), in most of which a very fine sediment is seen of the constituents of the ashes; in a few drops, however, there are to be found crystals of common salt (*d d*); further, many loose crystals spread over the whole space (*c c*). Probably

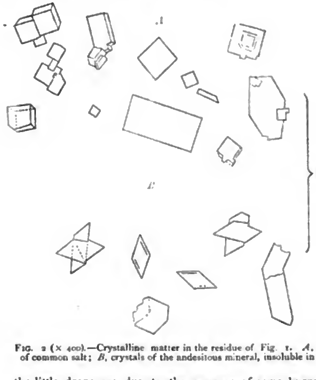


Fig.2.

FIG. 2 (× 400).—Crystalline matter in the residue of Fig. 1. *A*, crystals of common salt; *B*, crystals of the andesitous mineral, insoluble in water.

the little drops are due to the presence of some hygroscopic matter such as $MgCl_2$ or $CaCl_2$ around some salt crystals. Especially at the lower end of the whole drop assemble the larger, glassy, black and brown particles of the ashes.

The above proves that during the last few weeks crystals of a particular nature were floating in the air, and will perhaps explain the appearance of mock suns described by some of the observers of the after-glow.

In a sample of original ashes from Krakatoa, when examined in oil, I only found very few salt crystals, and the completely outgrown andesitous crystals not at all. I am, however, convinced that with longer research I should have found the latter, and others seem to have discovered them indeed, but they are without doubt very rare. So it seems to me that it may be taken for granted that in the atmospheric dust the proportionate number of completely formed crystals is larger than in the natural ashes, and the presence of so much common salt in the upper air during these days is surely a remarkable fact.

Wageningen, January 14 M. W. BEYERINCK

THE atmospheric appearances frequently seen during the last few months, principally at sunrise and sunset, from the similarity of some of the manifestations to auroral appearance, have led some persons to suspect connection of the phenomena with magnetism.

Hitherto auroral exhibitions have, at Greenwich, been invariably accompanied by considerable magnetic disturbance, and the absence of such disturbance on days on which the recent remarkable atmospheric phenomena have been seen at Greenwich seems conclusive as to the question of direct connection with magnetism. The Astronomer-Royal has therefore thought that a brief statement of the circumstances in this respect might be of interest to your readers. It appears that, either at sunrise or sunset, unusual atmospheric appearances were seen at Greenwich on November 8, 9, 13, 25, 26, 27, 28, 29, December 1, 2, 4, 5, 6, 7, 11, 17, and January 12 last. Of these days, on November 13 and January 12 the magnets were quiet, and on November 8, 9, 25, 26, 29, December 4, 5, 6, 7, and 17 very quiet; on November 27, 28, December 1, 2, and 11, there was a little motion. The whole period was quiet generally as regards magnetic activity; only at one time during the period from November 8 to January 12 was there any noteworthy disturbance, which occurred on the days from November 19 to 22, and in no case was it in any degree remarkable. WILLIAM ELLIS

Royal Observatory, Greenwich, January 26

ON p. 157 of your current volume you ask your "readers in all parts of the world" to communicate facts relative to the singular sunsets which have been seen.

Until seeing your request I had made no note of dates, but as far as I can trust my memory the "after-glow" was noticed here early in September, 1883. On one night it lasted about two hours after sunset. The phenomenon of "Contrast-Farben" mentioned by von Helmholtz in NATURE, December 6, 1883, p. 130, I have noticed most markedly on two occasions—once in October, and again on December 28 or 29, 1883. During this year the sunsets on January 5, 9, 12, and 13, have been accompanied by the "after-glow."

About 12 o'clock on the 13th I saw a peculiar colour in the neighbourhood of the sun, which on closer inspection was seen to be in the form of an ellipse, the major axis being in the plane of the meridian. The length of this axis was about 50°. The sun was situated nearer the upper extremity of this axis, in breadth about 20°. The colour of this ellipse was a pale reddish-violet ashen (if you can imagine such a combination). The sky at the time was a deep blue, except in the ellipse. I suppose the violet tinge was due to a combination of the red of what at evening forms the "after-glow" and the blue sky. There were a few clouds slowly moving from the west, and as one of these approached the sun, when within about 6 diameters of the sun, the edge nearer the sun became coloured a faint yellow; then followed pale pink, dark pink, green, then again dark pink in bands; as the cloud floated over the sun's disk one saw the bands of colour continuous, forming a halo. The clouds were of a fleecy texture; I believe they were "cirro-stratus," not, however, as open as what we call a "mackerel sky," and so tenuous that they did not appreciably diminish the sun's brilliancy. The sunset on this day (January 13) was followed by a most intense "after-glow," but of only short duration. The pink colour was at first in three broad rays, extending about 50° from the point at which the sun disappeared, the central ray almost vertical, one of the others on each side between the central ray and the horizon. After a short time the intermediate spaces became coloured red and then the colour ceased.

The colour itself when most marked I can best describe as that of burning cyanogen gas, a deep peach blossom. I have noticed that the brilliant after-glows here have been preceded by a dazzling glow, elliptical in shape, in the immediate neighbourhood of the sun, the outer edge of this ellipse being comparatively dull and marked, and not having the same colour as the sky a little further removed. The eastern horizon I have also seen tinged pinkish before the colours make their appearance in the west, and so marked has this been that I have regarded it as a sign of the coming after-glow.

I may add that for the last ten days the ground has been covered with snow, and the temperature during the early part of last week quite low, from 15°-20° F. during the day. During the end of the week the temperature was about 32° F.

I have written thus at length, hoping that there may be something of interest to you. Should you find anything it will give me pleasure; should you not, this will at least show you that some of your distant readers would like to aid you in paths which are not their own. W. G. BROWN

University of Virginia, U.S.A., January 15

THE brilliant morning and evening glows have not yet left us. In connection with a letter of one of your correspondents of December 20, 1883, it may be interesting to add that the year 1783, which was characterised by a fearful eruption of Skaptar Jokul in Iceland, and by remarkable sky-colour phenomena similar to those we have lately had, was also the year in which the last *great* eruption of Asama Yama in Japan took place (see *Transactions of the Asiatic Society of Japan*, vol. vi. part ii. p. 327). Asama Yama is the greatest *active* volcano in Japan. In connection also with the unusual quantity of aqueous vapour with which the atmosphere has been charged, as proved by the spectroscopic observations of Prof. Michie Smith and others, and the facility that dust particles give for the formation of clouds, and therefore also of snow, it may be interesting to note that the beginning of the present year has been characterised by the greatest fall of snow that the oldest inhabitants here have known for thirty years. The minimum temperature reached this winter (– 28° C. on the morning of December 23 in the neighbourhood of the college) is also the lowest for Kingston during the same period. Prof. Goodwin is now engaged in analysing the snow in order to find out whether similar impurities to those found in Europe and in Java are present.

D. H. MARSHALL

Queen's University, Kingston, Canada, January 13

Circular Rainbow seen from a Hill top

IN the *Philosophical Magazine* for January, 1884, p. 61, is an interesting article by Prof. Tyndall describing experiments made to produce circular rainbows by artificial light and artificial mist, his attention having been attracted to the subject by an observation made in the Alps on one occasion when the shadow of his body was projected at night time on to mist by a lamp behind him, and was seen to be surrounded by a luminous circle, or halo of light. I was so fortunate as to see lately identically the same effect produced with remarkable beauty and completeness in broad daylight from the summit of a Welsh hill. Staying last week for a couple of days at Pen-y-Gwryd, near Snowdon, in company with a friend, we walked one morning up the Glydr-Vach. The rain was steadily descending as we left the little inn, and the thick mist swathed the hill-sides in obliterating folds. Just as we reached the summit at noon a slight breeze thinned away the mist in front of the sun, and a burst of sunshine illuminated the hill-tops. Clambering on to the natural cairn which crowns the summit, we looked down into the valley, in which lies the small lake Llyn Idwal. Along the valley the wind drove masses of thin mist and scud, and on this we saw to our surprise the shadow of the summit with our own sharply-marked shadows projected on it. We waved our arms, and the mystic figures replied by waving theirs. Surrounding these immense shadowy figures we could see two concentric rainbows completely circular, the centre being the shadow of our heads. The colours of the inner rainbow were in the order of the primary bow, and the outer was a secondary and more faintly-tinted rainbow. During all this time the sun was shining brightly on our backs; when the wind cleared away the mist completely in the valley, the shadows and the rainbows vanished, but reappeared when fresh masses of vapour were blown into the line of our shadows. A very rough attempt at determining the angle subtended by the diameter of the primary bow seemed to show that it was much less than 90°, in fact not probably above 20°. This interesting appearance lasted only for a few minutes, as the wind drove up fresh mist in front of the sun, and the rainbow-circled phantoms disappeared. It would be interesting to know if any of your readers have ever observed a similar phenomenon. It has, I believe, been seen by balloonists when the altitude of the sun is great and a layer of mist and cloud lies beneath. Shadows thrown on mist are common; but this rainbow addition was new, not only to me, but to my friend, and his mountaineering experience has been very considerable.

J. A. FLEMING

Unconscious Bias in Walking

MR. LARDEN's letter in your issue of the 17th inst. (p. 262) regarding "circling to the left in a mist," and the replies of Messrs. G. H. Darwin and Hawksley, have opened an interesting question, and one which seems to be but imperfectly understood. The true explanation of this vexed question has for some years appeared to me to be that to which it is attributed by Mr. Hawksley, namely, inequality in the length of the legs. A few years ago I made some investigations on the length of the lower limbs in man, the results of which were published in the *Journal of Anatomy and Physiology*, vol. xiii. p. 502 (1879). I found that of seventy well-authenticated skeletons which I examined, the lower limbs were equal in length in only seven instances, or in 10 per cent.; in twenty-five instances, or 35·8 per cent., the *right* limb was longer than the left, while in thirty-eight instances, or 54·3 per cent., the *left* limb was longer than the right. The left leg I found not only to be more frequently longer than the right, but the difference in length between the two limbs is greater on an average when the left is the longer. Inequality in length is not confined to any particular age, sex, or race, but seems to be universal in all respects. My observations corroborated those of several American surgeons made on the living subject. The result of one limb being longer than the other will naturally be that a person will unconsciously take a longer step with the longer limb, and consequently will circle to the right or to the left according as the left or right leg is the longer, unless the tendency to deviation is corrected by the eye. The left leg being more frequently the longer, circling should, if this theory of its being due to inequality of the limbs be correct, take place more frequently to the right than to the left. This is precisely what we find to obtain, and in this respect Messrs. Larden, Darwin, and Hawksley's observations agree with some I made myself on this question. The diameter of the circle formed by those circling to the right should, if my observations on the skeletons be correct, be less than that made by those circling to the left, since the difference in length between the two limbs is greater when the left is the longer.

To determine the comparative lengths of the right and left arms I made observations on fifty skeletons (the first fifty of those measured to estimate the length of the lower limbs), the results of which I hope to publish soon. In thirty-six of these skeletons, or in 72 per cent., the right arm is longer than the left; in twelve, or in 24 per cent., the left arm is the longer; and in two, or 4 per cent., the arms are of equal length.

On comparing these measurements of arm and leg in the fifty skeletons the *right arm and left leg* are longer than the left arm and right leg in twenty-three instances, or in 46 per cent.; the *left arm and right leg* are the longer in six instances, or 12 per cent.; the *right arm and right leg* are longer than those of the left side of the body in thirteen instances, or 26 per cent.; the latter are the longer in four instances, or 8 per cent.; while in the remaining four skeletons the legs are of equal length but the right arm is longer than the left in two instances, and the arms are equal in two cases, but the left leg is the longer in one of those and the right in the other.

Asymmetry of both upper and lower limbs, then, is the rule, and not the exception, as might naturally be supposed. Not knowing the histories of the persons whose skeletons I measured, I am unable to throw any light as to the connection between the proportions of the limbs and right- and left-handedness.

The particular causes of inequality in the length of the bones of the right and left sides of the body will probably always be more or less a matter of theory. The general cause is, as Mr. Hawksley states, owing to more rapid growth of the one limb than the other. I do not think in the majority of instances it can be attributed to "illnesses to which we are subject in early life," as he surmises. Asymmetry is almost invariably found throughout the whole skeleton, for example it is extremely rare to find a skull the two sides of which are absolutely symmetrical. In the limbs it is perhaps more easily attributable to the blood-supply being greater to one bone than to another. The nervous system may also have to be taken into account as a cause.

J. G. GARSON

Royal College of Surgeons, London, January 26

I AM left-handed and left-footed; that is, if there is anything to do that requires strength or skill, the left hand is always used; in football-playing, or anything requiring the use of the foot, the left foot gets the work to do.

I remember being once lost in the woods in America whilst trying to make a short cut home, and, after walking a good many miles, came upon my own snow-shoe track on its left side; thus my bias had been from right to left.

In a bitter cold day with thick snowdrift and a gale of wind on our "left front," as a soldier would say, some men were on a sledge journey on the Arctic coast in 1847. It was important to reach a certain point, and each of the party in turn (including an Esquimaux) took the lead, but all failed to keep the correct course beyond a minute or two, so that the constant stoppages necessary to consult the compass were trying to the hands; in fact one of the native dogs, protected by a thick fur, fairly succumbed to the cold, and the poor thing had to be abandoned to its fate.

We at last thought of placing an Esquimaux boy of about fourteen as leader, and he managed to keep a straight course with wonderful accuracy, although he walked crab-fashion, sideways, so as to protect his face from the bitter blast.

Is Mr. Larden's theory correct, namely, "that those in whom the left leg is strongest would circle to the right?" I think not, because according to my idea it is the leg *from* which one steps, and not the leg that *takes the step* or that is placed in advance that imparts the impetus; so that a strong left leg would cause the step with the right foot to be longest, and the person would circle to the left. JOHN RAE

4, Addison Gardens, January 26

WITH reference to the letters by Messrs. Darwin and Hawksley in the current number of NATURE (p. 286), I may say that I am very strongly "left-legged" (also strongly right-handed), but so far as I am aware there is not the slightest difference in the *lengths* of the two limbs. I became aware of the peculiarity when a child, by noticing that on a slide the other boys used to go right foot first, and I left foot. Subsequent attempts to break myself of the habit only resulted in my coming ignominiously to grief, and if I tried now to leap a ditch right foot first I would tumble headlong into it instead of clearing it. The next time I find occasion to *kick* I will *try* to remember which foot was used. It is right to state, however, that in my case I think there has probably existed from infancy a very slight natural weakness of the right ankle. Attempts with me to walk a straight line with the eyes shut seem invariably to result in my swerving to the *left*, which appears to be contrary to Mr. Darwin's experience.

Lewisham, January 25 R. MCLACHLAN

MIGHT not the longer step taken by one leg be explained as follows:—

Most people when standing at ease habitually throw their weight on one leg; but, whichever it be, its movement is more likely to disturb the balance of the body. It would therefore be more quickly replaced on the ground, and a shorter step would result.

The unequal steps would not necessarily effect a circular course, as may be easily shown by experiment. A divergence, say, to the right would be caused by the left leg swinging in its step towards the right, and such would be its natural movement if the body inclined to the right. Now a person who constantly stands more on the right leg than the left would have that inclination in his walk, in spite of the alternate removal of the burden from each leg. This tendency to lean towards the right would be still further encouraged by the ancestral or individual use of the walking-stick in the right hand.

The suggestion of Mr. G. H. Darwin (January 24, p. 286) that the mounting a horse on the left side may be accounted for by the sword is strengthened by the freedom of the sword-arm requiring that the left hand be used to grasp the reins, which is the first act in mounting. There would be a momentary want of control over the horse if, under these circumstances, it were mounted from the right side. F. M. CAMPBELL

Rose Hill, Hoddesdon, January 28

IN a letter to you about another subject Mr. G. H. Darwin suggested last week that the British rule of the road for riding was justified by the advantage of having your sword hand towards a stranger, but why then should the rule of the road in walking be, what I understand it to be, the reverse of the rule in riding?

I would suggest that perhaps the rule in riding is adopted from the rule in driving, and that the latter results from the fact that a driver may be assumed to carry his whip in his right hand and therefore to sit to the right if there be two on the driving seat, and that when he is so seated he can see better how he is passing another vehicle if our rule is adopted.

This, like Mr. Darwin's suggestion, would leave us without xplanation why most nations have adopted a rule the reverse f ours.

It would perhaps be hardly scientific to say it is because Englishmen are always right and foreigners always wrong, nor would it be much more so to say that it is because English drivers like to make a close shave and foreigners as a rule give an obstacle a wide berth, for the latter fact, if it be an observed fact, may be the effect, not the cause, of the rule of the road. Can it be that the foreign rule was adopted where it was customary for the driver to sit alone on his seat and could therefore see equally well on both sides, and at the same time wished to have freedom to use his whip. STEPHEN A. MARSHALL

Diffusion of Scientific Memoirs

WHEN, in reviewing Prof. Stokes' *Reprint*, I spoke of "the almost inaccessible volumes of the *Cambridge Philosophical Transactions*," I was referring *expressly* to the *Transactions* only, and to the period 1845-54. That there are *now* 120 "centres" in which "*Transactions* or *Proceedings*, or both" are accessible, is an interesting and important fact, but wholly beside the question raised by my remark. [I leave out of account copies sent to Honorary Fellows; for these are not more accessible than those obtained by Ordinary Fellows.]

The question at issue between the Secretary of the Society and myself is:—What was the state of matters in 1854? Mr. Glazebrook gives me data for the present time, and for 1869, only. From these it is not possible to obtain more than an approximate answer to the question. But, in default of further data, I assume that (in accordance with the published statistics of similar Societies) the number of Hon. Fellows of the C.P.S. has not changed since 1854; and that the increase of "centres" from 1854 to 1869 was nearly the same as from 1869 to the present time. It follows from Mr. Glazebrook's data that the number of "centres" in 1854 must have been about 40 only.

But I referred to *Transactions* alone, not to "*Transactions* or *Proceedings*, or both." To obtain a rough idea of the correction to be made on this account, I take the numbers for the *Royal Society of Edinburgh* (with which I am best acquainted, and which are at least as large as those for the *Royal Society*). In Mr. Glazebrook's form of statement, these numbers are at present

Hon. Fellows	56
Total number distributed	343

Deduct the first number, and there remains 287. But of these "centres" 96 (one-third, say) receive *Proceedings* only.

Hence it would appear that, in 1854 and previous years, to which alone I referred, the *Cambridge Philosophical Transactions* were to be found at some 27 "centres" only; say 10 at home and 17 abroad. Surely this would much more than justify the term "almost inaccessible"!

I cannot recollect having made any application for the C.P.S.'s publications, though I have often asked Cambridge friends why I did not get them regularly. But, according to Mr. Glazebrook's view, I should either have received all, *or none*.

The state of matters, in the three Edinburgh "centres" to which Mr. Glazebrook alludes, is at present as follows:—

All three "centres" have the *Transactions* complete; except the University Library, which wants vol. xiii. parts 1 and 2.

The Advocates' Library has *not* the *Proceedings;* the Royal Society wants vols. i. and ii., all but a few pages; and the University Library wants vol. iv. parts 1, 2, 3, 4, 5. Thus one "centre" has no *Proceedings*, another has almost half, and the third three-fourths.

I must, in concluding, repeat my hope that NATURE may do a new and great service to science by collecting full statistics as to the "centres" at which the publications of the various scientific Societies are accessible. P. G. TAIT

College, Edinburgh, January 26

Water in Australia

REFERRING to my letters in NATURE of May 12, 1881, and March 30, 1882, on the underground water supply of Australia, it is interesting to observe that the search for it is being actively carried on by some energetic colonists, and that their efforts are successful. The following extract from *The Queenslander* of May 26, 1883, shows what can be done:—

"The subterranean waterflow now proved to exist beneath the vast arid plains of the west has been tapped at yet another point, and the discovery of another invaluable spring of fresh water is the result. Recently we have had many discoveries to record, all tending to encourage the search for underground water, on the supply of which the pastoral industry of this district so much depends; but none has been of more value to the discoverers or has tended more to encourage others to persevere in spite of difficulties. This latest discovery was made last week in the country known as the Pack-Saddle, forming the western portion of Messrs. Donelly and Co.'s Gnalta run. The well was started in the summer of 1881, but had to be abandoned some time after for want of water for the use of the men, and Mr. Donelly was urged to choose another site. He persisted, however, in continuing the original work as soon as surface water was available, and he has now come upon a practically inexhaustible spring. The flow was cut at 272 feet in a properly slabbed 6 feet × 3 feet shaft, and during the night following the water rose 172 feet, or within 100 feet of the surface. The discovery is worth every penny of 10,000*l.*, as it renders immediately available a large tract of good country hitherto dry and therefore comparatively useless. There is another fine well on Gnalta, from which 30,000 sheep have been watered in the dry season, and that discovered last week promises to be as good, if not better."

In my first letter I pointed out as one evidence of the underground water the growth of huge gum trees where there was no visible supply. In a recent number of the *Scientific American* it is stated that, on clearing out a well, the owner was surprised to find the bottom covered with a dense mass of fine, fibrous roots, which were traced to a Eucalyptus growing at a distance of fifty yards. The large Eucalypti are trees of remarkably rapid growth, which implies the absorption of large quantities of water. By what subtle sense did that root find out where water could be had, and travel so far to get it? Darwin has shown that there is some kind of irritability in the growing points of plants, and that it is sometimes communicable to distant parts. We shall probably come in time to admit that there is a nervous current in plants, though without visible nerves; and that this rudimentary system of sensation is accompanied by rudimentary desires, and even by rudimentary ideas, which guide the growing points in their search for the desired objects.

F. T. Mott

Birstal Hill, Leicester, January 20

Deafness in White Cats

This subject has been of much interest to me, and otologists as well as evolutionists must feel indebted to your contributor in Nature of December 13, Mr. Lawson Tait, for his efforts to determine the cause. May I be permitted, however, from an otologist's point of view, to draw attention to a possible source of error in conducting researches of this kind when deductions are made, as they were in this instance, from acoustic experiments mainly? I allude to Mr. Tait's method of determining the hearing power of the animal experimented on, namely, his cat, "Old Pudge," and the conclusions that he has drawn from the results obtained; thus he infers that purely "tympanic" deafness, consisting in an entire failure of the transmitting mechanism of the middle ear to respond to aërial undulations of sound, existed in the case of "Old Pudge," *because* the concussion produced by stamping on the floor could be heard by that animal, whilst the voice was not heard. Abnormal hearing of this kind, I am convinced, by no means establishes the fact that inner ear trouble does not exist, since such deaf-mutes as are believed to be defective in this regard are very sensitive to grave or deep tones—thunder, for example, being painful even to them. Pudge's cochlear (inner ear) functions were believed to be serviceable, inasmuch as he could use his voice; but such evidence cannot be accepted as conclusive, for absolutely deaf persons, who have been deprived of both "tympanic" and "cochlear" functions, are yet capable of making noises, and often of learning to speak after a fashion. Another point is also of interest in this connection: the ears of Pudge, it is said, were found to be normal in every respect, both as to their transmitting and perceptive functions, with the exception of the absence of a triangular gap from either tympanic membrane. In reference to this it may be said, in the first place, that it is difficult to understand how the delicate mucous membrane lining the tympanum retained its "normal" condition under such exposure; and, in the second place, these defects could scarcely be the cause of absolute deafness, since it is a well-known fact that quite good hearing often remains in the human subject where, from disease, much greater loss in the tympanic membrane has been sustained than was found to exist in the hearing organs of Pudge. Altogether it seems probable that in certain white cats great congenital deafness may exist, and that the animal, on finding aërial transmission of sound to be imperfect, comes finally, like man under similar circumstances, to disregard its use entirely, and place its reliance solely on sound that can be *felt*, as it were. Moreover, is it not probable also that the trouble, in some degree at least, may lie in the perceptive centre of the brain? It is a significant fact that in Pudge at least some disease of the nervous centres existed, since he was the subject of epileptic convulsions.

Samuel Sexton

12, West Thirty-fifth Street, New York, January 3

FURTHER DISCOVERIES IN THE FLORA OF ANCIENT EGYPT[1]

SINCE my last communication on the Flora of Ancient Egypt (Nature, vol. xxviii. p. 109) I have made some interesting new botanical discoveries in connection with the mummies of the twenty-first dynasty, found at Deir-el-Bahari in July, 1881, which I will now describe in some detail; the objects having been forwarded to the Museum of the Royal Gardens, Kew.

In the coffin of the Princess Nzi-Khonsu of the twenty-first dynasty there was a large number of well-preserved wreaths, in which I found three species of plants of the ancient flora not previously authenticated by specimens. Besides wreaths of the leaves of *Mimusops Schimperi* and the petals of *Nymphæa cærulea*, already described from examples found on the mummy of Ramses II., there were on the mummy of the Princess Nzi-Khonsu, daughter of Tontonthuti, numerous floral wreaths composed as follows: (1) folded leaves of a willow (*Salix safsaf*) strung on threads of the leaves of the date palm, and serving as clasps; (2) perfect flowers of the corn poppy (*Papaver rhœas*); (3) complete flower-heads of a corn flower (*Centaurea depressa*); and (4) complete flower-heads of a composite (*Picris coronopifolia*).

The flowers of *Papaver rhœas* equal in size those of the small form one has an opportunity of seeing in such abundance in the Mediterranean region in the spring months as a weed in cornfields, by roadsides, and on walls. In order to prevent the petals from falling, the flowers were picked in an unopened condition; and in drying in the vault the petals had shrivelled and shrunk up into a ball, to which circumstance is due the fact that in examining the moistened flowers all the inner parts appear before the eyes in a wonderful state of perfection. Not a stamen, not an anther is wanting; nay, one might almost say that not even a pollen-grain is missing. Rarely are such perfect and well-preserved specimens of this fragile flower met with in herbaria. The colour, too, of the petals is maintained in a high degree, as in dried specimens of the present day. It is a dark brown-red, that leaves a deep stain on the paper where the flowers have been soaked. The very caducous sepals were wanting in the flowers examined; but all the peduncles were thickly beset with the characteristic, horizontally-spreading, bristly hairs. The petals are destitute of the dark spot on the claw which is common to many varieties of the species. The naked ovary is shortly obovate in shape, or, in some of the very young flowers, cylindrical, though never so much elongated that one could doubt its belonging to the genuine variety described by Boissier in his "Flora Orientalis." The stigmatic disk is obtusely and broadly conical; and the rays vary in number from eight to ten. The edge of the stigmatic disk is bordered with orbiculate, auriculate, white appendages incumbent upon it. The anthers are oblong, twice as long as broad, and

[1] This article was sent by the author, Dr. G. Schweinfurth, to Sir Joseph Hooker, together with the botanical objects described therein. The original is in German, and the translation here given is as nearly literal as possible.—W. Botting Hemsley.

the filaments subulate. The smallness of the flowers ($2\frac{1}{2}$ cm. in diameter), the broad petals, the red colour, the bristly peduncles, the 8–10 stigmatic rays, the oblong oval anthers, the subulate filaments, &c., point conclusively to the determination of the plant as *Papaver rhœas*, var. *genuina*.

At the present time this species is found nowhere in Upper Egypt, and also appears to be absent from the whole Nile Valley, while it is met with in abundance near Alexandria and on the Mediterranean coast as a weed in cornfields.

The flower-heads of *Centaurea depressa*, the involucral part of which is 15 to 17 cm. in diameter, belong to a form that is now met with in Persia and Afghanistan; whereas in many countries—Greece, for instance—only small-headed varieties seem to occur. The peduncle served, as in the poppy flowers, to fix the heads in the garlands, which was not always the case in the ancient floral wreaths.[1] Two or three of the leaves are still left on many of the specimens. They are narrow-linear, almost sessile, and exhibit, besides the arachnoid-canescent pubescence characteristic of the species, the peculiar prickle-like tip, which is several millimetres long, and serves to distinguish *C. depressa* from its only allies *C. cyanus* and *C. cyanoides*. From most of the leaves, however, this brittle appendage has fallen, in consequence of repeated handling of the wreaths. Close under the base of the flower-heads appear some linear bracts, shaped like the upper leaves of the stem. In the ancient specimens these bracts were present in unequal numbers, from two to seven, and often wanting altogether. They do not overtop the whole involucre. This character was rather against the correctness of the identification, for such bracts are not usually present below the heads of *C. depressa*, though they are in *C. cyanoides*, which differs very much in having pappusless achenes. But I have seen a recent specimen (Afghanistan, Griffith, 3294) having one or two leafy bracts at the base of each head. In the recent forms of *Centaurea depressa*, the lanceolate teeth of the membranous margin of the involucral bracts are sometimes colourless, sometimes brown at the base. In the flower-heads of the twenty-first dynasty these teeth are deep brown in the middle, with a white margin and a white tip, and they are here, as the specific character requires, a little shorter than the breadth of the bract. The three or five teeth at the tips of the bracts are grown together about half their length. On the lowermost bracts of the involucre the teeth are quite decurrent and colourless; on the upper they are more limited in number—from eleven to fifteen—and only towards the tip. In consequence of the incautious handling of the wreaths when the coffin was opened, the beautiful ray-flowers, which in this species are exceptionally large, are mostly fallen away. In many heads, however, they are still attached, and exhibit a dark violet colour, similar to recently-dried specimens. The lobes of the limb of the corolla are broad, almost ovate and acuminate. Very well-developed achenes occur in the ancient flower-heads, affording indubitable evidence of the correctness of the determination of the species. The achene is light in colour, shining, slightly laterally compressed, and oblong-ovoid in shape. The areole incloses half the length of the achene, and at the base there are a few small hairs, as in recent specimens from Schiraz (Kotschy, 302), Afghanistan (Griffith, 3294), and from Sber (C. Koch), while others from Asia Minor are quite naked.[2] The intermediate bristles of the pappus are one-fourth longer than the achene, the inner ones half as long. The long prickly tips of the upper leaves, the large, broadly-lobed ray-flowers, and the achene bearing a pappus exceeding it in length, prove that the flower-heads of the mummy-wreaths belong to *Centaurea depressa*. This species is wanting in the present flora of Egypt as well as in that of the contiguous countries. It now occurs as a cornfield weed in all parts of Asia Minor, Armenia, Persia, Afghanistan, Beluchistan, and West Thibet; and Prof. Heldreich found it around Tripolitza, in Arcadia, and in the Attic Plain, near Hergellon. In the last-named country the species flowers in April. There are no localities for this plant in Syria and Palestine to my knowledge. Specimens of this Centaurea from ancient Egyptian wreaths are preserved in the museum at Leyden.[1] It is not stated, however, from what epoch they date.

[1] Thus, for example, only flowers of *Sesbania ægyptiaca* with half of the calyx cut off were used.
[2] Hooker, "Fl. Brit. Ind.," iii. p. 385, in his diagnosis of the species has "basal areole bearded."

Many of the wreaths of the mummy of Nzi-Khonsu consist entirely of willow leaves and the flower-heads of *Picris coronopifolia*, Asch.[2] The numerous features in the parts of the flower-heads which characterise this species are easily seen in the ancient specimens, and not a single peculiarity is apparent by which it might be distinguished from the recent small form with low-spreading branches, now so common on the outskirts of the desert.

The indumentum of the involucral bracts is particularly well preserved. The bracts themselves are long lanceolate with an undulated membranous naked edge, and taper off into a long point; while on the outside along the midrib they are furnished with one to three rows of spreading bristles, glochidiate at the tip, and between these a white arachnoid felt—the same kind of tomentum clothing the peduncles. The achenes of the ray are smooth and cylindrical, more or less curved, as thick at the tip as in the middle, and crowned with a pappus of short persistent bristles cohering about half their length. The achenes of the disk are broadly club-shaped, somewhat constricted at the tip, and provided between the ten angles with two rows of small round tubercles. The pappus consists of bristles plumose at the tips and is deciduous, and exceeds the achene in length five times.

The dissimilarity of the inner and outer achenes of the ancient Egyptian *Picris* at once shows that it belongs to the section *Spitzelia*, Schultz Bip. The smallness of the flower-heads and the nature of the indumentum prove that it belonged to the small desert form, still common about Thebes, and not to the large-headed, otherwise hairy, varieties (*Picris lyrata* and *P. pilosa*), only found in the neighbourhood of Alexandria, and on the coast of the Mediterranean Sea. The ultimate inflexion of the involucral bracts over the ripening achenes ("phyllis demum carinatis, incurvis") is perceptible in many of the flower-heads from the ancient wreaths.

Picris coronopifolia belongs to that set of desert plants which are usually only found on the border of the desert as far as the waters of the Nile reach by infiltration. It is not met with in the valleys and channels of the lower desert strips any more than among the weeds which follow cultivation in the black earth of the Nile alluvium. It generally grows associated with *Crepis senecioides*, *Leontodon hispidulum*, *Picris sulphurea*, *Lotus pusillus*, &c., which likewise belong to the flora characteristic of the borders of the desert. The flowering time of these plants in Middle Egypt is March and April. In February they only begin to develop, and it may be assumed that the flora of Thebes is from two to four weeks in advance of that of the neighbourhood of Cairo. From the occurrence of the flowers of *Picris coronopifolia* in the wreaths of the mummy of Nzi-Chonsu we may conjecture that the solemn rites of placing this princess in the vault took place in March or April. The assumption that it took place in February or May would be doubtful, and it is very

[1] According to Prof. P. Ascherson in *Zeitschrift für Ethnologie*, ix. Jahrg., 1877, and Dr. W. Pleyte in 2 Ilylage tot de 35ste Jaarver-gadering der Ned.-Bat. Vereeniging. 29 Juli, 1882.
[2] Boissier, in his "Flora Orientalis," iii. p. 740, reduces this species to *Crepis radiata* (= *C. senecioides*, Del.), and this is done by many other authors. *Picris lyrata*, Del., and *P. pilosa*, Del., can only be regarded as varieties of *P. coronopifolia*, Asch. (*Leontodon coronopifolium*, Desf.).

unlikely to have happened in any other months of the year. At Thebes the floral carpet is quite dried up and destroyed as early as April, and in the district of Cairo in May, so that there would have been great difficulties attending the collection in one day towards the end of April of the large number of flower-heads requisite for the preparation of the wreaths of Nzi-Chonsu. And as far as the other flowers of these wreaths are concerned February to March are the only admissible months. This applies especially to the flowers of the poppy, which even in Alexandria disappear towards the end of April.

If we are able, from our knowledge of the seasons of the present Egyptian vegetation, to limit the interment of a mummy to a short series of months, it follows therefrom the fact, that in the case of the date of the funeral rites attending the placing of a mummy in the final tomb being originally indicated in the inscription on the coffin or elsewhere, light might be thrown on the theoretical determination of the relative Sothis (Sirius) periods. In chronological determinations, which, as far as concerns ancient Egypt, anterior to the time of the twenty-sixth dynasty, are still open to grave suspicion, the aid thus possibly attainable is not to be despised. We know from the hieroglyphical writings, the temple inscriptions and ornamental pictures of the temple, that the ancient Egyptians had a great predilection for their gardens; and we learn from the narratives of their crusades in distant countries that they gave a prominent place to foreign vegetable productions, even in their triumphal processions. Amongst objects met with in the funeral repasts and in the offerings in the tombs there are, moreover, so many products of evident foreign origin, that we cannot be surprised at finding that many of the flowers and leaves employed in the composition of the funeral wreaths and garlands could not have belonged to the native flora of the country, but must have been cultivated expressly for the purpose. This may, then, have been the case with *Centaurea depressa*, which, like *Alcea ficifolia* and *Delphinium orientale*, suggests Western Asia, and especially the countries of the Upper Euphrates. As far as *Papaver rhœas* is concerned, it may also be assumed that it was cultivated by the ancient Egyptians on account of its brilliantly coloured flowers, although this does not exclude the possibility, independently of any necessity for a change in the climate to have taken place in the interval, that the common poppy was not such an extraordinary rarity in the cornfields of that period as it is at the present time.

Among the mummies of the twenty-first dynasty discovered at Deir-el-Bahari, there may lie hidden a number of plant remains still unknown to me; as a careful search through the coffins, especially as far as those mummies are concerned which are still preserved with their wrappers intact, was for many reasons necessarily postponed. The garlands, particularly, in those coffins, composed as they are of various leaves and flowers, may be expected to furnish many novelties to the ancient flora of Egypt. Among a few fragments of the wreaths of Mimusops leaves and Nymphæa petals that have reached the Natural History Museum of Milan there accidentally appeared a detached corolla of a Jasmine, which may belong to *Jasminum sambac*, a species still commonly cultivated in Egyptian gardens. The Egyptian Museum in the Cairo suburb of Boulak contains in addition a number of plant remains of authenticated species taken from earlier explorations of tombs that would go to enrich the flora of ancient Egypt.

In the spring of last year Dr. Maspero discovered in the well-known burying-place of Nofert Sekeru, near Sheykh Abdel Gurna, Thebes, an unopened vault of later date, in which was a well-preserved female mummy of the Greco-Roman period. This mummy is swathed from head to foot in wreaths of the leaves of Mimusops, without any flowers. These leaves are larger (eight centimetres without the petiole), because fully grown, than those in the older garlands. The petioles are broken off short, and the whole construction of the wreaths is of a much ruder and more careless description. Specially interesting in this mummy is a wreath around the forehead composed entirely of the leaves of *Olea europæa*. These leaves are also folded and threaded edge to edge with the tips directed upwards; but the mode in which they are sewn together is different from the other wreaths, being done by a coarse string of a fibrous material as yet unknown. The Leyden Museum possesses similar funeral wreaths of olive leaves,[1] and in the Berlin Museum there are some bundles composed of branchlets of the olive tree. Whether the "wreath of justification" mentioned in the obituary of Osiris was such a wreath of olive leaves, or whether under this designation the garlands of Mimusops and willow leaves which encircled the neck and breast of the mummies were intended has not yet been ascertained.

Moreover, Theophrastus, Pliny, and Strabo authenticate the presence of the olive in Upper Egypt. According to Theophrastus (iv. 2, 9) the olive tree grew in the Theban province. According to Strabo (xvii. § 293) olive trees were only found in Fajum and in the vicinity of Alexandria. Now the olive tree flourishes in Lower and Middle Egypt, and very old trees exist in Fajum and in the Oases.

In a special glass case in the Egyptian museum at Boulak is a variety of objects which formed the funeral repasts and offerings in a vault at Dra Abu Negga (Thebes) of the twelfth dynasty (2200 to 2400 B.C.) Among them are the following vegetable products: grains of barley[2] and wheat; tubers of *Cyperus esculentus*; kernels of *Mimusops Schimperi*; fruits of *Punica granatum*, *Ficus Carica*, *Balanites ægyptiaca*, *Hyphæne thebaica*, *Medenia argun*; a water-flask of *Lagenaria vulgaris*; two cones of *Pinus Pinea*; a mess of *Lens esculenta*; two seeds of *Faba vulgaris*, and one seed of *Cajanus indicus*; a broom made of *Ceruana pratensis*; a bowl full of capsules of *Linum humile* intermixed with pods of *Sinapis arvensis*, var. *Allionii*. Among the plants here cited the Linum deserves special consideration, for, notwithstanding our ample knowledge of its cultivation, thanks to the records of the early authors, botanists who have busied themselves with the investigation of the vegetable remains of ancient Egypt have hitherto not been able to determine with certainty the species of Linum cultivated.

Linum capsules of the twelfth dynasty exist in a very good state, together with the calyx and pedicel, the latter two centimetres long. They are all closed, although the seeds appear to have attained perfect maturity. The length of the capsules reaches 8 millimetres, and the breadth 6·75 millimetres; and the seeds are 5 mm. long. The dimensions given are very little inferior to those of the capsule of the Linum, cultivated in Egypt at the present day. In external characters it is so like the capsule of the flax now cultivated, that one detects no difference at first sight; and it is only after cutting the seed through that one becomes aware of the change wrought in the course of 4000 years. The proportionate size of the seed, which is much narrowed upwards, but above all the numerous long weak hairs which occur on the inside of the partitions of the capsule, leave no doubt as to the ancient flax belonging to the kind exclusively cultivated still in Egypt and Abyssinia, the *Linum humile*, Mill. (syn. *Linum usitatissimum*, Linn., var. *crepitans*, Schübl. and Martens).

Another coincidence in the ancient and modern Linum

[1] They belong, according to Dr. Pleyte, to a mummy of the time of Osorkon (twenty-second dynasty). See also De Candolle, "Physiologie," p. 666.

[2] In this museum is also preserved a bowl containing broken ears of barley of the time of the fifth dynasty (3300 to 3500 years B.C.) which was found near Saqqara.

cultivation is the presence among the ancient capsules of numerous seed-vessels of a species of mustard which is still the commonest and most flourishing weed in every flax field in Egypt. The pods of mustard are almost spherical in shape with a long point, and are seated on pedicels a little less than half the length of the whole pod. Judging from the shape described, the pods must belong to one of the two varieties, common in Egypt, of *Sinapis arvensis*, Linn., namely, *S. Allionii*, Jacq., and *S. turgida*, Del., for the common form of this species is distinguished by elongated pods. As the two varieties named can only be distinguished from each other with certainty by the degree of cutting of the leaves, it would be difficult to decide to which of the two the pods of the twelfth dynasty belong were it not for the circumstance that as *S. Allionii*, Jacq. (characterised by the long-pointed much-divided leaves), is the prevailing form at the present time in Middle Egypt, a probability offers itself that the ancient pods belong to this form. On the other hand *Sinapis arvensis*, Linn., var. *turgida*, Linn., affects the winter cornfields.

It may be assumed that this species of wild or colonised mustard answers to the Sinapis to which Pliny refers (lib. xix. 54 [8]), as a plant commonly met with under such conditions, and of which he asserts that the Egyptian was the best for yielding oil, and that the Athenians called it Napy, others Thapsi, and others again Saurion.

Lentils, as far as I know, have not hitherto been authenticated from the ancient graves. Pliny (lib. xviii. 31) mentions them as a product of Egypt, where two kinds of them were cultivated. The lentils of the twelfth dynasty appear in consequence of boiling and subsequent shrivelling to have lost a considerable part of their bulk. They are 3½ mm. in diameter, while the recent ones average 4½.

From *Ceruana pratensis*, a characteristic composita of the banks of the Nile, which has hitherto only been found in Nubia and Egypt, the ancients made those hard hand brooms, still met with in every part of Egypt, and used for sweeping out the houses and especially the privies; for which purposes they are offered for sale in all the markets. The Egyptian department of the British Museum contains a similar specimen.

Furthermore, the two pine cones (*Pinus Pinea*) noted belong to a species not previously known from the ancient Egyptian relics. Like *Parmelia furfuracea* and the juniper berries (*Juniperus phœniceus*), they point to the commercial relations that existed between Egypt and Greece, Asia Minor and Syria. The pine cones which were found in a large basket filled with numerous kinds of fine linen thread, fruits of the Doum palm and a small calabash of Lagenaria, are small and unripe, the scales clinging close together. It is evident that only such of these rare northern exotic fruits as were unsuitable for the table were put in the offerings.

Among objects not previously authenticated from ancient Egypt are the legumes *Faba vulgaris* and *Cajanus indicus*. Unger[1] suggests that the broad bean (*Faba*) was probably not found in the tombs because it was regarded as unclean.[2] The two seeds in question were found amongst dried grape-skins and matters of that kind. In shape and relative size they fully correspond to the variety cultivated on a large scale in Egypt at the present day. They are smaller, rounder, and thicker than the European broad bean.[3] The dimensions of the ancient beans are 10, 8, and 6½ mm.

Pliny (lib. xviii. 12 [30]) says of the broad bean that it was used in funeral solemnities; hence the priests ate none, &c. Perhaps the presence of the broad bean in the offerings of the twelfth dynasty had a meaning similar to that which it had for the Romans.

[1] *Sitzungsberichte der Kais. Akademie der Wiss., Wien.*, 1859, Band xxxix.
[2] Compare "Herodotus," ii. p. 37.
[3] The author most likely alludes to the variety called "field" or "horse-bean" in this country.—W. B. H.

Among the funeral offerings of the ancient Egyptians often occur messes of a pap of roughly cut or coarsely ground grain of barley. They are in small earthen bowls, placed on the floor of the vault like the other offerings. In Prof. Maspero's opinion these messes of barley, which are in no way suitable for human nourishment, answer to the Mola (*Mola salsa*) offerings of the Romans of earlier epochs; and I would hazard an explanation of the presence of the broad beans in the offerings of the twelfth dynasty as an example of a possible analogy between ancient Rome and ancient Egypt. For, supposing the correctness of Herodotus's account that the ancient Egyptians regarded the broad bean as unclean, that they ate it in no shape or form, and that their priests could not bear the sight of it, some explanation for its presence must be found. The single seed of *Cajanus indicus* found with the broad beans in no way differs from the Upper Egyptian variety with yellow flowers. The plant, which is cultivated and wild all over India, as well as in all parts of tropical Africa, is nowhere cultivated in Egypt, though it occurs here and there in a wild state in Upper Egypt. It is certainly one of the oldest cultivated plants in the world, a fact further attested by its discovery in the ancient tombs. G. SCHWEINFURTH

METAMORPHISM AMONG DEVONIAN ROCKS

THE tract of Devonian rocks which stretches through the north of France and Belgium, and across Rhenish Prussia into Westphalia and Nassau, has furnished ample materials for geological disquisition. Among the problems which it presents to the observer, not the least important is the remarkable metamorphism of certain bands or areas of its component strata. Dumont first called attention to this feature in the Belgian Ardennes. It was subsequently shown by Lossen to be extensively developed in the Taunus. More recently the question has been attacked anew with all the appliances of modern petrography. M. Renard has subjected some of Dumont's original localities to a critical revision, which has resulted in a confirmation of the accuracy of that remarkable geologist's observations. The latest contribution to the literature of the subject is a paper (*Annales Soc. Géol. du Nord*, vol. x. p. 194) by Prof. Gosselet, who at first refused to admit the metamorphism contended for by Dumont and corroborated by M. Renard, but who now comes forward with independent evidence in its support, from another locality. He describes the arkose of Haybes and of Franc-Bois de Villerzies on the frontier of Belgium as having undergone such a metamorphism as to be no longer recognisable. M. Barrois reports that on examining microscopically some sections of the altered rocks, he found among them bi-pyramidal crystals of quartz with liquid inclusions and movable bubbles, as in the quartz of pegmatite. These crystals have been broken *in situ*, with conchoidal fractures, and the surrounding paste appears as if injected into them. This paste is composed of small irregular quartz-grains like those of schists, and is coloured by fibrous chlorite, so arranged as to impart a more or less schist-like structure. The chlorite, arising from alteration of biotite, is predominant in some specimens, while the quartz-grains preponderate in others. M. Barrois compares this altered arkose with some porphyroids and some granitic veins in Brittany recently studied by him. Prof. Gosselet shows that these crystalline intercalations are portions of the true Devonian strata, and he accounts for their highly altered condition by what he terms a metamorphism by friction. A portion of the Devonian rocks has slipped down between two faults and has undergone great lateral pressure, and has in consequence been heated sufficiently that metamorphism has been determined in it. The extent of change has been proportionate to the degree of pressure. The metamorphosed arkose is provisionally referred to the Gedinnian division of the system.

M. Renard is understood to be at work upon a detailed memoir on the metamorphosed rocks of the Ardennes, in which their chemical constitution and microscopic characters will be fully described.

THE RECENT STORM

THE great and destructive storm of Saturday and Sunday last may almost take rank as a historical event, seeing that on the Saturday evening atmospheric pressure fell considerably lower in Scotland than is known ever to have occurred in these islands since the barometer became an instrument of observation. This remarkable barometric fluctuation, as observed at Edinburgh, is shown by the following observations made on those two days, the observations being reduced to 32° and sea level:—

	Barometer Inches		Barometer Inches		Barometer Inches
Saturday.		Saturday.		Saturday.	
9.0 a.m.	28·934	5.30 p.m.	27·853	9.30 p.m.	27·467
2.0 p.m.	28·376	6.0 ,,	·819	10.0 ,,	·451
2.30 ,,	·266	6.30 ,,	·779	10.30 ,,	·464
3.0 ,,	·167	7.0 ,,	·721	11.0 ,,	·505
3.30 ,,	·064	7.30 ,,	·6 1	11.30 ,,	·565
4.0 ,,	27·984	8.0 ,,	·580	Sunday.	
4.30 ,,	·934	8.30 ,,	·516	3.0 a.m.	27·835
5.0 ,,	·921	9.0 ,,	·494	4.30 ,,	·968
				9.0 ,,	28·311

As the barometer was closely watched for some time before and after 10 p.m., and no change was observed, the reading 27·451 inches may be regarded as absolutely the lowest that occurred. Since the wind veered during the storm from S.E. by S.W. to N.W., the centre of the storm passed to the northward, and along its path still lower readings were doubtless recorded.

The following observations have been already received, showing in inches the lowest observed readings and the hour when they occurred:—Moffat, 27·662 at 10·15 p.m.; Marchmont, near Duns, 27·581 at 11 p.m.; Inverness, 27·516 at 11·10 p.m.; Fort William, 27·467 at 8 p.m.; Joppa, near Edinburgh, 27·464, Leith, 27·453, and Edinburgh, 27·451, at 10 p.m.; Glasgow, 27·427 at 9 p.m.; Dundee, 27·382 at 10·30 p.m.; Ochtertyre, near Crieff, 27·332 at 9·45 p.m.; and 27·400 is stated to have occurred at Aberdeen. With the observations made at the 160 stations of the Scottish Meteorological Society, it will, in a few days, be easy to trace the history of this extraordinary atmospheric depression in its passage across the island.

At Ben Nevis Observatory, the lowest reading of the barometer on Saturday, 23·173 inches, occurred at 8.30 p.m.; at noon, temperature was 15°, and at 10 p.m. 22°; at 7 p.m. the wind was S.E. force 8, and at 10 p.m., N.E. force 4.

In the sixty years preceding 1827, during which Mr. James Hoy made barometric observations, the lowest reading was 28·007 inches; during the last 43 years observations have been made at Culloden, and the lowest reading, observed by the late Mr. Arthur Forbes, was 27·984 inches at 11 a.m. on December 27, 1852. During the interval between these two long continued series of observations, Mr. George Innes, optician, made observations at Aberdeen; and on the occasion of the memorable storm of January 7, 1839, recorded an observation on that morning of 27·695 inches. On the same morning, at 9 o'clock, the lighthouses on the east of Scotland, which were near the centre of the storm at the time showed readings varying from 27·806 inches in the Firth of Forth, to 27·716 inches near Peterhead.

As these three series of observations extend over the last 120 years, it is evident that over at least the east of Scotland, from Inverness to the Tweed, atmospheric pressure fell on the evening of Saturday the 26th from a third to half an inch lower than has occurred during that extended period.

NOTES

WE are glad to be able to announce that Prof. Flower has been definitely appointed by the Trustees to the position of Superintendent of the Natural History Department of the British Museum, vacated by the recent resignation of Sir Richard Owen.

THE German Emperor, at the instance of the Berlin Academy of Sciences, has been pleased to make Prof. Sir William Thomson a Knight of the Order *Pour le Mérite* for Science and Art.

ACCORDING to an announcement made by Prof. E. Stefan at the last meeting of the Vienna Physical Society, Prof. S. von Wroblewski, of Krakow, has succeeded in solidifying hydrogen

IT is reported that Prof. Wilhelm Klinkerfues, the well-known astronomer, shot himself on Monday in the Observatory at Göttingen.

WE are glad to see that the fishermen of Scotland have at last realised the necessity of a thorough scientific investigation into the habits of fish. At a meeting at Peterhead the other day the Solicitor-General for Scotland was requested to help the fishermen to obtain Government aid for the prosecution of such research; the country, it was admitted, is behind all others "in scientific information on fish." The Solicitor-General, Mr. Asher, admitted the lamentable deficiency of our knowledge of the habits of food fishes, and promised to do all he could to obtain a grant for the Committee of the Fisheries Board, who are now endeavouring, with the slender means at their command, to investigate the subject. "Prof. Ewart and his colleagues," Mr. Asher stated, "had entered upon an investigation which, if duly prosecuted, could not fail to be productive of immense results and advantages in connection with all kinds of fisheries."

AT the end of March the Austrian botanist, Mr. Joseph Knapp, Conservator des Herbariums des Allgemeinen Oesterreichischen Apothekervereines of Vienna, will go to Northern Persia (Azerbijan), with a scientific expedition for exploring the flora and fauna of that little-known province.

DURING February Prof. W. K. Parker will give a series of lectures at the Royal College of Surgeons on Mammalian Descent, as follows:—February 4th, Introductory; 6th, On Monotremes; 8th, On Marsupials; 11th, On Edentata; 13th, On Insectivora; 15th, Insectivora (continued); 18th, Insectivora (concluded); 20th, On the remaining Orders of Mammalia; 22nd, On Man (conclusion).

IN connection with the opening of the Turin Exhibition, the Italian Government offers a prize of 400*l.* to the inventor of the most practicable method for the transmission of electricity to a distance. The competition will be international.

WITHIN a few days the exhibition of the *Talisman* collection will be opened at the Jardin des Plantes of Paris, with diagrams exhibiting the circumstances of the operations, and the instruments which were used.

THE Asiatic Society of Bengal celebrated its centenary on Tuesday last week. The proceedings began with a special meeting, the Hon. H. Reynolds, the President of the Society, being in the chair. Six gentlemen, namely, Dr. Joule, Prof. Haeckel, Mr. Charles Meldrum, Prof. Sayce, M. E. Senart, and Prof. Monier Williams, were elected honorary members.

THE Cambridge University Press announces for publication "A Treatise on the General Principles of Chemistry," by M. M. Pattison Muir, M.A. This book is intended to give a fairly complete account of the present state of knowledge regarding the principles and general laws of chemistry; it is addressed to those students who have already a considerable acquaintance with descriptive chemistry, and it is hoped that by such students the book will be found complete in itself. An attempt is made to treat the chief theories of modern chemistry to some extent from an historical point of view, and to trace the connection between the older theories and those which now prevail in the science. Full references are given to all memoirs of importance. The first part treats of the atomic and molecular theory, and the application thereof to such objects as allotropy, isomerism, and the classification of elements and compounds; fairly complete accounts are also given of the methods and more important applications of thermal, optical, and other parts of physical chemistry. The second part is devoted to the subjects of chemical affinity, relations between chemical action and losses or gains of energy, and the various questions suggested by the expression "chemical equilibrium."

AT the weekly meeting of the Society of Arts on Wednesday last week, under the presidency of Sir John Lubbock, a paper was read by Mr. W. L. Carpenter, on "Science Teaching in Elementary Schools." The chairman said the subject under consideration was one of very great importance. The Duke of Devonshire's Commission had reported that the neglect of science and modern languages in our schools was a national misfortune; and though, no doubt, there was some improvement since that time, almost the same might be said now. Considering how much science had done, and was doing for us, the general, though happily now not universal, neglect of it in our schools was astonishing. If we did not avail ourselves to the utmost of the resources of nature, our great and growing population would become more and more miserable, and they would be distanced in the race by foreign nations. Mr. Carpenter said his object was not merely to draw attention to the crying need for elementary scientific instruction in our primary schools, but also to point out how such instruction could best be given, and to show that that could be done, and had been done on a large scale, with extraordinarily beneficial results to the children thus taught, without any more expenditure of time than at present. The one great mistake which vitiated the whole organisation of English education was the conception of intellectual training as the acquisition of information rather than as the development of the faculties. He pointed out the enormous value of science teaching in quickening the intelligence, as well as the very great practical value of the knowledge imparted. The special feature of the Liverpool School Board system was that the science demonstrations and experiments were given not by the ordinary staff of the school, but by a specially-appointed expert, whose sole duty it was to go round from school to school, giving practically the same lesson in each one until all had been visited, and abandoning altogether the use of text-books by the scholars. The results of that system were (1) the general quickening of the intellectual life of the school; (2) the sending of a large number of lads to science classes after leaving school; (3) the finding out of lads of exceptional scientific ability, and setting them on their road; (4) the attracting the attention of the ordinary teachers to science and to the results of teaching it. He concluded by urging that instruction in some branch of elementary science, preferably mechanics or physics for boys, and domestic economy for girls, should form a necessary part of the education of every child who remained in a public elementary school above Standard IV., that such instruction should be oral, that such teaching should be given during the ordinary school hours, and that such alterations should be made in the scale of grants under the new Code as should encourage the teaching of elementary science.

OUR readers may remember that some years ago Lieut. Julius von Payer, one of the discoverers of Franz Josef Land, gave up the sea for the brush; but he has carried his Arctic enthusiasm into art. He has for years been engaged on a series of four pictures illustrating the last expedition of Sir John Franklin, and according to the *Times* Paris Correspondent, the last of them, entitled "Starvation Cove," is just completed. Lieut. Payer has taken the greatest pains to acquaint himself with the minutest details of the expeditions of the *Erebus* and *Terror*, their formation and equipment, and the pictures will at least be interesting. We hope they may be exhibited in this country.

THE catalogue of the scientific books in the Reference Department of the Nottingham Free Library spins a list of about 750 titles out into a catalogue of nearly 40 pages, with between 50 and 60 entries upon each, and among them are a good collection of the most important *Journals* and *Transactions*. To a library the wide circle of whose frequenters forbids its shelves being thrown open to them all, it is doubtful whether a small collection of works with a full subject-catalogue is not of greater advantage than a large accumulation of books of which the librarian only is aware. But instead of giving any reference at all to the *subjects* treated in these books and papers, there is only given here the name of each *writer* and the heading under which his production may be found. This can be of little use to any student and none at all to the majority of those using a free library. A supplement of something less than 200 titles is added now, but the collection is so small at present that it is beneath criticism as to its deficiencies.

A TELEGRAM from Constantinople, Jan. 23, states that during the previous fortnight shocks of earthquake, varying in severity, have been felt throughout the district of Kalah-Jik, in the province of Castambul. Some of the minarets of the mosques have fallen in. Shocks also continue to be felt in Central Asia. One occurred at Tashkend a few days ago. A correspondent, writing from Vierno to the *Turkestan Gazette*, states that they have been lately very frequent, and somewhat severe at Oosh. Several shocks have also been recently experienced at Tiflis.

THE Naples Correspondent of the *Standard* writes:—"Prof. Silvestri, Director of the Observatory on Mount Etna, reported on the 15th inst. that frequent movements of the soil had taken place at Nicolosi and all the other villages near the site of the eruption of last March. Besides this, within a zone of about 60 km. in extent, the villages of Biancaritta, Aderno, Bronte, Maletto, Randazzo, Linguaglossa, and Piedimonte have experienced during the last few days subsultory and undulatory shocks; the most remarkable occurring on the evenings of the 10th and 14th inst. The oscillations moved in a north-easterly direction, along the mountain chain of Pilori, and were distinctly but slightly felt at Castiglione, Rovara, Castroreale, and as far as Messina. No damage was done, but at Randazzo and Linguaglossa, where the shocks were stronger, the people were much alarmed. At Catania, only the instruments of the Observatory registered the perturbation coincident with the above-mentioned shocks."

THE additions to the Zoological Society's Gardens during the past week include three Bonnet Monkeys (*Macacus sinicus* ♂ ♀ ♀) from India, a Toque Monkey (*Macacus pileatus*) from Ceylon, an Arabian Baboon (*Cynocephalus hamadryas* ♂) from Arabia, an Indian Gazelle (*Gazella bennetti* ♂ India, presented by Capt. Spencer Stanhope; two Bonnet Monkeys (*Macacus sinicus* ♂ ♀) from India, presented by Mrs. St. John Mitchell; a Huanaco (*Lama huanacos* ♀) from Peru, presented by Mr. J. W. Firth; four Harvest Mice (*Mus minutus*), British, presented by Mr. G. T. Rope; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. George Wood; a Great Grey Shrike (*Lanius excubitor*), British, presented by Master Arthur Blyth; two American Flying Squirrels (*Sciuropterus volucella*) from North America, presented by Mr. F. S. Mosely, F.Z.S.; a Cape Adder (*Vipera atropus*) from South Africa, presented by Mr. C. B. Pilians; a Black Tanager (*Tachyphonus melaleucus*), a White-throated Finch (*Spermophila albigularis*), a Tropical Seed Finch (*Oryzoborus torridus*), a Common Boa (*Boa constrictor*), a South African Rat Snake (*Spilotes variabilis*) from South America, a Cheela Eagle (*Spilornis cheela*) from Ceylon, two Illiger's Macaws (*Ara maracana*) from Brazil, a Common Guillemot (*Lomvia troile*), British, purchased; two Brown-tailed Gerbilles (*Gerbillus erythrurus*), born in the Gardens.

GEOGRAPHICAL NOTES

THE first report of Prof. Hull, dated from Gaza, January 1, has been received. It is necessarily brief, the details being reserved for the full report to follow, but it announces the success of the expedition so far. The professor has made a complete geological survey of the Wady Arabah and the Dead Sea, with a traverse across Southern Palestine. Capt. Kitchener, R.E., who accompanied him, has made a trigonometrical survey. Akabah he found to be laid down too far south; the south part of the Dead Sea as shown on the maps, is quite out of its true shape and position, and the Lisan has to be shifted three miles. From Gaza, when the rest of the party were in quarantine, Capt. Kitchener rode back to Egypt, accompanied by four Arabs only. He took a previously unknown route, particulars as to which will follow, and arrived at Ismailia after a ride of 200 miles. He was everywhere well received by the Arabs, who took him for a cousin of Sheikh Abdullah (the late Prof. Palmer), whose memory is still revered among them, and whose murder they still deplore. They are also reported to be deeply impressed with the energy and pertinacity of Sir Charles Warren's pursuit of the murderers. As regards the other members of Prof. Hull's party, Mr. Hart is reported to have made large additions to the flora; Mr. Lawrence has kept a continuous series of meteorological observations, and Mr. Gordon Hull has obtained a hundred photographs, large and small. Prof. Hull had still to execute two traverses of the country, in which he is no doubt at present engaged. The complete reports, both of himself and Capt. Kitchener, will be extremely important. They will probably be published in the journal of the Society.

WE have received the ninth issue of the *Geographisches Jahrbuch*. In the present volume, the reports which appeared in the first six publications on the additions successively made to our knowledge of extra-European parts of the earth are resumed; the new African annexations to geography being disposed of by Prof. K. Zöppritz, the Asiatic by Dr. Hans Lullies, and the Polar by Herr W. Wichmann. Two important departments in geography find for the first time distinct places assigned them in the present number; geographical onomatology and theoretic cartography. The former has indeed but very recently been recognised as the independent and important province of geography it really is. The first and as yet only comprehensive scientific work on the subject is that by its reviewer in the present *Jahrbuch*, Prof. J. J. Egli, "Versuch einer Allgemeinen Geographischen Onomatologie" (Leipzig, 1870-72), essay towards a general geographical onomatology. The name of a place is either immediately descriptive of its physical features ("nature-names," as Prof. Egli calls this class) or descriptive of some historical or other connection between the place and its earlier or later inhabitants or discoverers ("culture-names"), in either and every case is significant and interesting and an organic part of its geography.—Prof. Sigismund Günther, in his masterly review of theoretic cartography, first gives a brief yet clear and comprehensive "history of the development of geometrical cartography," taking notice more particularly of modern works on the subject, and then estimates recent works on projection.—Prof. von Oppolzer, reporting the progress made in European measurement of degrees, summarises the transactions of the sixth General Conference held on the subject at Munich, September 13-16, 1880. He calls special attention to the results deduced by von Bauernfeind from taking the measurement of the zenith simultaneously at Dobra and Kappellenburg, in which the same anomalies came to light as those pointed out years before by von Bayer. These anomalies are entirely parallel with those which appear in taking barometrical measurements of heights, and von Bauernfeind attributes them to the circumstance that the registered temperatures at given places form no correct criterion of the temperatures of the intermediate air-strata, the temperatures at the given places being to a certain extent determined by purely local influences. These conclusions are confirmed by Oppolzer's studies in astronomical refraction, in which analogous anomalies are to be explained by the fact that the universal law of diminution of temperature with ascent is modified in the lowest air-strata by local causes. In clear nights, *e.g.*, the temperature in the lowest atmospheric strata invariably rises with ascent up to a certain moderate height. During the day, on the other hand, in corresponding conditions, temperature diminishes with ascent at a rate considerably above the average. These facts afford Oppolzer a very simple explanation of hitherto puzzling phenomena.—In the review of geographical meteorology by Prof. J. Hann is presented a great treasure of data as to rainfall, nebulosity, atmospheric pressures, winds, &c.—In a map by Remon of the nebulosities of different parts of Europe and North Africa, the extremes are given at 20° in the Algerian Sahara, and 68° in the north-west of Europe. Cloudiness in general diminishes southwards and eastwards, as compared with the centre of Europe.—Space allows only of the bare mention of the review of the geography of plants by Prof. Drude; of animals, by Prof. Schmarda; of ethnology, by Prof. Gerland; of deep-sea exploration, by Prof. von Boguslawski; of the structure of the earth's surface, by Prof. von Fritsch; and of the method of geography, by Prof. Wagner.

WE understand that the expedition with which Mr. Wilfrid Powell has undertaken to explore New Guinea will leave this country about the beginning of March. It will consist of Mr. Powell, with four or five Europeans, including a naturalist and a geologist, and the work of traversing the thousand or twelve hundred miles which have been mapped out for the route is likely to occupy over a year. Mr. Powell has chartered a small screw steamer, in which the party will proceed up the Amberno river, a large stream in Dutch territory, on the north coast. The explorers will proceed up this river in a steam launch as far as they can get. The launch will then return to the steamer, and the party will strike in a south-westerly direction across the high central range of mountains which runs from east to west, called the Snow Mountains, or the Finisterre Mountains. When this difficult task has been accomplished, Mr. Powell will march to the east coast, where he will hope to find his screw steamer in Astrolabe Bay. After refitting, he will again strike westwards, across the south-east corner of the island, to Port Moresby. Mr. Powell will thus explore the country from north to south, avoiding the Fly River, or any other portion which has been visited by Europeans.

THE *St. Petersburger Zeitung* has received news from Khartoum about Dr. Junker. Herr Bohndorf, Dr. Junker's companion, has arrived at Khartoum, and reports that Junker is still in the Niam Niam country, and that his researches are favourably progressing.

THE last issue of the *Bulletin* of the St. Petersburg Academy of Sciences contains a letter of M. Bunge, the medical officer of the Lena polar meteorological station. The country around the station is but little fitted for collecting. It is a flat region, periodically covered by the tide, and there may be no question about sea-flora or sea-fauna to be found in the creeks that intersect the ground. The ice bear sometimes makes his appearance, as also the wolf, the fox, especially *Canis lagopus*, of which the neighbouring Yakuts catch about 300 every year; the *Mustela herminea* is not very rare. The Yakuts do not know lemmings, but one species at least, the *Myodes torquatus*, inhabits the delta. The reindeer come in large flocks in the summer, returning to the forest region in the autumn. They are killed when passing the streams, shooting being prohibited by the Yakut community. One *Ægocerus montanus* has been perceived, from a great distance, within the delta. Walruses, sometimes seals, and dolphins also enter the mouth of the Lena. As to the birds, M. Bunge gives a list of 101 species he has observed or shot during his journey. The water invertebrata are very poorly represented in the Lena. As M. Bunge gives great attention to the collecting of skulls of animals, his collection promises to be of great value, as also his collection of human skulls taken from the coffins that dot the *tundra*—the Yakuts merely putting them on the surface between a few rough planks. It is worthy of notice that, whilst having many opportunities for visiting the sick Yakuts in the neighbourhood, M. Bunge has not yet noticed a single case of scurvy; it is quite unknown among them.

We have received a separate copy from the forthcoming number of the *Izvestia* of the Russian Geographical Society of a notice of the remarkable Russian expeditions to the Pamir, carried on during last summer. It is sufficient to cast a glance at the map that accompanies this note to ascertain that "the Roof of the World" has now been quite deprived of the veil of mystery that covered it for centuries past. Many years since Russian travellers penetrated into it, and studied detached portions as they followed the course of the rivers which led to these gigantic plateaux, inclosed between still higher mountains. Pursuing his researches for several consecutive years, Dr. Regel and his companions have explored the valleys of the Panj and of its numerous tributaries, penetrating as far south as Sist (37° N. lat.) and as far east as the sources of Shakh-dere, 72° 50′ E. long. An immense bend to the west of the Panj River beneath Kala-vamar, due to the presence of a high chain of mountains running north east, and a wide lake, Shiva, 11,000 feet high, situated to the west of this bend, discovered by Dr. Regel, considerably modify our former maps of the western part of the Pamir region. But the expedition of last summer, which consisted of MM. Putiata, of the general staff, Ivanoff, geologist, and Bendersky, topographer, throws quite a new light on the still less known eastern Pamir. The expedition has literally covered with a network of surveys the whole of this region from 39° 30′ N. lat. to the sources of the Vakhan-daria, in 37° 10′, and from 72° 10′ to 75° 20′ E. long., penetrating thus twice to the foot of the Mustag-aga, or Tagarma Peak. The great Pamir chain, between the Shakh-dere and the Upper Panj has been crossed at four places, 100 miles distant, and the Russian surveys have been brought into connection with those of the pundit M. S. The expedition seems to have established that the pundit M. S. was misled, and that the Ak-su is really the upper part of the Murghab. The other results of this expedition are also very important: not only a map on the scale of five versts to an inch of the whole of this wide region has been drawn, but also the heights of a very great number of points have been determined by barometrical and trigonometrical measurements; large geological and botanical collections have been brought in, as well as many drawings, and a dictionary of the Shugnan language. Detailed reports will follow, the foregoing information being due to a preliminary letter of M. Ivanoff.

A telegram from Nerchinsk, in Siberia, states that M. Joseph Martin, the French traveller, passed through that place recently on his way to Irkutsk. M. Martin has (says a Reuter's telegram) explored the country from the Lena to the Amur, and has crossed the intervening Stanovi Mountain range He has collected a large amount of geographical and geological information concerning the region which he has traversed.

Mr. Schuver, the Dutch African explorer, has been murdered at Bahr Gazal, in South Kordofan.

According to the latest number of the *Annalen der Hydrographie und maritimen Meteorologie* the greatest depth of the Atlantic is 8341 metres; this was found in 19° 39′ 10″ N. lat., and 60° 26′ 5″ W. long. The next greatest depression of the sea bottom is in 19° 23′ 30″ N. lat., and 66° 11′ 45″ W. long., where 7723 metres were found.

THE AIMS AND PROSPECTS OF THE STUDY OF ANTHROPOLOGY[1]

Those who are present at this meeting need scarcely be reminded of the importance of the subject which is our common bond of union, that which is defined in the prospectus of the Institute as "the promotion of the science of mankind by the accumulation of observations bearing on man's past history and present state in all parts of the globe."

But those present are a very small fraction indeed of the persons in this country to whom this great subject is, or should be in some one or other of its various divisions, a matter of deep interest, and as it is possible that the words which it is my privilege and duty as your president to address to you on this occasion may be read by some who are not yet so much conversant with the aims of anthropology and the means for its cultivation which this Institute affords as those who have taken the trouble to come here this evening, I hope that you will pardon me if I bring before you some general considerations, perhaps familiar to all of you, regarding the scope and value of the science the advancement of which we have at heart.

One of the great difficulties with regard to making anthropology a special subject of study, and devoting a special organisation to its promotion, is the multifarious nature of the branches of knowledge comprehended under the title. This very ambition, which endeavours to include such an extensive range of knowledge, ramifying in all directions, illustrating and receiving light from so many other sciences, appears often to overleap itself and give a looseness and indefiniteness to the aims of the individual or the institution proposing to cultivate it.

The old term ethnology has a far more limited and definite meaning. It is the study of the different peoples or races who compose the varied population of the world, including their physical characters, their intellectual and moral development, their languages, social customs, opinions, and beliefs, their origin, history, migrations, and present geographical distribution, and their relations to each other. These subjects may be treated of under two aspects—first, by a consideration of the general laws by which the modifications in all these characters are determined and regulated; this is called general ethnology: secondly, by the study and description of the races themselves, as distinguished from each other by the special manifestations of these characters in them. To this the term special ethnology, or, more often, ethnography, is applied.

Ethnology thus treats of the resemblances and differences of the modifications of the human species in their relations to each other, but anthropology, as now understood, has a far wider scope. It treats of mankind as a whole. It investigates his origin and his relations to the rest of the universe. It invokes the aid of the sciences of zoology, comparative anatomy, and physiology; and the wider the range of knowledge met with in other regions of natural structure, and the more abundant the terms of comparison known, the less risk there will be of error in attempting to estimate the distinctions and resemblances between man and his nearest allies, and fixing his place in the zoological scale. Here we are drawn into contact with an immense domain of knowledge, including a study of all the laws which modify the conditions under which organic bodies are manifested, which at first sight seem to have little bearing upon the particular study of man.

Furthermore, it is not only into man's bodily structure and its relations to that of the lower animals that we have to deal; the moral and intellectual side of his nature finds its rudiments in them also, and the difficult study of comparative psychology, now attracting much attention, is an important factor in any complete system of anthropology.

In endeavouring to investigate the origin of mankind as a whole, geology must lend its assistance to determine the comparative ages of the strata in which the evidences of his existence are found; but researches into his early history soon trench upon totally different branches of knowledge. In tracing the progress of the race from its most primitive condition, the characteristics of its physical structure and relations with the lower animals are soon left behind, and it is upon evidence of a kind peculiar to the human species, and by which man is so pre-eminently distinguished from all other living beings, that our conclusions mainly rest. The study of the works of our earliest known forefathers, "prehistoric archæology," as it is commonly called, although one of the most recently developed branches of knowledge, is now almost a science by itself, and one which is receiving a great amount of attention in all parts of the civilised world. It investigates the origin of all human culture, endeavours to trace to their common beginning the sources of all our arts, customs, and history. The difficulty is what to include and where to stop; as, though the term "prehistoric" may roughly indicate an artificial line between the province of the anthropologist and that which more legitimately belongs to the archæolo-

[1] Address delivered at the anniversary meeting of the Anthropological Institute of Great Britain and Ireland, January 22, 1884, by Prof. Flower, LL.D., F.R.S., P.Z.S., &c., President.

gist, the antiquary, and the historian, that the studies of the one pass insensibly into those of the other is an evident and necessary proposition. Knowledge of the origin and development of particular existing customs throws immense light upon their real nature and importance, and conversely, it is often only from a profound acquaintance with the present or comparatively modern manifestations of culture that we are able to interpret the slight indications afforded us by the scanty remains of primitive civilisation.

Even the more limited subject of ethnology must be approached from many sides, and requires for its cultivation knowledge derived from sciences so diverse, and requiring such different mental attributes and systems of training, as scarcely ever to be found combined in one individual. This will become perfectly evident when we consider the various factors or elements which constitute the differential characters of the groups or races into which mankind is divided. The most important of these are—

1. Structural or anatomical characters, derived from diversities of stature, proportions of different parts of the body, complexion, features, colour and character of the hair, form of the skull and other bones, and the hitherto little-studied anatomy of the nervous, muscular, vascular, and other systems. The modifications in these structures in the different varieties of man are so slight and subtile, and so variously combined, that their due appreciation, and the discrimination of what in them is essential or important, and what incidental or merely superficial, requires a long and careful training, superadded to a preliminary knowledge of the general anatomy of man and the higher animals. The study of physical or zoological ethnology, though it lies at the basis of that of race, is thus necessarily limited to a comparatively few original investigators.

2. The mental and moral characters by which different races are distinguished are still more difficult to fathom and to describe and define, and although the subject of much vague statement, as there are few people who do not consider themselves competent to give an opinion about them, they have hitherto been rarely approached by any strictly scientific method of inquiry.

3. Language.—The same difficulties are met with in the study of language as in that of physical peculiarities, in the discrimination between the fundamental and essential, and the mere accidental and superficial resemblances, and in proportion as these difficulties are successfully overcome will be the results of the study become valuable instead of misleading. Though the science of language is an essential part of ethnology, and one which generally absorbs almost the entire energies of any one who cultivates it, its place in discriminating racial affinities is unquestionably below that of physical characters. Used, however, with due caution, it is a powerful aid to our investigations, and in the difficulties with which the subject is surrounded, one which we can by no means afford to do without.

4. The same may be said of social customs, including habitations, dress, arms, food, as well as ceremonies, beliefs, and laws, in themselves fascinating subjects of study, placed here in the fourth rank, not as possessing any want of interest, but as contributing comparatively little to our knowledge of the natural classification and affinities of the racial divisions of man. When we see identical and most strange customs, such as particular modes of mutilation of the body, showing themselves among races the most diverse in character and remote geographically, we cannot help coming to the conclusion that these customs have either been communicated in some hitherto unexplained manner, or are the outcome of some common element of humanity, in either of which cases they tell nothing of the special relations or affinities of the races which practise them.

This subject of ethnography, or the discrimination and description of race characteristics, is perhaps the most practically important of the various branches of anthropology. Its importance to those who have to rule, and there are few of us now who are not called upon to bear our share of the responsibility of government, can scarcely be overestimated in an empire like this, the population of which is composed of examples of almost every diversity under which the human body and mind can manifest itself. The physical charactereStics of race, so strongly marked in many cases, are probably always associated with equally or more diverse characteristics of temper and intellect. In fact, even when the physical divergences are weakly shown, as in the case of the different races which contribute to make up the home portion of the empire, the mental and moral characteristics are still most strongly marked. As it behoves the wise physician not only to study the particular kind of disease under which his patient is suffering, and then to administer the approved remedies for such disease, but also to take into careful account the peculiar idiosyncracy and inherited tendencies of the individual, which so greatly modify both the course of the disease and the action of remedies, so it is absolutely necessary for the statesman who would govern successfully, not to look upon human nature in the abstract and endeavour to apply universal rules, but to consider the special moral, intellectual, and social capabilities, wants, and aspirations of each particular race with which he has to deal. A form of government under which one race would live happily and prosperously would to another be the cause of unendurable misery. No greater mistake could be made, for instance, than to apply to the case of the Egyptian fellah the remedies which may be desirable to remove the difficulties and disadvantages under which the Birmingham artisan may labour in his struggle through life. It is not only that their education, training, and circumstances are dissimilar, but that their very mental constitution is totally distinct. And when we have to do with people still more widely removed from ourselves, African Negroes, American Indians, Australian or Pacific Islanders, it seems almost impossible to find any common ground of union or *modus vivendi*; the mere contact of the races generally ends in the extermination of one of them. If such disastrous consequences cannot be altogether averted, we have it still in our power to do much to mitigate their evils.

All these questions, then, should be carefully studied by those who have any share in the government of people of races alien to themselves. A knowledge of their special characters and relations to one another has a more practical object than the mere gratification of scientific curiosity; it is a knowledge upon which the happiness and prosperity, or the reverse, of millions of our fellow-creatures may depend.

It is gratifying to find, then, that there are in our own country —for on this occasion I will not speak of what is being done elsewhere—many signs that the prospects of a thorough and scientific cultivation of anthropology in its several branches are brightening.

I may first mention the publication of the final Report of the Anthropometric Committee of the British Association for the Advancement of Science, of which formerly the late Dr. W. Farr, and recently our vice-president, Mr. Francis Galton, have been chairmen, and in which Mr. Charles Roberts, Dr. Beddoe, Sir Rawson Rawson, and some other of our members have taken so active a part. This Report, and those which have from time to time been issued by the Committee during the progress of the work, contain a large mass of valuable statistical information relating to the physical characters, including stature, weight, chest girth, colour of eyes and hair, strength of arm, &c., of the inhabitants of the British Isles, illustrated by maps and diagrams. Excellent as has been the work of the Committee, there is still much to be done in the same direction, and larger numbers of observations even than those already obtained are in many cases necessary to verify or correct the inferences drawn from them. This is thoroughly acknowledged in the Report, which states in one of the concluding paragraphs that "the Committee believes that it has laid a substantial foundation for a further and more exhaustive study of the physical condition of a people by anthropometric methods, and that its action will prove that it has been useful as an example to other scientific societies and to individuals in stimulating them, as well as directing them in the methods of making statistical inquiries relative to social questions."

It is satisfactory to learn that many portions of the work thus inaugurated will be carried on by bodies specially interested in particular departments, as the Collective Investigation Committee of the British Medical Association, and the Committee of the British Association for collecting photographs and defining the characteristics of the principal races of the United Kingdom, a subject in which Mr. Park Harrison is taking so deep an interest.

It should be mentioned that the original returns upon which the reports of the Committee are based, including much information which has not yet been analysed and tabulated, on account of the time and labour such a process would involve, as well as the instruments of investigation purchased with funds supplied by the British Association, have been, by the consent of the Council of the Association, placed under the charge of the officers of this Institute.

It is very satisfactory, in the next place, to be able to record that our great centres of intellectual culture are gradually waking up from that state of apathy with which they have hitherto regarded the subject of anthropology.

In Oxford the impulse given by the genius and energy of Rolleston has begun to bear fruit. The University has taken charge of the grand collection of ethnological objects most liberally offered to it by our former president, General Pitt-Rivers, and has undertaken not only to provide a suitable building for its reception but also to maintain it in a manner worthy of the scientific discernment and munificence displayed by the donor in collecting and arranging it. Furthermore Oxford has shown her wisdom in affiliating to herself the most learned of English anthropologists in the widest sense of the word, one of the few men in this country who has made the subject the principal occupation of his life. I need scarcely say that I refer to another of our former presidents, Mr. E. B. Tylor. By conferring a Readership in Anthropology upon him Oxford has instituted the first systematic teaching of the subject yet given in any educational establishment in this country, and it is a great credit to the oldest University that it should thus lead the way in one of the most modern of sciences. It is, however, only a beginning; the whole of the great subject is confined to the teaching of one individual with modest stipend and not admitted to the dignity of the professoriate. In the École des Hautes Études at Paris anthropology is taught theoretically and practically in six different branches, each under the direction of a professor who has specially devoted himself to it, aided, in some cases, by several assistants.

In Cambridge also there are many hopeful signs. The recently-appointed Professor of Anatomy, Dr. Macalister, is known to have paid much attention to anatomical anthropology, and has already intimated that he proposes to give instruction in it during the summer term. An Ethnological and Archæological Museum is also in progress of formation, which, if not destined to rival that of Oxford, already contains many objects of great value, and a guarantee of its good preservation and arrangement may be looked for in the recent appointment of Baron Anatole von Hügel as its first curator.

Perhaps in no place in the world could so varied and complete an anthropological collection be expected as in the national museum of this country, which should be the great repository of the scientific gleanings of the numerous naval, military, exploring, and mercantile expeditions sent out by the Government or by private enterprise for more than a century past, and penetrating into almost every region of the globe. Our insular position, maritime supremacy, numerous dependencies, and ramifying commerce, have given us unusually favourable opportunities for the formation of such collections, opportunities which unfortunately in past times have not been used so fully as might be desired. There is, however, a great change coming over those who have charge of our national collections in regard to this subject. Thanks to the foresight and munificence of the late Mr. Henry Christy, and the well-directed energies of Mr. Franks and his colleagues, the collection illustrating the customs, clothing, arts, and arms of the various existing and extinct races of men, in the British Museum, is rapidly assuming an importance which will be a surprise to those who see it for the first time arranged in the large galleries formerly devoted to mammals and birds. Even the grand proportion of space allotted to this collection in the rearrangement of the Museum is, I am told, scarcely sufficient for its present needs, to say nothing of the accessions which it will doubtless receive now that its importance and good order are manifest.

A national collection of illustrations of the physical characters of the races of men, fully illustrated by skeletons, by anatomical specimens preserved in spirit, by casts, models, drawings, and photographs such as that which exists in the Muséum d'Histoire Naturelle at Paris, is still a desideratum in this country. The British Museum till lately ignored the subject altogether, and in the beginning of the century actually expelled such specimens of the kind as had accidentally found their way within its walls. Recently, however, skulls and skeletons of man have been admitted, and since the removal of the zoological collections to the new building at South Kensington their importance as an integral part of the series has been recognised, and their exhibition in the osteological gallery will doubtless stimulate the growth of what we may trust will be ultimately a collection worthy of the nation, although unfortunately, from causes too well known, the difficulties of procuring pure examples of many races are gradually increasing, and in some cases have become well-nigh insuperable. The museum contains at present 407 specimens illustrating human osteology, of which 10 are skeletons more or less complete.

In the meantime the College of Surgeons of England has done much to supply the deficiency. During the last twenty years it has let few opportunities pass of attracting to itself, and therefore saving from the destruction or lapse into the neglected, valueless condition into which small private collections almost invariably ultimately fall, a large number of specimens, now, it is to be hoped, placed permanently within the reach of scientific observation. The growth of this collection may be illustrated by the fact that, whereas at the time of the publication of the Catalogue in 1853 it consisted of 18 skeletons and 242 crania, it now contains 89 more or less complete skeletons and 1380 crania, nearly all of which have been added during the last twenty years. This is, moreover, irrespective of the great collection of Dr. Barnard Davis, purchased in 1880 by the College, which was thus the means of preserving intact, for the future advantage and instruction of British anthropologists, an invaluable series of specimens otherwise probably destined to have been dispersed or lost to the country for ever. This collection consists of 24 skeletons and 1539 crania, making, with the remainder of the College collection, a total of 3032 specimens illustrating the osteological modifications of the human species. These are all in excellent order, clean, accessible, and catalogued in a manner convenient for reference, although somewhat too crowded in their present locality to be readily available for observation.

Large as is this collection, and rich in rare and interesting types, it is far from exhaustive; many great groups are almost or entirely unrepresented even by crania, and the series of skeletons is (with the exception of one race only, the Andamanese) quite insufficient to give any correct idea of the average proportions of different parts of the framework. In fact, such a collection as would be required for this purpose must be quite beyond the resources of, as well as out of place in, any but a national museum.

The collections illustrating anatomical anthropology in the University museums of Oxford, Cambridge, Edinburgh, and Dublin have all greatly increased of late, but for the reasons just given they can never be expected to attain the dimensions required for the study of the subject in its profoundest details. The small, but very choice collections formed by the officers of the medical department of the army, and kept in the museum of the Royal Victoria Hospital at Netley, and that of the navy at Haslar Hospital, are, I believe, in a stationary condition, but in good preservation. Our own collection, which also contains some valuable specimens (notably the complete skeleton of one of the extinct Tasmanian aborigines, presented by the late Mr. Morton Allport), and which during the past year has been catalogued for the first time by Mr. Bloxam, has not been added to, owing to a feeling which the Council has long entertained, and which induced them to part with the ethnological collection, that a museum, entailing as it does, if worthily kept up, a very considerable annual expense, is not within the means of the Institute, at all events not until the more pressing claims of the library and the publications are fully satisfied.

This leads me to speak, in conclusion, of the work accomplished during the past year by the Institute, and of its present position and future prospects.

I must first refer to that portion of the retrospect of the year which always casts a certain sadness over these occasions—the losses we have sustained by death. Happily these have not been numerous, and do not include, as has been the case in many former years, any from whom great work in our own subject might still have been expected. Though we were all proud to number William Spottiswoode, the President of the Royal Society, among our members, and though we all honoured him for his accomplishments in other branches of science, and loved him for his work as a man who rose high above his fellows in his chivalrous sense of honour and simple dignity of demeanour, we could not claim him as a worker at anthropology.

Lord Talbot de Malahide's antiquarian pursuits frequently verged upon our own subjects in their proper sense, and he was often present at our meetings, and a very recent contributor to our journal. He had, however, reached the ripe old age of eighty-two.

From the list of our honorary members we have lost a still more venerable name, that of Sven Nilsson, Professor in the Academy of Lund. He was born on March 8, 1787, and died on November 30 of last year, and was therefore well on in his ninety-seventh year. His long-continued and laborious researches in the zoology, palæontology, anthropology, and antiquities of his native land gave him a high place among men of science. Among a host of minor contributions he was the author of a standard work on the Scandinavian fauna; but that by which he was best known to us is the book of which the English translation, edited by Sir John Lubbock, bears the title of "The Primitive Inhabitants of Scandinavia; an Essay on Comparative Ethnography, and a Contribution to the History of the Development of Mankind."

The number of our ordinary members has been fairly kept up, the additions by election having slightly exceeded the losses by death and resignation; but a larger increase in the future will be necessary in order to carry on the operations of the Institute in a successful manner, especially under the new conditions to which I shall have to advert presently. Even by the most careful management our treasurer has not succeeded in bringing the expenditure of the year quite within our ordinary income.

The journal, I am glad to report, has been brought out with exemplary punctuality, under the able and energetic supervision of our director, Mr. Rudler. To this part of our operations I think we may look with unmixed satisfaction, the number, character, and variety of the communications contained in it being quite equal to those of former years.

With regard to our future, the next year will probably be one of the most momentous in our annals, as we have determined upon a great step, no less than a change of domicile. It was ascertained in the course of last summer that we could only remain in our present quarters at an increased rent upon that which we had hitherto paid, and we therefore considered whether it would be possible to obtain as good or better accommodation elsewhere. It happened fortunately that the Zoological Society was about to move into new freehold premises at No. 3, Hanover Square, and would have spare rooms available for the occupation of other societies. A committee of the Council was appointed to examine and report upon the desirability of moving, and negotiations were entered into with the Council of the Zoological Society which have ended in our becoming their tenants for the future. We shall have for the purposes of our library, office, and Council meetings, two convenient rooms on the second floor immediately above the library of the Zoological Society, and for the purpose of storing our stock of publications a small room on the basement. We shall also have the use of a far more handsome and commodious meeting room than that which we occupy at the present moment, and in a situation which is in many respects more advantageous. Let us trust that this change may be the inauguration of an era of prosperity to the Institute, and of increased scientific activity among its members.

THE FORMATION OF SMALL CLEAR SPACES IN DUSTY AIR[1]

IN the introduction a few remarks are made on the growing interest in everything connected with dust, whether it be the organic germs floating in the air, or the inorganic particles that pollute our atmosphere. Prof. Tyndall's observations on the dark plane seen over a hot wire[2] are referred to, Lord Rayleigh's recent discovery of the dark plane formed under a cold body[3] is described, and attention called to Dr. Lodge's experiments described in a letter to NATURE, vol. xxviii. p. 297.

The experiments described in this paper were made in a small dust-box, blackened inside, glazed in front, and provided with a window at one side. For illumination two jets of gas inclosed in a dark lantern were used. The light entered the dust-box by the side window and could be condensed on any part of the inside of the box, by means of two lenses fixed in a short tube, and loosely attached to the front of the lantern. Magnifying glasses of different powers were used for observation. The dusts experimented on were made, some of hydrochloric acid and ammonia, some by burning sulphur and adding ammonia, some by burning paper, magnesium, or sodium. Calcined magnesia and lime were also used, as well as ground charcoal. These three last substances were stirred up by means of a jet of air.

For testing the effects of slight difference of temperature, tubes in some form or other were generally used. These tubes were closed at the front, projected through the back of the dust-box, and were brought close to the glass front for observation under strong magnifying power. The tubes were heated or cooled by circulating water through them, in a small tube passing through their interior.

Suppose the experiments to be begun by introducing a round tube into its place in the dust-box and then filling the box with any dust, everything being then left for some time so that all the apparatus may acquire the same temperature. If the light be now allowed to fall on the box, and be quickly brought to a focus on the tube, it will be found that the dust is in close contact with it on the top and sides, but *underneath* there will be seen a clear space. Close examination will show the particles to be falling on the upper surface of the tube, and coming into contact with it, while underneath a clear space is formed by the particles falling out of it. If the tube is now slightly cooled, a downward current is formed, and the currents of dustless air from below the tube meet under it, and form a dark plane in the centre of the descending current. It is shown that gravitation can, under favourable conditions, produce this separation of the dust quickly enough to keep up a constant supply of dustless air. No increase of effect is produced by a lower temperature. A temperature of − 10° C. makes the dark plane thinner, because it increases the rate of the descending current and carries away the purified air more quickly.

A form of apparatus was arranged to get rid of this separating effect of gravitation. It consisted of an extremely thin and flat piece of metal. This test-surface was placed *vertically* in the dust-box. The air in passing over this piece of apparatus was not caused to take up a horizontal movement at any part of its passage. The result was that even with a temperature of − 10° C. the dust kept close to its surface, and no dark plane was formed in the descending current. The dark plane in the cold descending current seems, therefore, not to be an effect of temperature, but is the result of the action of gravitation on the particles under the body. A dark plane was, however, observed when working with this flat surface when cooled, but it was not formed in dusty, but in foggy air, and was found to be due to the evaporation of the fog particles when they approached the cold surface.

If a very little heat, instead of cold, is applied to the round tube in the previous experiment, then the dark space under the tube rises and encircles the tube and the two currents of clear air unite over the tube and form the dark plane in the upward current. But in addition to this heat has been found to exert a repelling effect on the dust. This was proved by putting the thin vertical test surface in the dust-box and heating it, when it was found that the dust was repelled from its surface, and a dark plane formed in the ascending current, neither of which effects was obtained with cold. The dust begins to be repelled with the slightest rise of temperature, and the dark space in front of the test-surface becomes thicker as the temperature rises. An experiment is then described in which air flowing up between two parallel glass plates is caused to pass from side to side of the channel by the repelling action of heat at different points.

For testing the effects of higher temperatures a platinum wire heated by means of a battery was used. The platinum wire was bent into a U-shape, the two legs being brought close together. This wire was fixed in the dust-box with the bend to the front, and the legs in the same horizontal plane, the two copper wires to which it was attached being carried backwards and out of the box. By this arrangement a clear view was obtained all round the wire, and other advantages secured. Experimenting with this apparatus it was found that every kind of dust had a different sized dark plane. With magnesia and other indestructible dusts it was very thin, with the sulphate dust it was much thicker, and with the sal-ammoniac dust thicker still. So thick was it with the two latter kinds of dust that the dark planes over the two legs expanded and formed one plane. As the particles could be seen streaming into the dark space under the wires, it was obvious that these large dark planes were not caused by repulsion, but by the evaporation or by the disintegration of the dust particles. When making the experiment in a mixture of different kinds of dusts, the hot wire was surrounded by a series of zones of different brightness, and having sharp outlines. The size of the different zones was determined by the temperature necessary to evaporate the different kinds of dust present, and

[1] Abstract of a paper read to the Royal Society of Edinburgh, January 21, 1884, by Mr. John Aitken.
[2] "Essays on the Floating-Matter in the Air," p. 5. (Longmans, Green, and Co., 1881.)
[3] NATURE, vol xxviii. p. 139.

outside these zones was another, caused by the evaporation of the water from the particles.

The conclusions arrived at from these experiments are that the downward dark plane is produced by this separating action of gravitation, in the space under the cold body, and that the upward dark plane is produced (1) by the separating action of gravitation, (2) by the repulsion due to heat, (3) by evaporation, and (4) by disintegration.

The effect of centrifugal force is considered. It is pointed out that as the air, in its passage over a body such as a tube, curves as much in one direction as it does in another, therefore any centrifugal effect produced in the one part will be reversed in the other. An experiment is described in which an air current is caused to curve through 180° in its passage round the edge of a thin plate, and without any curving in the opposite direction, but no decided centrifugal action could be detected.

The motions of the dust particles produced by the repulsion of the hot surface suggested that electricity might play some part in these phenomena. Experiments were made to test this. The hot body was insulated and connected with an electroscope; but no electrical disturbance was observed, nor could any electrification be got from the dust and hot air streaming up from the hot wires. The effects of electrification were studied by insulating and charging the hot surface. The effect was found to be the opposite of the heat effect. If the potential is slight, and the temperature high, the heat is able to keep the dust off the surface of the body and the dark plane district, but if the temperature falls, or the potential is increased, a point is reached when the electrical attraction overcomes the heat effect, and the dust particles break in upon and destroy the dark space.

It was observed that after the dust particles were electrified they tended to deposit themselves on any surface near them, and experiments were made to determine the best conditions for purifying air in this manner. It was found to be best done by causing as rapid a discharge of electricity as possible, by means of points, surfaces being placed near them to increase the electrification of the dust, and to augment the rate of the currents of air which were driven from the points. These surfaces became places on which the dust deposited itself before losing its charge. A large flask was found to be rapidly cleared of a cloud of dust by means of a point—the dust being almost entirely deposited on the inside surface of the flask. If the end of the conductor in the flask terminated in a sphere, but little effect was produced. Electricity has also been found capable of depositing the very fine dust of the atmosphere. The air in a large flask was purified much more quickly by means of the electric discharge than it could have been by means of an air-pump and cotton-wool filter.

It is shown that a wet and hot surface repels dust more than twice as strongly as a hot dry one. From this it is concluded that the heat and moisture in our lungs exert a protecting influence on the surface of the bronchial tubes and tend to keep the dust in the air which is ebbing and flowing through them from coming into contact with their surfaces. This was illustrated by placing a hot and wet surface in a current of dense smoke, where it remained some time without receiving a speck of soot, while a similar surface, but cold, was blackened with the smoke. It is pointed out that on account of the irregularities on the surface of the tubes, and of the more violent movements of the air in the lungs, and on account of curves and projecting edges, the protection in the lungs is not perfect. Still it is thought that this repelling action at these surfaces must have some influence, and it seems possible it may explain some climatic effects, as it is evident that the lungs will be much better protected in such places as Davos Platz, where the air is cold and dry, and the repelling forces at a maximum, than at places like Madeira, where the air is warm and moist and these forces are at a minimum. This point can, however, only be determined satisfactorily by anatomical examinations of lungs which have lived under the different conditions.

In the experiments it was observed that dust not only tended to move away from hot surfaces, but also that it was attracted by cold ones, and attached itself to them. To study this effect glass plates were put in different positions near the hot platinum wire. Very beautiful impressions of the dark plane can be obtained by placing a piece of glass vertically and transversely over the hot wire. The hot air in flowing over the glass, deposits its dust on the surface of the plate leaving a clear line in the middle, indicating where the dustless air of the dark plane had passed. In this way the dust is trapped on the glass to which it adheres with some firmness, and not only the impressions but the dark planes themselves may thus be preserved.[1]

Other experiments to study the repulsion and attraction of hot and cold surfaces were made by placing glass plates on both sides of the hot wire. An interesting result was obtained when the plates were about 1 mm. apart. Using magnesia powder, the particles could be seen rising in the current, and approaching the hot wire; they were then observed to be violently repelled towards the cold surface, to which they adhered. If there was sufficient difference of temperature, not a single particle of dust was carried by the current past the hot wire.

A thermic filter is then described. In this filter the air is passed through the space formed between two concentric tubes. One tube is kept cold by a stream of water, and the other heated by means of steam or a flame. This instrument was shown in action; one end of the filter was connected with a glass flask, in which the condition of the air was tested. So long as the difference of temperature was kept up, and the current not too rapid, the air passing through it showed no signs of producing cloudy condensation on the pressure being reduced, showing that the filter had trapped all, even the invisible dust particles.

Some experiments on the effect of diffusion on the distribution of dust at the surface of a diaphragm are described. When carbonic acid diffuses into a space, the dust comes close to the diffusing surface, but if hydrogen is the diffusing gas, a clear space is formed in front of the diaphragm.

An explanation is then offered of the repulsion of dust by hot surfaces and its attraction by cold ones. It seems possible, that the dust might be repelled in the same way as the vanes of a Crookes' radiometer, by a radiation effect. That this was not the true explanation was, however, proved by placing in the dust-box a polished silver flat test-surface, one half of which was coated with lamp-black, when it was found that the dark space in front of the lamp-black was not any thicker than that in front of the polished metal. It is thought that the repulsion is due to the diffusion of the hot and cold air molecules. The hot surface repels because the outward diffusing molecules are hot, and have greater kinetic energy than the inward moving ones; and as the side of the dust particle next the hot surface is bombarded by a larger number of hot molecules than the other side, it is driven away from the hot surface. The attraction of a cold surface is explained by the less kinetic energy of the outward than of the inward diffusing molecules. Some experiments are referred to, to show that the rate at which gas molecules diffuse indicate that this diffusion effect is sufficient to account for the repulsion and attraction of the dust.

If the explanation here given is correct, then the dust is repelled in the same way as a vane of a radiometer when placed in front of a surface fixed inside the radiometer bulb, and hotter than the residual gas, the principal part of the energy producing the motion being transferred from the hot surface to the repelled surface by the kinetic energy of the molecules, and not by radiation.

In illustration of the tendency of dust to move from hot and to deposit itself on cold surfaces, the following experiments were made. Two mirrors, one hot and the other cold, fixed face to face and close to each other, were placed in a vessel filled with a dense cloud of magnesia, made by burning magnesium wire. After a short time the mirrors were taken out and examined. The hot one was quite clean, while the cold one was white with magnesia dust. In another experiment a cold metal rod was dipped into some hot magnesia powder; when taken out it had a club-shaped mass of magnesia adhering to its end, while a hot rod attracted none.

This tendency of dust to leave hot surfaces and attach itself to cold ones explains a number of familiar things, among others it tells us why the walls and furniture of a stove-heated room are always dirtier than those of a fire-warmed one. In the one case the air is warmer than the surfaces, and in the other the surfaces are warmer than the air. This effect of temperature is even necessary to explain why so much soot collects in a chimney. It explains something of the peculiar liquid-like movements of hot powders, and perhaps something of the spheroidal condition.

For practical applications, it is suggested that this effect of temperature might be made available in many chemical works for the condensation of fumes, and that it might also be used

[1] Specimens of these trapped dark planes were shown at the meeting, some of them made of white powder deposited on blackened glass, others of charcoal deposited on opal glass.

for trapping soot in chimneys. A small trap of this kind was shown. It consisted of a tall metal tube or chimney, surrounded by another tube slightly larger. The products of combustion are taken up the centre tube and down the intervening space. The heat of the gases is thus made to do its own filtering. This apparatus being placed over a smoky lamp, it trapped out most of the soot, and deposited it on the inside of the outer tube. This arrangement of apparatus is too delicate and troublesome for general use, and it is suggested that, as by simply cooling gases in presence of plenty of surface much of its dust is deposited, it might be possible and advantageous under certain conditions to purify air by heating and cooling it a number of times, which could be done at a small expense by means of regenerators.

Experiments were also made by discharging electricity into the smoke in a chimney. This also produced a marked diminution in the blackness of the escaping smoke. The supply of electricity of sufficiently high potential is however a difficulty for the present.

A VAST DUST ENVELOPE[1]

SCIENTIFIC men have evinced extraordinary interest in the wonderfully brilliant sunsets that have for some time past been observed in different parts of the world. Various theories have been advanced, but all are agreed that the real cause is not yet definitely determined. At the Brevoort House yesterday, a *Tribune* reporter spent a couple of hours with Prof. S. P. Langley, astronomer at Allegheny Observatory, Allegheny, Penn. His views upon the topic of the transmissibility of light through our atmosphere are stated below:

"At first I supposed the sunset matter a local phenomenon, but when the reports showed it to have been visible all over the world, it was obvious that we must look for some equally general cause. We know but two likely ones, and these have been already brought forward. One is the advent of an unusual amount of meteoric dust. While something over ten millions of meteorites are known to enter our atmosphere daily, which are dissipated in dust and vapour in the upper atmosphere, the total mass of these is small as compared with the bulk of the atmosphere itself, although absolutely large. It is difficult to state with precision what this amount is. But several lines of evidence lead us to think it is approximately not greatly less than 100 tons per diem, nor greatly more than 1,000 tons per diem. Taking the largest estimate as still below the truth, we must suppose an enormously greater accession than this to supply quantity sufficient to produce the phenomenon in question; and it is hardly possible to imagine such a meteoric inflow unaccompanied with visual phenomena in the form of 'shooting stars,' which would make its advent visible to all. Admitting, then, the possibility of meteoric influence, we must consider it to be nevertheless extremely improbable.

"There is another cause, which I understand has been suggested by Mr. Lockyer—though I have not seen his article—which seems to be more acceptable—that of volcanic dust; and in relation to this presence of dust in the entire atmosphere of the planet, I can offer some little personal experience. In 1878 I was on the upper slopes of Mount Etna, in the volcanic wastes, three or four hours' journey above the zone of fertile ground. I passed a portion of the winter at that elevation engaged in studying the transparency of the earth's atmosphere. I was much impressed by the fact that here, on a site where the air is supposed to be as clear as anywhere in the world, at this considerable altitude, and where we were surrounded by snow-fields and deserts of black lava, the telescope showed that the air was filled with minute dust particles, which evidently had no relation to the local surroundings, but apparently formed a portion of an envelope common to the whole earth. I was confirmed in this opinion by my recollection that Prof. Piazzi Smyth, on the Peak of Teneriffe, in mid-ocean, saw these strata of dust rising to the height of over a mile, reaching out to the horizon in every direction, and so dense that they frequently hid a neighbouring island mountain, whose peak rose above them, as though out of an upper sea. In 1881 I was on Mount Whitney, in Southern California, the highest peak in the United States, unless some of the Alaskan mountains can rival it. I had gone there with an expedition from the Allegheny Observatory, under the official direction of General Hazen, of the Signal Service, and had camped at an altitude of 12,000 feet, with a special object of studying analogous phenomena. On ascending the peak of Whitney, from an altitude of nearly 15,000 feet the eye looks to the east over one of the most barren regions in the world. Immediately at the foot of the mountain is the Inyo Desert, and on the east a range of mountains parallel to the Sierra Nevadas, but only about 10,000 feet in height. From the valley the atmosphere had appeared beautifully clear. But from this aërial height we looked down on what seemed a kind of level dust-ocean, invisible from below, but whose depth was six or seven thousand feet, as the upper portion only of the opposite mountain range rose clearly out of it. The colour of the light reflected to us from this dust-ocean was clearly red, and it stretched as far as the eye could reach in every direction, although there was no special wind or local cause for it. It was evidently like the dust seen in mid-ocean from the Peak of Teneriffe—something present all the time, and a permanent ingredient in the earth's atmosphere.

"At our own great elevation the sky was of a remarkably deep violet, and it seemed at first as if no dust was present in this upper air, but in getting, just at noon, in the edge of the shadow of a range of cliffs which rose 1,200 feet above us, the sky immediately about the sun took on a whitish hue. On scrutinising this through the telescope it was found to be due to myriads of the minutest dust particles. I was here at a far greater height than the summit of Etna, with nothing around me except granite and snow-fields, and the presence of this dust in a comparatively calm air much impressed me. I mentioned it to Mr. Clarence King, then Director of the United States Geological Surveys, who was one of the first to ascend Mount Whitney, and he informed me that this upper dust was probably due to the 'loess' of China, having been borne across the Pacific and a quarter of the way around the world. We were at the summit of the continent, and the air which swept by us was unmingled with that of the lower regions of the earth's surface. Even at this great altitude the dust was perpetually present in the air, and I became confirmed in the opinion that there is a permanent dust shell inclosing the whole planet to a height certainly of about three miles (where direct observation has followed it), and not improbably to a height even greater; for we have no reason to suppose that the dust carried up from the earth's surface stops at the height to which we have ascended. The meteorites, which are consumed at an average height of twenty to forty miles, must add somewhat to this. Our observations with special apparatus on Mount Whitney went to show that the red rays are transmitted with greatest facility through our air and rendered it extremely probable that this has a very large share in the colours of a cloudless sky at sunset and sunrise, these colours depending largely upon the average size of the dust particles.

"It is especially worth notice that, as far as such observations go, we have no reason to doubt that the finer dust from the earth's surface is carried up to a surprising altitude. I speak here, not of the grosser dust particles, but of those which are so fine as to be individually invisible, except under favouring circumstances, and which are so minute that they might be an almost unlimited time in settling to the ground, even if the atmosphere were to become perfectly quiet. I have not at hand any data for estimating the amount of dust thrown into the air by such eruptions as those which recently occurred in Java and Alaska. But it is quite certain, if the accounts we have are not exaggerated, that the former alone must have been counted by millions of tons and must in all probability have exceeded in amount that contributed by meteorites during an entire year. Neither must it be supposed that this will at once sink to the surface again. Even the smoke of a conflagration so utterly insignificant, compared with nature's scale, as the burning of Chicago, was, according to Mr. Clarence King, perceived on the Pacific Coast; nor is there any improbability that I can see in supposing that the eruption at Krakatoa may have charged the atmosphere of the whole planet (or at least of a belt encircling it) for months with particles sufficiently large to scatter the rays of red light and partially absorb the others, and to produce the phenomenon that is now exciting so much public interest. We must not conclude that the cause of the phenomenon is certainly known. It is not. But I am inclined to think that there is not only no antecedent improbability that these volcanic eruptions on such an unprecedented scale are the cause, but that they are the most likely cause which we can assign."

[1] From the *New York Daily Tribune*, January 2. Communicated by Prof. Piazzi Smyth.

THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[1]

THE insular position of Britain, which we are accustomed to regard as an essential and aboriginal feature of the country, is merely accidental, and has not always been maintained. The intimate relation of Britain with the Continent is well shown by the Admiralty charts. If the west of Europe were elevated 200ft.—that is, the height of the London Monument—the Straits of Dover, half of the North Sea, and a large part of the English Channel would be turned into dry land. If the elevation extended to 600ft.—that is, merely the united heights of St. Paul's and the Monument—the whole of the North Sea, the Baltic, and the English Channel would become land. There would likewise be added to the European area a belt of territory from 100 to 150 miles broad, stretching to the west of Ireland and Scotland. A vast plain would unite Britain to Denmark, Holland, and Belgium, and would present two platforms, of which the more southerly would stretch from what are now the Straits of Dover northward to the northern edge of the Dogger Bank. The steep declivity separating the two plateaux is doubtless a prolongation of the Jurassic and Cretaceous escarpments of Yorkshire. It is trenched at either end by marked depressions, of which the western is a magnificent valley through which the united waters of the Rhine and Thames would flow between the Dogger Bank and the Yorkshire cliffs. The eastern gap would allow the combined Elbe and Weser to escape into the northern plain. Possibly all those rivers would unite on that plain, but, in any case, they would fall into a noble fjord which would then be revealed following the southern coast line of Norway. Altogether an area more than thrice that of Britain would be added to Europe. By a total rise of 1,800 feet, Britain would be united to the Faroe Islands and Iceland; while the Arctic and Atlantic Oceans would be separated. From its position on the oceanic border of a continent, Britain has been exposed to a great variety of geological change. In such a position marine erosion and deposit are most active, and a slight upheaval or depression, which would have no sensible effect in the interior of a continent, makes all the difference between land and water. Moreover, there appears to be a tendency to special disturbance along the edge of an ocean. America affords the most marked proofs of this tendency, but in the structure of Scandinavia and its prolongation into Scotland and Ireland there appear to be traces of similar ancient ridging up of the oceanic border of Europe.

There is a remarkable convergence of geological formations in Britain, each carrying with it its characteristic scenery. The rugged crystalline rocks of Norway reappear in the Scottish Highlands; the fertile Chalk, with its smooth downs and gentle escarpment, stretches across to us from the north of France; the great plains of North Germany, strewn with the debris of the northern hills, extends into our eastern lowlands; even the volcanic plateaux of Iceland and Faroe are prolonged into the Inner Hebrides and the north of Ireland.

The present surface of Britain is the result of a long, complicated process in which underground movements, though sometimes potent, have only operated occasionally, while superficial erosion has been continuous, so long as any land has remained above the sea. The order of appearance of the existing features is not necessarily that of the chronological sequence of the rocks. The oldest formations have all been buried under later accumulations, and their re-emergence at the surface has only been brought about after enormous denudation. In its general growth, Britain like the rest of Europe has, on the whole, increased from the north by successive additions along its southern border. The oldest upheavals ridged up the Palæozoic rocks into folds running north-north-east and south-south-west, as may yet be seen in Scotland, in the Lake Country, and in Wales. By a later series of folds the younger Palæozoic rocks were thrown into north and south and east and west ridges, the latter of which still powerfully affect the topography in southern Ireland, and thence through South Wales and Belgium. An east and west direction was followed by the more important subsequent European disturbances, such as those that upheaved the Pyrenees, Jura, and Alps. Some of the latest movements that have powerfully affected the development of our scenery were those that gave the Secondary rocks their general tilt to south-east. It is very doubtful if any part of the existing topography can be satisfactorily traced back beyond middle or older Tertiary time. The amount of erosion of some of the hardest rocks of the country since that date has been prodigious, as may be seen in the fragmentary condition of the volcanic plateaux of the Inner Hebrides.

The main topographical features of Britain may be arranged as mountains, tablelands, valleys, and plains. All our mountains are the effect of erosion on areas of land successively upheaved above the sea. In the development of their forms, the general outlines have been mainly determined by erosion independent of geological structure; while the details have been chiefly guided by structure, but partially also by the rate and kind of erosion. Ruggedness, for example, has resulted primarily from structure, but has been aggravated by greater activity of erosion. The mountainous west, with a greater rainfall and steeper slopes, is more rugged than the mountainous east. The tablelands of Britain are of two orders—1, those of deposit, which may be either (*a*) of sedimentary rocks, horizontal or nearly so, as in the millstone grit and Jurassic plateaux of Yorkshire, or (*b*) of volcanic rocks, as in the wide plateaux of Antrim, Mull, and Skye; 2, those of erosion, where, as the result of long-continued degradation, a series of plicated rocks has been cut down into a more or less uniformly level surface, as in South Wales. By the elevation of such a surface into a high plateau, erosion begins anew, and the plateau is eventually trenched into a system of ridges and isolated hills, as has happened in the Highlands. The valleys of Britain are the result of erosion either (*a*) guided by geological structure, as in what are called longitudinal valleys, that is, valleys which run along the strike or outcrop of formations, as the Great Glen and Glen Spey in Scotland and the valleys of the Trent and Avon in England; or (*b*) independent of geological structure, as in the transverse valleys which embrace the great majority of British examples. Our plains have been produced by the spreading out of *detritus* by the operation of rain and rivers, as in river terraces and alluvial plains; by the sea, as in raised beaches; or by land-ice and floating-ice, as in the glacial drifts of the Lowlands. The existing watershed of Britain is profoundly significant, affording a kind of epitome of the geological revolutions through which the surface of the country has passed. It lies nearer the west than the east coast. The western slope being thus the steeper, as well as the more rainy, erosion must be greater on that side, and consequently the watershed must be slowly moving eastward. Probably the oldest part of the watershed is to be found in the Highlands, where its trend from north-north-east to south-south-west was determined by the older Palæozoic upheaval. Its continuity has been interrupted by the dislocation of the Great Glen. After quitting the Highlands it wanders across the Scottish Lowlands and Southern Uplands, with no regard to the dominant geological structure of these districts, as if, when its course was originally determined, they had been buried under so vast a mass of superincumbent rock that their structure did not affect the surface. Running down the Pennine Chain the watershed traverses a region of enormous erosion, yet from its general coincidence with the line of the axis of elevation, we may perhaps infer that the anticline of the Pennine Chain has never been lost under an overlying sheet of later undisturbed rocks. The remarkable change in the character of the watershed south of the Pennine Chain carries us back to the time when the great plain of the Secondary rocks of England was upraised with a gentle inclination to east and south-east. The softer strata between the harder escarpment-forming members of the Jurassic series and the Palæozoic rocks of the Pennine Chain were worn away, and two rivers carrying off the drainage of the southern end of that chain flowed in opposite directions, the Avon turning south-west and the Trent northwards. By degrees these streams moved away across the broadening plain of softer strata as the escarpments emerged and retreated. At the same time streams collected the drainage from the uprising slope of Secondary rocks and flowed south-eastward. Successive lines of escarpment have since been developed, and many minor watersheds have arisen, while the early watershed has undergone much modification, these various changes pointing to the continuous operation of running water.

[1] Abstract of the first of five lectures by Archibald Geikie, F.R.S., Director-General of the Geological Survey, given at the Royal Institution, January 29.

SOCIETIES AND ACADEMIES

LONDON

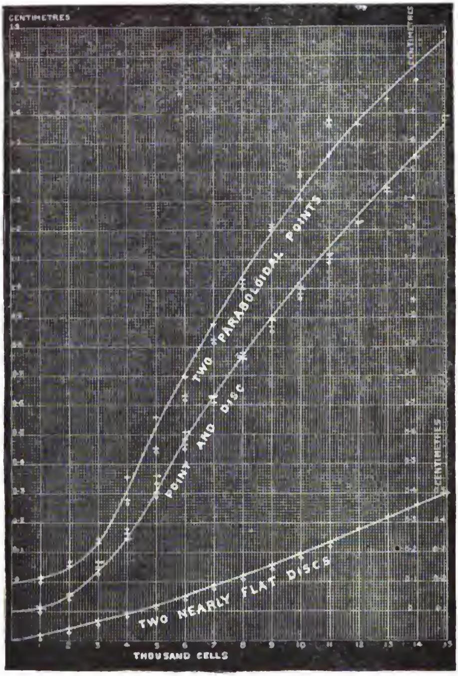
Royal Society, December 13, 1883.—"Experimental Researches on the Electric Discharge with the Chloride of Silver Battery." By Warren De La Rue, M.A., D.C.L., Ph.D., F.R.S., and Hugo W. Müller, Ph.D., F.R.S.

SECOND POSTCRIPT TO PART IV. "PHIL. TRANS.," PART II., VOL. CLXXIV.

Striking Distance.—In a post-cript to Part IV. of our researches,[1] we stated that, with 14,400 cells, partly of the rod form, partly of the chloride-in-powder form, the length of the spark between paraboloidal points was 0·7 inch (17·8 mm.), and between a point and disk 0·62 inch (15·7 mm.), and that it does not appear, therefore, that the law of the spark being as the square of the number of cells holds good beyond a certain number.

These results were obtained at the Royal Institution; since the removal of the battery to our laboratory we had not, at the date of the postscript to Part IV. of our researches, charged up the whole of it. Recently, however, we have put the battery in thorough order, by scraping the zinc rods[1] of the cells already charged up and added newly made up cells to bring up the total to 15,000 cells, all of the rod form.

Having the whole 15,000 cells in perfect order, we thought that it would be desirable to make fresh determinations of the striking distance, increasing the potential a thousand cells at a



time, between two very slightly convex disks (planes), a point and disk, and two paraboloidal points. These points are one-eighth of an inch (3·175 mm.) in diameter, and three-eighths of an inch (9·525 mm.) long. In the case of a point and disk, the point was like one of those used for two points, and the disk was $1\frac{5}{16}$ inch [3·334 cm.] in diameter. The two planes used were $1\frac{5}{16}$ inch [3·334 cm.] in diameter.

As the points, particularly the negative, are deformed by the discharge, the precaution was taken to touch up the point after each discharge in the shaping-tool, screwed to the mandril of the lathe, mentioned in Part I. of our researches,[2] and thus to restore them to a true paraboloidal form.

Results were obtained which are plotted down in the diagram.

The several results, the different sets being distinguished by plain crosses or crosses with a dot, are laid down on the diagram, Fig. 1, to which are also added other results already published from former experiments; these latter have a ring on one of the members of the cross.

[1] *Phil. Trans.*, part ii. vol. clxxiv. p. 477, separate copy p. 249

[1] We are at present making experiments in order to prevent the deposit of oxychloride of zinc on the zinc rods by covering the charging fluid with a layer of paraffin oil.

[2] *Phil. Trans.*, part i. vol. clxix. p. 79, separate copy p. 25.

From these curves were deduced the numbers given in Tables I., II., III. in C.G.S. units.

TABLE I.—*Two Disks*

E.M.F. in volts	Striking distance in centimetres	Difference of potential per centimetre. Volts	Intensity of force	
			Electro-magnetic	Electro-static
1,000	0·0205	48,770	4·88 × 10¹²	163
2,000	0·0430	46,500	4·65 ,,	155
3,000	0·0660	45,450	4·55 ,,	152
4,000	0·0914	43,770	4·38 ,,	146
5,000	0·1176	42,510	4·25 ,,	142
6,000	0·1473	40,740	4·07 ,,	136
7,000	0·1800	38,890	3·89 ,,	130
8,000	0·2146	37,280	3·73 ,,	124
9,000	0·2495	36,070	3·61 ,,	120
10,000	0·2863	34,920	3·49 ,,	116
11,000	0·3245	33,900	3·39 ,,	113
12,000	0·3566	33,652	3·37 ,,	112
13,000	0·4068	31,957	3·20 ,,	107
14,000	0·4463	31,369	3·14 ,,	105
15,000	0·4882	30,725	3·07 ,,	102
15,450	0·5029	30,722	3·07 ,,	102

TABLE II.—*A Paraboloidal Point and a Disk*

E.M.F. in volts	Striking distance in centimetres	Difference of potential per centimetre. Volts	Intensity of force	
			Electro-magnetic	Electro-static
1,000	0·0123	81,103	8·11 × 10¹²	270
2,000	0·0567	35,274	3·53 ,,	118
3,000	0·1379	21,755	2·18 ,,	73
4,000	0·2447	16,347	1·63 ,,	54
5,000	0·4029	12,410	1·24 ,,	41
6,000	0·5631	10,655	1·07 ,,	36
7,000	0·7039	9,945	0·99 ,,	33
8,000	0·8447	9,471	0·95 ,,	32
9,000	0·9709	9,270	0·93 ,,	31
10,000	1·0874	9,196	0·92 ,,	31
11,000	1·1990	9,174	0·92 ,,	31
12,000	1·3058	9,190	0·92 ,,	31
13,000	1·4078	9,234	0·92 ,,	31
14,000	1·5145	9,244	0·92 ,,	31
15,000	1·6116	9,307	0·93 ,,	31
15,450	1·6600	9,307	0·93 ,,	31

TABLE III.—*Two Paraboloidal Points*

E.M.F. in volts	Striking distance in centimetres	Difference of potential per centimetre. Volts	Intensity of force	
			Electro-magnetic	Electro-static
1,000	0·0173	57,866	5·79 × 10¹²	193
2,000	0·0493	40,568	4·06 ,,	135
3,000	0·1282	23,409	2·34 ,,	78
4,000	0·3078	12,996	1·30 ,,	43
5,000	0·5107	9,790	0·98 ,,	33
6,000	0·6845	8,766	0·88 ,,	29
7,000	0·8496	8,239	0·82 ,,	27
8,000	1·0117	7,908	0·79 ,,	26
9,000	1·1602	7,757	0·78 ,,	26
10,000	1·2913	7,744	0·77 ,,	26
11,000	1·3130	7,785	0·78 ,,	26
12,000	1·5243	7,873	0·79 ,,	26
13,000	1·6271	7,990	0·80 ,,	27
14,000	1·7146	8,165	0·82 ,,	27
15,000	1·7961	8,351	0·84 ,,	28
15,450	1·8500	8,351	0·84 ,,	28

An inspection of the diagram, drawn on a reduced scale from the curves as originally laid down, shows that the curve for approximate planes (slightly convex, to insure the centres being the most prominent) is continuously concave, whereas those for both point and disk and two points are concave only for a certain distance, and then turn off and become convex. Moreover, it is seen that the intensity of force per centimetre decreases continuously up to 15,450 volts in the case of planes; but that, in the case of a point and disk, and also in that of two points, the decrease ceases after a certain potential has been reached, and that then it increases so as to become nearly a constant quantity. Between a point and a disk the potential per centimetre at 9,000 volts and beyond is very nearly 9,200; consequently, if the law holds good, to produce a spark 1 decimetre (3·94 inches) long, 92,000 volts, one 1 metre (39·37 inches) long, 920,000 volts,[1] and a flash of lightning 1 kilometre (0·621 mile) in length, a potential of 920,000,000 volts would be required, but this potential would be lessened by the diminution of the atmospheric pressure at the height of a kilometre, namely 607·4 mm. (799,210 M), or a mean pressure of 713·8 mm. (939,211 M) between 1 kilometre and the earth. Taking the mean pressure 939,211 M, it would require 864,000,000 volts to produce a discharge between a cloud (regarded as a point) 1 kilometre high and the earth.

It is extremely difficult to conjecture how a cloud can become charged to such an enormous potential, unless the charged molecules balance each other (as those of a stratum in a vacuum tube may be conceived to do) until a disturbing cause breaks up the arrangement; and then the whole of them are discharged in one direction with their aggregate potential.

We may add that less than 15,000 cells would not have sufficed to make out the fact that the intensity of force to produce a discharge between a point and disk or two points becomes a constant after 9,000 to 11,000 cells has been reached.

The following table gives the ratios of the striking distances between a point and a disk and two points respectively, taking those between two disks as unity. And also the relation between the striking distances between a point and a disk and between two points, taking those between a point and a disk as unity.

Cells	Ratio between point and disk to that between two disks	Ratio between two points and that between two disks	Ratio between two points and that between a point and disk
With 1,000	0·60	0·84	1·40
,, 2,000	1·32	1·15	0·87
,, 3,000	2·09	1·94	0·93
,, 4,000	2·68	3·37	1·26
,, 5,000	3·42	4·34	1·27
,, 6,000	3·82	4·65	1·22
,, 7,000	3·91	4·72	1·21
,, 8,000	3·94	4·71	1·20
,, 9,000	3·89	4·65	1·20
,, 10,000	3·80	4·51	1·19
,, 11,000	3·69	4·35	1·18
,, 12,000	3·58	4·18	1·17
,, 13,000	3·46	4·00	1·16
,, 14,000	3·39	3·84	1·13
,, 15,000	3·30	3·68	1·12
			Mean 1·16

The striking distances from which the above ratios are calculated are those obtained from the smoothed curves.

January 17.—"Evidence of a Large Extinct Australian Lizard (*Notiosaurus dentatus*, Ow.)," by Sir Richard Owen, K.C.B., F.R.S., &c.

This evidence is based on a small fragment, seemingly of coal, with roots of two teeth adherent thereto, transmitted to the author from the Department of Mines, Sydney, New South Wales; but stated to be from a Pleistocene deposit. The author had

[1] To produce a spark between a point and a disk used for example as the dischargers of an induction coil—

In length	It would require in E.M.F. volts
1 inch	23.367
1 foot	280,400
1 yard	841,230

noted that vegetable fossils from the same formation and locality presented a similar jet-black colour, and glistening petrified fracture. The paper details a series of comparisons with known recent and fossil Saurians. The size and striated exterior of the teeth suggested, at first, crocodilian affinity. But closer comparisons, aided by application of the microscopic test to the tissues of both the bone and tooth, led to a conclusion of the affinities of the fossil reptile represented by the fragment of mandible and attached parts of teeth. It was equal in size to the extinct horned lizard *Megalania*, which had an armature of the mouth like that of a tortoise. *Notiosaurus* was a toothed and pleurodont lizard, like the large existing *Hydrosaurus* of Australia, but of more than twice its size.

Linnean Society, January 17.—Sir John Lubbock, Bart., president, in the chair.—Mr. A. S. Pennington was elected a Fellow of the Society.—Dr. R. C. A. Prior exhibited and made remarks on a series of useful timbers from British Guiana. These were all hard woods, among which may be mentioned the "greenheart" (*Nectandra rodiei*); the "duealibolly," a rare, red wood used in the colony for furniture; "wamara," a very hard wooded tree sixty feet high, used by the natives for clubs, &c.; "letterwood" (*Brosimum aubletii*), useful for inlaying and making very choice walking sticks; "hyawabolly" (*Omphalobium lamberti*), a rare tree of twenty feet high, known commercially as zebra wood.—Mr. H. N. Ridley drew attention to a fasciated branch of holly from Herefordshire, in which certain of the leaf-branches were curiously interwoven.—A presumed portrait of Linnæus, in oil, was exhibited on behalf of Mr. F. Piercy.—A paper was read by Mr. J. G. Baker, viz. a review of the tuber-bearing species of *Solanum*. As they stand in De Candolle's "Prodromus" and other botanical works, the tuber-bearing Solanums are estimated as belonging to twenty distinct species. Mr. Baker thinks that not more than six of those are really distinct, viz. (1) *Solanum tuberosum*, a native of the dry, high regions of the Andes from Chili northwards to Venezuela, reappearing in other varieties in Mexico and the Rocky Mountains; (2) *S. maglia*, an inhabitant of the damp coasts of Chili, as far south as lat. 44° to 45°; (3) *S. commersoni*, a low-level plant of Uruguay, lately introduced as a novelty under the name of *S. ohrendii*; (4) *S. cardiophyllum*, a little-known species from the Mexican highlands; (5) *S. jamesii*, a native of Mexico and the Rocky Mountains; and (6) *S. oxycarpum*, a native of Central Mexico. The two last have the tubers very small. All our cultivated races of potato belong to *S. tuberosum*; but the plants gathered by Darwin in the Chonos Archipelago, and that experimented upon by Solme at Chiswick, are both *S. maglia*. The author attributes the deterioration of the potato partly to its being cultivated in too humid climates, and partly to the tuber having been unduly stimulated at the expense of the other organs of the plant. There are many hundred species of Solanum known which do not produce any tubers, but maintain their ground in the world by their seeds alone, and he urges that, in order to extend the power of climatic adaptation of potato species, (2), (3), and (4) should be brought into cultivation and tried both as pure specific types and as hybridised with the numerous forms of *S. tuberosum*.—The next paper read was by Mr. A. D. Michael, on the "Hypopus" question or life history of certain Acarina. From a careful series of experiments and observations he concludes that true "Hypopi" are not adult animals, but only a stage, or heteromorphous nymphs of *Tyroglyphus* and allied genera. Nor do all individuals become "Hypopi," which latter stage takes place during the second nymphal ecdysis. It seems a provision of nature for the distribution of the species irrespective of adverse conditions. "Hypopi" are not truly parasitic, nor confine themselves to any particular insect. A new adult form described is called by the author *Disparipes bombi*, and he believes there are other species of the genus. Donnadieu's bee parasites are admitted to be adults, though it is uncertain if they are identical with Dufour's *Trichodactylus*.—Dr. M. C. Cooke made a communication on the structure and affinity of *Sphæria pocula*. Its position has hitherto been unquestioned, since originally described by Schweinitz in 1825. Dr. Cooke, however, shows from microscopical examination that structurally it is Hymenomycetal, and not Ascomycetal, being allied to the genus *Polyporus* or *Porothelium*. He designates it as *Polyporus* (*Mesopus*) *poculus*, Schwein., allied perhaps in habit to *P. pendulus*, but in substance to *P. rhipidium*.—A paper by Mr. W. Joshua was read, viz. notes on some Burmese Desmidieæ, in which he figures and describes new and interesting species.—Novitates Capensis was the title of a paper by Mr. Henry Bolus, and mainly confined to diagnoses of new or rare orchids from South Africa.

Institution of Civil Engineers, January 22.—Sir Frederick Bramwell, F.R.S., vice-president, in the chair.—The paper read was on the adoption of standard forms of test-pieces for bars and plates, by Mr. William Hackney, B.Sc., Assoc.M.Inst.C.E.

EDINBURGH

Royal Society, January 7.—T. Stevenson, C.E., vice-president, in the chair.—Papers were read on the approximation to the roots of cubic equations by recurring chain fractions, by Mr. E. Sang, and on the researches of M. E. de Jonquières on periodic continued fractions, by Thomas Muir, M.A. The author showed that the results which M. de Jonquières is from time to time communicating to the French Academy are merely particular cases of a more general result which he communicated to the Society some years ago.—A paper was also read on new forms of nerve-terminations in the skin of mammals, by S. Hoggan, M.B., the latter being communicated by Prof. Turner.—A second paper was laid on the table on a diagnosis of the phanerogamous plants of Socotra, by Prof. Bayley Balfour.—A communication was read on the Tunicata of the *Porcupine* Expedition by Prof. Herdman.—An arrangement of the metals in an electro-frictional series was submitted by A. Macfarlane, M.A., D.Sc. As the result of a large number of quantitative experiments, he found that the arrangement of the metals according to the amount of negative electricity produced upon them by a constant amount of friction (without abrasion) is as follows:—Gold, 181; platinum, 136; tin, 126; silver, 102; copper, 100; lead, 62; nickel, 59; brass, 59; iron, 56; aluminium, 50; zinc, 45; magnesium, 43; antimony, 38; German silver, 32; bismuth, 22.

CONTENTS

THURSDAY, FEBRUARY 7, 1884

JURASSIC ROCKS UNDER LONDON

ON two previous occasions[1] the attention of the readers of NATURE has been directed to the facts which have been revealed by deep borings in search of water under London. In the first of these communications it was shown how completely the predictions of geologists, as to the nature, succession, and thicknesses of the different strata under London had been verified; and in the second the question of the possibility of finding workable coal-seams beneath the metropolitan area was discussed at some length.

Quite recently, however, a new boring has been put down within the London Basin, which has made known so many new facts of surpassing interest to the geologist, and has at the same time furnished them with new data, tending to modify their former conclusions on some important problems, that it may be well to recur to the subject in the pages of this journal, and to give a short account of these remarkable discoveries.

The growing wants of the town of Richmond in Surrey have caused the local authorities of that place to seek an augmentation of their water-supply by carrying to a much greater depth a well which had some years ago been put down into the Chalk. This has been done by boring by Mather and Platt's flat-rope system, the work being done under the direction of Mr. C. Homersham, C.E., and at the present time a depth of 1308 feet has been attained. Not only is this well actually a few feet deeper than the famous well at Kentish Town, which was carried 1302 feet beneath the surface, but, commencing as it does near the level of the Thames, it reaches, reckoning from the Ordnance datum line, a level more than 150 feet lower than that of any well hitherto sunk within the London Basin.

Up to the present time only insignificant supplies of water have been obtained, but it is to be hoped that as the work is carried on this spirited enterprise may meet with the success it so well deserves. To the student of London geology it has already afforded a number of facts of wonderful novelty and interest.

The succession of strata found in this well was as follows:—

		feet
	Made ground and gravel	10
Tertiary, 243½ feet	London Clay	160
	Woolwich and Reading Series	60
	Thanet Sand	23½
Cretaceous, 888½ feet	Chalk with flints, Grey Chalk, Chalk Marl	671
	Upper Greensand	16
	Gault	201½
	Neocomian (?)	10
	Great Oolite	87½
	New Red Sandstone and "Marl"	60 +

The lines indicate unconformable breaks in the series of strata, and the lapse of enormous periods of time between the deposition of the beds which they separate.

Down to the base of the Gault the order and thicknesses of the several formations was exactly what would be predicted by any geologist conversant with the details of London geology. Some very interesting facts concerning the divisions of the Chalk strata under London have, however, been made out for the first time by the study of the admirable series of "cores" brought to the surface during these boring operations.

But it is with respect to the strata found lying beneath the Gault that the greatest amount of interest has been excited among geologists.

The Gault clay has at its base the usual band of phosphatic nodules, the so-called "coprolites," and beneath this was found a series of beds, ten feet in thickness, the nature of which is peculiar, while their age is somewhat problematical.

These beds appear in fact to consist of materials derived from the wearing away of the rocks on which they repose, but include fragments of other rocks evidently brought from a distance. They contain many "derived fossils," greatly fractured and waterworn, but very few of its organic remains are of the age of the deposit itself, and serve to fix its geological age. From a consideration of the whole of the evidence in this case, however, this series of rocks, ten feet in thickness, may be referred with considerable probability to some part of the Neocomian period. Unfortunately the typical Lower Greensand was wholly wanting, and the expected supplies of water from this source were therefore missed.

But immediately beneath this peculiar and somewhat puzzling stratum, deposits of great interest to the geologist were encountered. They consisted of thick beds of oolitic limestone, with some subordinate beds of clay, fuller's earth, and sandstone, the whole having a thickness of 87½ feet. A few fossils, for the most part very imperfect, were found in the limestone, but one of the clay bands, when carefully washed, proved to be veritable "El Dorado" to the palæontologist. It was seen to be crowded with specimens of Brachiopods, Bryozoa, Echinoderms, and other organisms, all of them in the most exquisite state of preservation. It is evident that these organisms which flourished upon the floor of the sea were killed and overwhelmed by a sudden influx of muddy sediment. The species found in this interesting bed of clay, which is only six inches in thickness, are similar to those which occur in the Bradford Clay of Wiltshire, and the Calcaire de Ranville of Normandy. It is evident, therefore, that the deposit which contains them is of the age of the Great Oolite. These great oolite strata are found to rest directly on the Trias,—the Inferior Oolite, Lias, and Rhætic being absent.

Now no strata of the age of the Lower Oolites were before known to exist under the London Basin, though it is but fair to remember that Mr. Godwin-Austen, in his celebrated essay on the probable existence of coal under London, distinctly pointed out the possibility of the existence of such deposits.

In the boring which in the year 1878 was put down at Messrs. Meux's Brewery in the Tottenham Court Road some anomalous strata about 64 feet in thickness were found lying between the Gault Clay and the Devonian rocks in which that boring terminated. From some obscure casts of fossils detected in these beds, they were, at the time of their discovery, referred to the Neocomian.

[1] See NATURE, vol. xvi. p. 2, and vol. xxv. pp. 311, 361.

But a careful re-examination of the question shows that, like the beds above described at Richmond, they certainly belong to the Great Oolite, though they were deposited under shallower water conditions than their equivalents at the latter place, and were perhaps, in part at least, of estuarine origin.

The Trias is another formation which has not hitherto been certainly detected under London. It is true that some geologists think that the rocks reached in the Kentish Town and Crossness borings belong to that formation, but this identification is disputed by some very eminent authorities. Although no fossils have been found in the red and variegated strata of the Richmond boring, yet their mineral characters are such as to leave scarcely any room for doubt that they belong to some part of the "Poikilitic" or New Red Sandstone system. They consist of coarse and fine grained sandstones, often exhibiting false-bedding, which alternate with red and variegated clays or "marls." It will be of great interest to geologists if it can be determined upon what member of the Palæozoic rocks these Triassic strata repose.

The result of the deep boring at Richmond is to show that while the water-bearing strata of the Lower Greensand do not extend so far northward as Richmond, other unexpected deposits do exist beneath that town. During portions of the Triassic and Jurassic periods the great Palæozoic ridge, stretching between the Mendips and the Ardennes, was in part or wholly submerged, and thus we find deposits of these ages along its flanks. The relation of the Great Oolite under the central and southern metropolitan district are strikingly similar to those of the Lower Oolite in the Boulonnais. Taking into consideration the proved thickness of the Upper and Middle Oolites in the "Wealden boring" at Battle, we most be prepared to find the Palæozoic axis, with its possible coal-beds, at a considerably greater depth beneath the surface in the southern half of the London Basin than had hitherto been anticipated.

Although no beds of Middle Oolite age have as yet been found under the London Basin, yet, that strata of this period were originally deposited there, we have a very interesting and curious proof. Among the beds of the Lower Greensand of the North Downs, between Sevenoaks and Farnham, we often find deposits consisting of such coarse materials as almost to merit the name of conglomerates. These consist in great part of waterworn fragments of hard and sub-crystalline rocks, evidently derived from the great Palæozoic ridge lying to the north. Mingled with these pebbles are great numbers of excessively eroded but sometimes still recognisable fossils evidently washed out of beds of Lower and Middle Oolite age. The former, as we have just showed, have now been detected under London; but such is not the case with the latter, which may not improbably have been wholly removed by denudation before the deposition of the Cretaceous strata.

In one of the articles referred to at the commencement of this notice, it was pointed out that not only might coal be found at workable depths under London, but that, when discovered, this coal would probably be of the anthracite variety. Now although no beds of coal have hitherto been found in place beneath the metropolis, yet the Richmond boring has yielded striking and unmistakable evidence as to the presence and nature of the coal-seams under the London Basin. In several of the deposits pebbles of coal-measure sandstone with fragments of anthracite have been detected. From this interesting fact it may be justly inferred that while the beds in question were being deposited on the flanks of the old Palæozoic ridge, portions of that ridge consisting of Carboniferous strata and containing seams of anthracite rose above the level of the sea and yielded the fragments mentioned. That the source of these fragments was not very distant may be inferred from the brittleness of anthracite, which certainly could not have travelled far. Thus at last the prediction of geologists has been verified, and coal has been found under London, though as yet unfortunately not *in situ*.

JOHN W. JUDD

MENTAL EVOLUTION IN ANIMALS

Mental Evolution in Animals. By G. J. Romanes, M.A., LL.D., F.R.S., &c. With a Posthumous Essay on Instinct, by Charles Darwin. (London: C. Kegan Paul & Co., 1883.)

IN the present volume Mr. Romanes redeems a part of the promise which he gave us in his "Animal Intelligence." He traces in its main outlines the development of mind in the lower animals. The other part of the promise, to follow the course of mental development in man, will be fulfilled in another work. We think it well that the author has thus divided his task. Each division is of sufficient magnitude to require a separate volume; and though as an evolutionist Mr. Romanes would of course maintain the continuity and identity of the process of mental evolution from its first obscure manifestations in the lower grades of animals up to its highest present point of attainment in civilised man, he would probably allow that the two stages of the process, the sub-human and the human, are sufficiently differenced by the difference in the degree of complexity of the factors involved. To this it may be added that the detailed study of each of these two stages of mental life requires a body of knowledge of its own, a special modification of psychological method, and a particular kind of psychological interest.

In the present work the author has to face a much more difficult task than that which he undertook in his earlier volume. This no doubt had its difficulties. For in what we call the "observation" of mind, whether in our fellow-men or in the lower animals, a process of inference is involved; and when the action to be psychologically interpreted is far removed from the ordinary types of human action, this process is one of peculiar difficulty. But in the earlier work inference or interpretation played a subordinate part. Here, however, it becomes the main problem. In order to connect the facts ascertained and to present a systematic view of mental life as a whole, we must have clear notions respecting the nature of mind in general, as well as of its several phases, which we mark off by the names of the faculties perception, imagination, &c. It is not too much to say that in carrying out the task of tracing the evolution of mind in the lower region an inquirer needs to combine the special aptitudes of a naturalist with those of a psychologist.

Readers of the earlier writings of Mr. Romanes are well aware that he possesses a considerable skill in psychological analysis; and the present volume amply justifies the high expectations in this respect which his other works had excited. He shows acuteness and now and again subtlety. But ingenuity is invariably kept in check by that too uncommon quality, sound common sense. He does not strain after originality, but rather takes pleasure in affiliating his views on the doctrines of recognised masters of the science. The reader has throughout the conviction that the writer has a disinterested enthusiasm for his subject, and cares much more for adding to the store of well-ascertained truth than for adding to his own reputation as a contributor to this result. In all this he seems to have caught something of the spirit of his favourite master, Charles Darwin, of whose valuable work in animal psychology the present volume is to so large an extent a continuation.

At the very outset Mr. Romanes has to face a question which makes unusual demands on the inquirer's sobriety of judgment. What are we to include under the head of mind? How far down in the zoological scale can we confidently maintain that mind is to be found? And by what criterion are we to ascertain its presence? The student of psychology need not be reminded that even competent writers have grown confused in seeking to demarcate the area of mental phenomena, whether as presenting themselves in connection with a single organism, or with the sum of organic beings. A trained psychologist like G. H. Lewes used the terms "sensibility" and "sentience" in a way that left his readers perplexed as to whether he was speaking of a psychical phenomenon properly so called, that is, a mode of feeling, or simply of a physiological phenomenon, actions of the nervous system or nervous processes. Mr. Romanes has steered clear of this confusion. He rightly criticises Lewes's use of the term "sensation," and confines it to its proper subjective signification. Mind being thus coextensive with feeling or states of consciousness, the author proceeds to lay down a criterion for ascertaining its presence in any given case. It is as follows:—"Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience?" Otherwise expressed, it is the manifestation of choice, choice being proved by "the antecedent uncertainty of adjustive action." In laying down this test, however, Mr. Romanes is careful to point out its imperfections. "It is not rigidly exclusive, either, on the one hand, of a possibly mental character in apparently non-mental adjustments, or, conversely, of a possibly non-mental character in apparently mental adjustments." That is to say, it is a rough test sufficient for practical purposes, and eminently in accordance with the dicta of common sense.

After a brief account of the structure and function of nerve-tissue, and of the growing complexity of nerve-structures as evidenced by the double result, compounding of mental elements and compounding of muscular elements, the writer proceeds to discuss what he terms the root-principles of mind. He has already told us that the criterion of mind is choice. He now considers what is involved in the simplest type of choice. Being a mental quality, it must have its physiological correlative. This the author takes to be what he variously calls "the power of discriminating between stimuli *irrespective of their relative mechanical intensities*," the power of "selective discrimination," of "discriminative excitability," &c. It is illustrated by the capability of a sea-anemone which had been surrounded by a turmoil of water, after a time of expanding its tentacles on contact with a solid body. This implies the discrimination of qualitatively unlike stimuli. Each of the organs of special sense has as its function "the rooting out, selecting, or discriminating the particular kind of stimulation to which its responsive action is appropriate." This power of discrimination is regarded as the root-principle of mind. This doctrine has a certain resemblance to the theory of Mr. Spencer and Dr. Bain, that the feeling of difference is the fundamental mode of consciousness. But the author is very explicit in saying that the discrimination he speaks of is a physiological and not a psychological property. Indeed, he allows that it manifests itself in plants, that is to say, much lower down in the scale of organisms than mind can be supposed to reach. It may, however, occur to the reader that the property is not even peculiar to organic structures. Does not a piano manifest just this selective discrimination (to qualitatively unlike stimuli) when its several strings pick out and resonate to the appropriate vibrations of a composite mass of sound? And is it not easy to conceive an artificial mechanism showing such discrimination in a far higher degree than the lower grades of animals? It may be urged, further, that what choice, as previously defined by Mr. Romanes, requires as its correlative is a germ of *conscious* discrimination. A new adjustive action, not provided for by the inherited nervous structures, seems to involve some vague consciousness of a difference between the new and the old, the exceptional and the usual, circumstances. Mr. Romanes might not improbably meet these difficulties by saying that in calling this physiological discrimination the root-principle of mind he simply means to single out the most important property of nerve-structures, the development of which up to a certain point is an antecedent condition of the appearance of mind or consciousness. But even then it would be hard to see why this was exclusively erected into the root-principle of mind to the disregard of another property, retentiveness or memory, which Hering and others have shown to be a property of all organic structure, and the importance of which, indeed, the author seems to allow later on in his work.

In order to complete the author's account of the physiological conditions of mind it is necessary to add that he supposes consciousness to arise when the time occupied by the nervous process, or the interval between sensory stimulation and muscular action reaches a certain magnitude. Mere complexity of nervous actions does not involve consciousness, as we may see in the case of highly compound reflexes. To use the author's graphic language, consciousness involves as its immediate physiological condition a ganglionic "friction" or "state of turmoil." This increase of time "implies that the nervous mechanism concerned has not been fully habituated to the performance of the response required." As more complex organisms are evolved, and the stimuli playing on them become in consequence more varied, this insufficiency of mechanical arrangements and consequent rise of ganglionic friction become more and more marked, and the insufficiency is met by the activity of the higher centres in "focusing many and more or less varied stimuli," which function involves a higher manifestation of the aptitude of discrimination, and as a consequence of this a psychical accompaniment or consciousness.

The author now proceeds to sketch out his general scheme of mental evolution by the aid of a somewhat elaborate diagram. By this last, which is of a tree-like form, we see how out of excitability, the distinguishing property of living matter, there arises, by a double root, contractility, the property of nerve-fibres, and discrimination, the property of nerve-cells, first reflex action, then conscious or voluntary. In branch-like appendages of the stem are represented the successive grades of intellect on the one side, and emotion on the other. To this are added at the sides two finely graduated scales giving the products of emotional and intellectual development. Opposite the numbered divisions of these scales appear the names of those classes of animals, species or larger groups, in which the particular products first distinctly present themselves. Finally the corresponding stages of mental development of the human individual are appended in a parallel scale. It is only fair to Mr. Romanes to say that in thus seeking to mark out by definite stages or levels the progress of mind in the animal series, he is fully aware of the impossibility of assigning hard and fast lines of demarcation. His psychological knowledge tells him that the several faculties, sensation, perception, &c., are not absolutely distinct one from another, but involve common psychical functions. And his clear sense of the limits of our insight into the mind of the lower animals keeps him from dogmatically asserting that a particular faculty or product of mind is not present below a certain zoological level.

Having thus mapped out his ground, Mr. Romanes goes on to investigate its several divisions in detail. The order of treatment is as follows:—(1) sensation, (2) perception, (3) pleasures and pains, memory and association of ideas, (4) perception, (5) imagination, (6) instinct, (7) reason, (8) animal emotions. This does not seem a very good logical arrangement of the subject, or one which grows naturally out of the diagram. It appears, moreover, to make too much of the intellectual side of the animal mind, and too little of the emotional. This strikes one in the cursory treatment of pleasures and pains along with memory, &c., and in the somewhat meagre review of the emotions in the final chapter. The same thing is seen, too, in the elaborate discussion of instinct, in which the highly interesting emotional element in the phenomenon is hardly touched on.

But it is, perhaps, ungracious, in view of the interesting and valuable material with which the author here supplies us, to complain of what he has not given us. To touch on only one or two points of interest, the account of the development of the several varieties of sensation from their simplest rudiments is full and instructive. The fundamental fact in memory, namely, retentiveness, is clearly seized, and it is satisfactorily shown that different grades of memory, *e.g.* mingling of traces of past sensations with present ones, recalling of absent sensations by association, precede the apparently simple but really complex act of perception.

The facts brought forward in proof of the existence of imagination, that is the power of mentally picturing absent objects, even low down in the scale of animals, are interesting and conclusive. The presence in dogs, horses, asses, &c., of what the author calls the third degree of imagination, where the image is not suggested by external objects present at the time, is ingeniously maintained by the facts of dreams, delusions, and evidences of prolonged anticipation, *e.g.* of the stable by the homeward-journeying horse, and recollection, *e.g.* of the lost master or mistress by the pining dog.

The *pièce de résistance* in the volume is, as we might expect, the discussion of the perplexing subject of instinct. To this no fewer than eight chapters are devoted. Here Mr. Romanes shows himself at his very best. We see that he has mastered the wide range of facts involved, and keeps the many varieties of the phenomena steadily in view. We see, too, that he has pondered long and well on his facts, reading what has been said by others on the subject of his meditation. Finally we recognise his thorough sobriety of judgment, freedom from one-sidedness and from everything like speculative extravagance. Mr. Romanes begins by showing that instinct is clearly marked off from reflex action, not merely by the degree of its complexity, as Mr. Spencer says, but by its accompaniment of consciousness. Then he proceeds to illustrate perfect instincts, in which the actions are perfectly adapted to the circumstances of life for the meeting of which the instincts exist, and imperfect instincts, in which the adjustment to the circumstances of the animal's life is less perfect.

This prepares the way for the main problem, the explanation of the origin and development of instinct. There have been two chief theories propounded to meet the case. On the one hand, G. H. Lewes, and also with him apparently Wundt and others, conceive of instinct as a kind of "lapsed intelligence" analogous to the effect of habit as operating during the development of a single human life. Just as we come to do things in a mechanical and semi-conscious way as the result of having frequently done them with full consciousness, so actions of the lower animals carried out with conscious design at first may, as the result of long continuance in succeeding generations and the operation of the principle of heredity, ultimately become instinctive. In opposition to this view, a more humble origin has been assigned to the phenomenon. According to this theory, instinct does not involve intelligence in any stage of the action. Its origin is mechanical. The germ of instinctive action is due to accidental variations which have become fixed and perfected by natural selection. With this view we may take that of Mr. Herbert Spencer, that instincts grow out of reflex actions when these reach a certain degree of complexity, and only involve consciousness in their later stages of development. Mr. Romanes combines these different theories. He allows a certain weight to Mr. Spencer's hypothesis as serving to explain the lowest type of instinctive action occupying the border land between reflex and instinctive actions proper, that is those accompanied by consciousness. But fully developed instincts can only be accounted for by the principle of variation and natural selection, and by that of lapsed intelligence. In the first place, what the writer calls primary instincts, including those of many low animals and certain instincts of higher animals, *e.g.* incubation, arise by the action of the first cause. This is proved by the fact that purposeless habits, tricks of manner, *e.g.* the trick of barking round a carriage showing itself in certain varieties of dogs, occur and are inherited. In the second place, secondary instincts, including many of those of the higher animals, *e.g.* dread and shunning of man, or other enemies, were originally intelligent actions, and illustrate the principle of habit or lapsed intelligence. This proposition, again, is established by showing first, that "intelligent adjustments when frequently performed become automatic in the individual, and next that they are inherited till they become automatic habits in the race," *e.g.* in the tendency of certain breeds of dogs to "beg."

In combining both these principles in his theory of instinct, Mr. Romanes follows his master, Mr. Darwin, and he has derived much assistance from the valuable essay on instinct by that writer, which was written for the "Origin of Species," but, having been withheld from that publication for want of space, now appears for the first time as an appendix to Mr. Romanes' volume. But the author has elaborated the theory sketched out by Mr. Darwin. More particularly he has illustrated at great length how the two causes may combine. He shows how on the one hand, primary instincts may come to be put to better uses by intelligence, and, on the other hand, secondary instincts may be modified and put to better uses by natural selection. The effects of domestication illustrate most clearly this conjoint action of the two principles. With respect to the comparative importance of the two causes, Mr. Romanes seems inclined to look at natural selection as the chief agency, intelligent adjustment being regarded as an auxiliary agency, the chief function of which is to supply to the controlling principle of natural selection an additional class of variations which are from the first adaptive. Mr. Romanes supports his theory by a cumulative chain of argument of very great strength, and he orders the successive steps of it in such a way as to make the reader feel its full force. His main positions seem to us unassailable. The only point we feel inclined to criticise is the limitation of the action of intelligence in the instincts of animals low down in the scale. The author appears to argue on general grounds that these must to a large extent be due to the working of natural selection. But the facts of intelligent modification of instinctive actions cited by him, *e.g.* in the case of the constructive actions of bees, &c., appear to show that the animals concerned possess a considerable measure of genuine sagacity. And while it is no doubt difficult, as the author remarks (p. 191), to attribute to an animal so low down in the scale as the larva of the caddice fly a power of consciously reasoning, it seems, on the other hand, hard to understand how, by the mere play of natural selection unaided by any rudiment of conscious discrimination and adaptation of means to ends, this little creature could have acquired the habit of either lightening its floating case by attaching a leaf to it or weighting it by attaching a small stone according as it becomes too heavy or too light. But the author shows himself so completely the master of his subject, that the reader feels disposed to accept his conclusions in the very few instances in which his individual judgment leans the other way.

JAMES SULLY

OUR BOOK SHELF

An Introduction to the Study of Heat. By J. Hamblin Smith, M.A. (London: Rivingtons, 1883.)

THOUGH the author states in the preface that "he has endeavoured in this book to explain the elementary facts connected with the theory of heat so far as a knowledge of them is required by the University of Cambridge in the general examination for the ordinary B.A. degree," it will be found that he has succeeded in producing a book which is not only admirably adapted to help a student who is preparing for this or any other elementary examination, but which, from the simple nature of the language and the clearness of the descriptions, may be read with advantage by those who have no examination to pass, but who may wish to understand something of the science of heat for its own sake.

The text is composed of short numbered paragraphs, in each of which the author deals with one new fact only, a plan eminently adapted to save the student confusion. These paragraphs may be taken as model answers to imaginary examination questions.

Over two hundred questions are given on those parts of the subject, such as expansion, calorimetry, conductivity and hygrometry, which admit of being put in simple numerical form. Many of these are essentially exercises in arithmetic, and must irresistibly remind the reader of the unlikely questions which he used to have to answer at school. In the questions on thermometers, for instance, an observer seems to have noted the sums, differences, products, &c., of the readings of every kind of thermometer in his laboratory, without noticing what those readings were, and then, when too late, to have met with the necessity of finding from his observations the temperatures which the instruments actually indicated. However, though observations of such a kind are rarely made, the exercises which they furnish will of necessity make those who work them out absolutely familiar with the fundamental principles of the subject.

C. V. B.

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.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Ear a Barometer

AT a time when I frequently went between Peterborough and London by the Great Northern Railway express trains, I found that the sudden compression of the air produced on entering a tunnel was not only perceptible by the ear, but even unpleasant, and that this unpleasant sensation remained till the open air was reached, when it suddenly ceased. Of course it was natural to suppose that the noise was the primary cause, but I satisfied myself that this had nothing to do with the effect, for on swallowing after entering the tunnel the sensation ceased, but recurred in the opposite sense on leaving the tunnel, when a second operation of swallowing removed it. This showed clearly that what was observed was real.

As far as I remember there was, as measured by the sensation, an increase of pressure, at first sudden, and then gradually rising for a second or two on entering, and a corresponding gradual and sudden decrease on leaving a tunnel.

I did not at the time have the opportunity of taking an aneroid with me to measure the amount of the compression, but intended to try an air thermometer which I thought would be more sensitive to a sudden change of pressure than even the most delicate aneroid.

It is strange that so few people have noticed this sensation in the ears; besides Mr. Horace Darwin I do not know of any one who I may say has been disturbed by it.

During the gale on the 22nd and 23rd inst. it occurred to me to try whether I could get an idea of the pressure that could be felt by the ear. My room faces west, and the wind was beating against the windows; so after shutting the door I opened one of the windows suddenly during a furious gust, at which a small gas-flame bobbed nearly out, and the same instantaneous sensation was plainly felt. On shutting it again the gas-flame started up, but the inverse sensation was not perceptible. The gas-flame stood at apparently the same height with the window shut or open. Its movements were simply due to the starting and stopping of an extra draught in the chimney. On examining the meniscus at the top of the column in a mercurial barometer, the change of pressure was plainly visible, not by a rise and fall of the whole column, but by a change of curvature which was very marked when the window was opened during the stronger gusts. A pocket aneroid showed the same thing perfectly, rising, as far as I could judge, about 1/150 inch in general, but during one very furious blast 1/20 inch; on that occasion only did the shock on the ears seem at all comparable with what I remember to have felt in the tunnels.

It is not necessary to wait for a gale in the right direction to test the ears. I found that if a friend charged the door with his whole strength, much the same compression was produced as by the average gusts of wind. Of course the compression will depend partly on the contents of the room, which were, in the case in question, about 2500 cubic feet.

It is probable that the change of pressure noticed by the ear is greater than that shown by the barometer, for the instantaneous effect on the gas flame was enormous, while the permanent action was barely perceptible; on the other hand, the aneroid showed a permanent displacement with only a very slight recoil. The greater mobility of the gas doubtless corresponds to the great sensibility of the ear.

If the actual change of pressure felt by the ear is 1/150 inch, which corresponds to a change of level of six feet, it might be expected that a sensation would be observed on running up or down stairs. This I have not noticed, the change of pressure being so gradual.

I need hardly add that descending a mine at the high speeds common in the collieries is most painful to me, and is only rendered bearable by continuously swallowing.

The very great and apparently unrecognised difference that there seems to be in the sensibility of the ears of different individuals may be an excuse for occupying so much of your valuable space with what is in other respects a long and uninteresting letter.

C. V. Boys

Physical Laboratory, South Kensington

The Remarkable Sunsets

In Nature for December 20, 1883, Dr. James Macaulay has collected (pp. 176, 177) some recorded instances of the wide distribution at former periods of volcanic dust. Perhaps the following may be worth adding. It is to be found in that extraordinary repertory of curious information and suggestion, the "Philosophical Notes" to Darwin's "Botanic Garden" (part ii. 3rd edition, 1791, p. 167).

W. T. T. D.

The Rev. Mr. Sterling gives an account of a darkness for six or eight hours at Detroit in America, on October 19, 1762, in which the sun appeared as red as blood, and thrice its usual size; some rain falling covered white paper with dark drops like sulphur or dirt, which burnt like wet gunpowder, and the air had a very sulphureous smell. He supposes this to have been emitted from some distant earthquake or volcano (*Phil. Trans.* v. liii. p. 63).

In many circumstances this wind [the Haimattan] seems much to resemble the dry fog which covered most parts of Europe in the summer of 1780, which has been supposed to have had a volcanic origin, as it succeeded the violent eruption of Mount Hecla and its neighbourhood. From the subsidence of a white powder, it seems probable that the Haimattan has a similar origin, from the unexplored mountains of Africa. Nor is it improbable that the epidemic coughs which occasionally traverse immense tracts of country may be the products of volcanic eruptions; nor impossible that at some future time contagious miasmata may be thus emitted from subterranean fissures in such abundance as to contaminate the whole atmosphere and depopulate the earth (Darwin's "Botanic Garden," part ii. 3rd edition, 1791, p. 167).

We had the sunset display again to-night, but the after-glow was much less prolonged, suggesting that the stratum of dust and crystals is slowly settling down. But repeated flashes of lightning and peals of thunder, in a place where storms, at the usual time of year for them, are very infrequent, seem to suggest also the question whether the ash is not brought within the sphere of rain-clouds rather by loss of electricity than the influence of surface-gales. At the same time the large fluctuations of pressure seem to tell, on the contrary, that the whole column is affected to unusual altitudes. Since I have been a reader of journals I have seen nothing more enthralling in its interest than the contributions made, week by week, to Nature on this subject from all parts of the world. It marks an era in observation from which we may hope great things in the future.

Bregner, Bournemouth, February 2 Henry Cecil

Referring to the latter part of Mr. Hawell's letter in Nature, January 24 (p. 285), there seem to be several different ways in which volcanic dust might affect the temperature, and though all of them seem likely to have but small effect, the quantities they affect are so vast that a very small percentage may form a very considerable quantity.

1. The volcanic gases would form at first a stratum much warmer than would be natural to the heights at which they would rest, and would thus retard the outward flow of heat from the earth.

2. The volcanic dust, forming an unusually high stratum of opaque matter, would intercept rays from the sun that would be otherwise lost to the earth.

3. The volcanic dust would act as a screen to prevent the earth losing heat by radiation, while it would also (4) act as a screen to prevent the sun's rays reaching the earth; but in so doing would make the dust stratum warmer, and so would aid cause No. 1.

The indirect effects, as influencing evaporation and condensation, and the formation of clouds, are probably greater than the direct, but are more difficult to analyse.

December 3.—I have noticed that December 3 was generally remarkably cloudy. Here, however, it was conspicuous as the day on which all the most marked features of the sunsets culminated. At 4.45 the green and pink glows covered the western half of the sky, and the rest of the sky was filled with a purple glow of like character, while the crescent moon was green. These glows had to a great extent faded at 5; and though the phenomenon lasted late, I can give no more details, as I took no notes, not being able to give it continuous attention.

37, The Square, Ripon, January 28 W. W. Taylor

Christian Conrad Sprengel

Speaking of Christian Conrad Sprengel's discoveries, Dr. H. A. Hagen says (Nature, vol. xxix. p. 29):—"In Germany these discoveries were well known to every naturalist during the whole century. Certainly between 1830 and 1870 at every university in Prussia the same facts were taught as well-known facts of the highest importance, and of course known by every student." From the complete want of papers relating to the facts observed, and the theories proposed by Sprengel in the German botanical and entomological periodicals published before the time of Darwin, strangely contrasting with the profusion of such papers in modern botanical literature, one might have been led to a very different conclusion, viz. that Sprengel had fallen into almost complete oblivion in Germany also, and that hardly any professor in any of the universities of Prussia and of Germany in general duly appreciated and taught his discoveries before Darwin's time. And this, I think, is really the case. Certainly at the University of Berlin in 1841, neither Lichtenstein, in his lectures on zoology, nor Kunth in those on botany, ever spoke of Sprengel and his work, nor did Erichson in his course on entomology. At the University of Greifswald, in 1842, the professor of natural history, Hornschuch, never mentioned Sprengel's discoveries. In 1848 my brother, Hermann Müller, began the study of zoology and botany at the University of Halle, where he never heard of Sprengel, with whose work he became acquainted only much later through Darwin's books. Thus it appears that between 1840 and 1850, in three at least of the six universities of Prussia, Sprengel's work had fallen into the most complete oblivion. Now it is improbable in the highest degree that the several professors of natural history in these universities should have ceased, unanimously and at the very same time (1841) to teach what, between 1830 and 1840, they had taught "as well known facts of the highest importance." Hagen's statement, therefore, needs some further proof before it can be accepted.

If in Germany Sprengel's discoveries had been "well known to every naturalist during the whole century," the opinion that his treatise had been unduly neglected until it was, as it were, re-discovered by Darwin, could never have prevailed, as it appears to do, among German botanists, and Prof. Eduard Strasburger could never have written the following lines, with which I may appropriately conclude this letter: "Until 1860 and some years afterwards in any catalogue of old botanical books, the work of Conrad Sprengel, published in 1793, 'Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen' might be found at the price of about 15 sgr. (*1s. 6d.*), and I myself bought it there at that price as a curiosity, for the sake of its strange title. In the 220th catalogue of Friedlander (1873) the price of the same book is 3 thlr. 20 sgr. (*11s.*) This rise in the price of Sprengel's book shows very strikingly the change through which in the meantime it has passed in our appreciation. For only during the last ten years, after it had remained *wholly unnoticed* for nearly seventy years, the old book has come to be duly valued. It was Charles Darwin, who by his excellent book on Orchids . . . revived the questions treated by Sprengel" (*Jenaer Literatur Zeitung*, 1874, article 140.)

FRITZ MÜLLER

Blumenau, Santa Catharina, Brazil, December 15, 1883

Diffusion of Scientific Memoirs

PROF. TAIT appears to have misunderstood my object in writing the letter published in your issue of January 24 (p. 287). It refers distinctly to his letter of December 27, and not directly to the review which began the correspondence. In that letter Prof. Tait stated publicly that he had not received certain publications of the Cambridge Philosophical Society. I desired, as secretary, to explain that it was not due to the neglect of the officers of the Society. He also says:—"NATURE would do a real service to science by collecting statistics as to the numbers of different centres . . . at which the *Transactions* of various scientific societies were freely accessible in 1883 (say) and also in 1853." It was in my power to give the statistics for "*Transactions* or *Proceedings* or both" for the year 1883; in answer to part of Prof. Tait's suggestion I did so. There is no reference in my letter to the year 1854, so that Prof. Tait is not correct in stating (NATURE, January 31, p. 311) that the question between us is, "What was the state of matters in 1854?" The year 1869 was the earliest for which, with the data ready to hand, I could obtain the numbers, I therefore gave statistics for that year in addition; I had no knowledge of what may have been the case in 1854, and I said nothing about it. Prof. Tait referred to a malady and suggested a cure. I merely wished to show that the cure had already been applied. My remarks were addressed solely to that point, and were not "beside the question." Prof. Tait, in your last issue, has an elaborate argument to prove that about one-third of the centres receiving publications receive *Proceedings* only. In this he is entirely mistaken. At present the number of such centres is 6; in 1854 it was 0. The history of the case is as follows. Until the year 1843 the Cambridge Philosophical Society published no *Proceedings*. Between that year and 1864 short accounts of the papers read and of the discussions were published in the *Phil. Mag.*, and separate copies were supplied to the Society. In 1864 these were collected, and form vol. i. of the *Proceedings*. At the time they were not circulated separately; circulation was given them in the *Phil. Mag.* In that year the arrangement with the *Phil. Mag.* came to an end, and notices of the same kind were printed by the secretaries and distributed to *resident Fellows*. Almost without an exception all the important papers published by the Society appeared in the *Transactions*. There was no need therefore to circulate *Proceedings*, and it was not done. This practice was continued up to 1876, when the second volume of the *Proceedings* was closed, and a new system begun. Thus up to 1876 *all centres* receiving publications *necessarily received Transactions*, and as a matter of fact nothing else. A few copies of vols. i. and ii. of the *Proceedings* have since been issued. Vol. iii. of the *Proceedings* was commenced in 1876, and both it and succeeding volumes contain in full the shorter or the less important communications made to the Society, as well as abstracts of matter published in full in the *Transactions*. Vols. iii. and iv., then, of the *Proceedings* have, as a general rule, been sent with the *Transactions*, and the centres have usually, since 1876, received both. Within the last few years, however, 6 centres have been added to the list which receive the *Proceedings* only. Thus in 1883 (omitting the honorary Fellows) 114 centres received *Transactions* only, or *Transactions* and *Proceedings*, in most cases the latter, and 6 received *Proceedings* only; while *in* 1853 *all the publications distributed were Transactions*. I do not pretend to know what the number of centres was at that date, and my first letter made no direct reference to it. Nothing in that letter, however, supports the arguments adduced by Prof. Tait to prove that "it follows from Mr. Glazebrook's data that the number of centres in 1854 must have been about 40 only."

R. T. GLAZEBROOK,
Secretary of the Cambridge Philosophical Society

Cambridge, February 4

Brooks' Comet

I SEND you a sketch of Brooks' comet, in which an attempt is made to represent a remarkable change which took place in the comet about January 13. On that evening the well-defined and almost circular envelope which is represented in the figure was entirely wanting when the comet was seen on previous occasions. The nucleus was much more condensed and star-like than at any time before. The envelope was of nearly uniform brightness, with a perfectly defined outline, which was easily measured. It seemed to be produced by two fan-shaped emanations from the nucleus, which, curving backward toward each other, met at the outer edges, leaving a darker elliptical space on each side of the nucleus, the space on the north side being the darker, and the preceding fan-shaped portion having an extension on the north side. A line drawn through the middle of the dark spaces would be perpendicular to the axis of the tail.

The diameter of this envelope was 1′ 20″, while the diameter of the outer nebulous envelope, as far as it could be readily traced, was about 6′ 9″. The spectroscope showed a bright continuous spectrum, which was surprisingly strong in the red, which completely masked any lines. As the comet had not been seen here for several days previous to the 13th, this appearance may have been of considerable duration. Clouds prevented another view until January 17, when the inner envelope had entirely lost its sharp outline, and the following portion had disappeared, leaving a corresponding dark space, while the preceding portion had increased its angular dimensions and revolved through an angle of about 60°.

This is the appearance it presented, though the change may have occurred in a very different manner. The 26-inch equatorial did not bring out any additional details. The distance from the following side of the nucleus to the outer edge of the inner envelope was about 32″, whereas it had been 40″ on the 13th, taking half the diameter of the envelope on that occasion to represent the corresponding measurement on the 17th.

A very marked increase in the length of the tail of the comet occurred between December 27 and 28. For about one-third of its length the tail was broad and fairly uniform in brightness; from the middle of this broad portion issued two long bright streams, one being longer and brighter than the other. The total length was about 4°.

W. T. SAMPSON

Naval Observatory, Washington, January 19

"Mental Evolution in Animals"

THE appearance of Mr. Romanes' new book with the above title reminds me of a reference in his work on "Animal Intelligence" to an observation of my own. I have intended for at least twelve months past to write you about the matter, but as Mr. Romanes' new book is practically a continuation o his former work, you will probably not conclude that I have procrastinated too long.

On page 251 of "Animal Intelligence" Mr. Romanes quotes my story of a skate in the Manchester Aquarium. The fish in question, unable to seize a morsel of food lying in the angle formed by the glass front and bottom of the tank, "raised himself into a slanting posture, the head inclined upwards and the under surface of the body towards the food," and, by waving his fins, caused a current in the water which lifted the food straight to his mouth. Mr. Romanes adds that this observation is practically worthless "from the observer having neglected to repeat the conditions in order to show that the movements of the fish were not, in their adaptation to these circumstances, purely accidental."

I quite agree with Mr. Romanes that such observations should be tested in every possible way, and I should have been only too glad to repeat the conditions of this and other observations had I been able to do so. The fact is, however, that as neither the directors nor the curator of the Manchester Aquarium were willing to call in the aid of those extra attractions which you London people seem to have successfully employed in the case of the Westminster institution, the Manchester Aquarium came to an untimely end, and thus my observations were cut short. There are, however, two comments which I should like to make. On p. 351 of "Animal Intelligence" (the coincidence in the numbering of the respective pages may help the reader's memory), Mr. Romanes quotes a story by Mr. J. S. Hutchinson concerning a Polar bear at the "Zoo." A bun was thrown into a pond, and fell "at the angle" beyond the reach of the bear. The animal thereupon "commenced stirring the water with its paw, so that it established a sort of rotatory current which eventually brought the bun within reach." This story was communicated to Mr. Romanes privately, and my skate story was published in your columns four years before Mr. Romanes published his book (see NATURE, vol. xix. p. 160). No repetition of the conditions is mentioned in the case of the bear, yet Mr. Romanes speaks of the story as "a most remarkable observation." In justice to Mr. Romanes I must add that he appears to accept the bear story as a proof of intelligence in that animal because it corroborates a similar story communicated to Mr. Darwin by another observer. I feel, however, that I have a right to back my skate against either of the bears named, for the following reasons. Had I repeated the conditions in the case of the skate with precisely the same result, it would have appeared as though the skate acted in obedience to inherited habit, or instinct, and even the similar conduct of the bears suggests this inference in their case. On the other hand, had a second trial with the skate failed, it would not have been proved that the first case was accidental, and therefore not the result of a "happy thought" on the part of the skate; for it might still have been contended that the skate, like a man, might display presence of mind on one occasion, and not on another, and the chief interest of the incident lies in the assumed spontaneity of the action. Finally, if Mr. Romanes will reflect upon the attitude of the fish as described in my narrative, I think he will see that the movements could not be "purely accidental." For, from the position of the skate's eyes, it follows that, when in the slanting posture described, he *could no longer see the food*. Yet he opened his mouth and adroitly caught it, the waving of the fins and the opening of the mouth being necessarily rapidly consecutive actions. This fact seems to me to show that he *expected* the food to rise in the way in which it did rise. F. J. FARADAY

Manchester, January 21

YOUR correspondent seems to think that I had some particular spite against his skate, and quotes my indulgence to a bear as proof of inconsistency. But the two cases are very different. Even apart from the unconscious corroboration to which he alludes (and which as evidence of a fact I consider better than even verification by the same observer), we must remember that the stirring of water for a long time in the same direction with its paw is not quite so habitual an action on the part of a bear as is the ordinary swimming movement on the part of a skate. As for any difficulty which the skate may have had in seeing the food approach its mouth, surely the fact of its opening its mouth when the food was near enough to grasp is no better evidence of design than of accident. In either case, under the conditions, and more especially the "attitude," described, the seizure of the food at the proper moment can only be ascribed to the sense of *smell*, which in the skate is so highly developed. Lastly, why does your correspondent begin by saying that verification would have been desirable, and end by arguing that it would have been of no use? Even if the experiment had failed on repetition, he says, his inference would not thereby have been negatived. If this is so, assuredly there would have been no object in repeating the conditions. I once told a terrier to fetch me the ace of hearts from a pack of cards, and he did it. I happened previously to have known that the ace of hearts was the top card. Suppose I had repeated the experiment fifty times, and the dog had every time brought the wrong card, should I have been justified in attributing the first success to a "happy thought"?
GEORGE J. ROMANES

The Storm of January 26

I SEND you inclosed particulars of the great storm of January 26 and 27 as observed at Newport, opposite Dundee. Another observer six miles to the north-east of Newport took readings which corresponded almost exactly with those at Newport for the fall, but were thirty to forty minutes later for the rise. They were as follows, being reduced and corrected:—

Hour	Inches	Hour	Inches
2.15 p.m. Saturday,	28·429	11 p.m. Saturday,	27·385
3.15 ,, ,,	28·218	11·15 ,, ,,	27·385
4.15 ,, ,,	28·036	3 a.m. Sunday,	27·665
6.15 ,, ,,	27·834	6 ,, ,,	27·922
8.15 ,, ,,	27·598	9 ,, ,,	28·143
10.15 ,, ,,	27·406	11 ,, ,,	28·230

Dundee, January 30 DAVID CUNNINGHAM

Ozone at Sea

DURING my voyage hither from London in the *Maranoa*, viâ the Canal, and calling at Malta, Aden, and Colombo, I was surprised at the low values for ozone as registered by Moffat's tests, which I pinned to the "uprights" in Stevenson's thermometer screen. I tried periods of exposure varying from half an hour to twenty-four hours, and the highest value noted was but 5·6 for eight hours (scale 0 to 10). The test papers, however, were always tinted, more or less, sometimes to 3·0 in half an hour, whereas tests exposed at the same time and examined when eight hours had elapsed, only gave 4·6. At Ben Nevis and Fort William, and in the moorlands of Staffordshire I have recorded far higher ozone values than at sea under the same force of wind and like periods of exposure. From my long experience of these tests I cannot consider them satisfactory; but in the absence of a more reliable method I would strongly suggest that they would give results more intercomparable if uniformly exposed for an agreed hourly period, especially at the various land stations. CLEMENT L. WRAGGE

Adelaide, South Australia, December 22, 1883

Meteor

AT 9.55 p.m. on Sunday, January 27, I saw a meteor start from a point in Taurus, near to Saturn, and fall vertically a distance of 20°, and then burst with a brilliant flash, giving off several colours that almost instantaneously died away. The meteor was visible about three seconds, and increased greatly in brightness from the time first seen until it burst. It was the most brilliant meteor I ever saw, and its greatest brightness much exceeded that of Venus. E. HOWARTH

Museum, Sheffield, February 5

Ravens in the United States

OUR Natural Histories say *Ravens* are common all over the United States, but I have never met any one who was aware of having ever seen one. Are they common in Westchester County, near the Hudson, and confounded with crows?

New York, January 11 MANHATTAN

Unconscious Bias in Walking

THE thought has occurred to me that "unconscious bias in walking" may be the result of inequality in the length of the lower limbs caused by the manner in which young children are carried. Each person appears to nurse solely on one arm; I think the right is more frequently employed. I have noticed when a child is held in the arm the side which is nearer the nurse appears to be in a somewhat cramped and unnatural position, the leg more or less bent, while the outer side is comparatively straight and free. Would not this, while preventing the full play of the muscles of the inner leg, tend to arrest to some extent its proper development at a time when growth is very rapid, and thus cause that difference in the length and strength of the limbs remarked by your correspondents? SARA S. OWEN

4, Soames Street, Grove Park, S.E., February 2

ON THE HEIGHT OF THE AURORA BOREALIS

IT is with pleasure that I respond to the invitation of NATURE to give an account of the work of the Danish Meteorological Station, which was maintained, under the international scheme, at Godthaab in Greenland, in 1882–83, and of which I had the honour of being the chief. I intend, in the present article, to confine myself to the aurora borealis.

The results, which have been obtained from calculations of the height of the aurora borealis in the temperate zone, which lies south of the so-called auroral belt, all agree in fixing the minimum height of the aurora very high, as the auroræ seem to be confined to the part of the atmosphere where its density is only a fraction of that at the surface of the sea. However different the value may have been of the heights of the auroræ observed outside their true zone, the average of the minimum heights is hardly under two hundred kilometres. On the other hand, the observations in the Arctic regions show that the auroræ may descend to much lower elevations above the earth's crust, and that they may even reach down into regions of the atmosphere where the density is about the same as on the surface of the sea.

Dr. S. Fritz has thus, at Ivigtut in South Greenland, in February and March, 1872, measured auroræ the lower edges of which were only from 50 to 200 metres above the level of the sea, while in nearly every monograph of the aurora borealis cases are cited in which the auroræ appear to have reached much further down in the atmosphere. I may further mention some instances, which have, by the bye, not been made public before, observed by the eminent zoologist, Prof. Steenstrup, and which he has permitted me to publish here.

During Prof. Steenstrup's sojourn in Iceland, 1839-40, he saw, on several occasions, auroræ which hid the top of the mountain Esia, some 600 metres in height, lying behind Reykjavik. He further states that he has seen auroral streamers between the masts of a ship, in such a manner that they disappeared where there were sails, and reappeared where the space was free. The Professor asserts even that on one occasion, on January 28, 1840, when walking between Reykjavik and Bessastad with the chief magistrate, Herr Tvede, and Judge Jonasson, he, as well as these two gentlemen, saw auroral streamers appearing *between themselves*. The phenomenon was not a solitary one, but occurred three or four times during this walk, and in spite of the pedestrians keeping about a yard from each other.

Although many estimates of the low descent of auroræ in the Arctic regions may have been due to optical illusions, specially through irradiation, one cannot, even from a casual observation of this magnificent phenomenon, but come to the conclusion that, while some auroræ lie in the same great, indefinable distance from the observer as those observed in the temperate zone, there are others whose whole appearance has the character of being a phenomenon of a purely local nature. During our stay at Godthaab this point had my special attention, as it appeared to me of importance to demonstrate by measurements as accurate as possible whether this subjective impression answered to the true facts.

To this end the Danish international station at Godthaab, 64° 10′ 36″ N. lat. and 51° 40′ 0″ E. long., has, during October and December, 1882, effected a series of measurements. The site of the station was particularly suited for the solution of the problem, as it lies just at the northern border of the great Arctic auroral belt, *i.e.* in a place where the auroræ appear with all the peculiarities which distinguish them in their true zone.

The distance between the two points of observation, separated by the Godthaab Fjord, was 5·8 kilometres, and the direction between them coincided with the magnetic meridian. The two instruments used for the measurements, exactly similar in construction, were arranged as universal instruments. Instead of a telescope, a tube was employed, which had in one end a small opening, and in the other a metal cross of very fine wires. In order that the errors in the observations should not affect them very much, measurements were only made in the vertical plane between the two points of observation. The placing and reading of the instruments were effected by means of pre-arranged fire-signals, and only those measurements of which the reading signals were instantaneously answered, and for which the time of reading exactly coincided, were recorded. Only the lower edges of the auroral bands were measured, as these are nearly always the most clearly defined.

We have, during our evenings of observation, measured the height of thirty-two auroral bands. The subjoined figures, showing the result of these, demonstrate that the lower edge of the band certainly descends very low. Thus of the thirty-two auroræ measured by this method ten only had a parallax under 1°, for six the parallax was between 1° and 2°, four had a parallax of between 3° and 4°, two one between 5° and 6°, four one between 7° and 8°, while we measured six of 10°, 14°, 15°, 17°, 86°, and 143° respectively.

Leaving the auroræ whose parallax was under 1° out of the calculation, I have found the following heights for the other twenty-two lower edges:—

1	67·81 kilometres.	12	7·43 kilometres.
2	59·60 ,,	13	6·16 ,,
3	54·73 ,,	14	5·28 ,,
4	46·94 ,,	15	3·72 ,,
5	45·04 ,,	16	3·69 ,,
6	38·09 ,,	17	3·22 ,,
7	29·81 ,,	18	2·87 ,,
8	19·14 ,,	19	1·99 ,,
9	9·76 ,,	20	1·96 ,,
10	9·40 ,,	21	1·35 ,,
11	7·67 ,,	22	0·61 ,,

The three heights of 1·99, 2·87, and 3·22 kilometres belong to the same aurora as that whose edge was measured at an interval of two minutes between each measurement. The two auroræ of 1·35 and 0·61 kilometres stood both above the fjord between the observatories. From the southern one they were seen at an altitude of 13°·6 and 30°·3 respectively above the northern horizon, while at the northern station they were 80°·5 and 7°·25 respectively above the southern horizon. These two and the above-mentioned third, the height of which was measured three times, had the appearance of curtains with large folds, or of bunches or wreaths of streamers lying close together, separated by darker, faintly-shining spaces, but connected below through a common band. The others were bands or arcs without radiating streamers. The edges measured were all nearly at right angles with the magnetic meridian. Only the height of those edges which were distinctly defined, and whose course did not deviate greatly from perpendicularity on the magnetic meridian, were measured.

I must further, as regards the small height of the auroræ observed at Godthaab, state that not only three observers besides myself, but even a student as conversant with auroral phenomena as Herr Kleinschmidt, all agree that auroræ were seen *below the clouds* on several occasions during the winter of 1882-83. On this point we do not entertain the least doubt.

In conclusion I will describe some observations made on several occasions during our stay at Godthaab of the peculiar type of the aurora known as phosphorescent auroral clouds.

On September 21, 1882, Herr C. Petersen, one of my assistants, observed, at 9.45 p.m., an aurora appearing as a lustrous green light behind the nearest hills. The top of the mountain, "Sadlen," 1200 metres in height, was distinctly seen *above* the lustrous plane. The phenomenon rapidly disappeared. At 10.45 a light was seen in the south, which resembled that of dawn, and contracted into a faint shining cloud, oblong in shape, which oscillated slowly before the mountains "Hjortetakken" (1200 metres) and "Store Malene" (800 metres) at a distance of 8 to 12 kilometres from the station. The tops of the two mountains were distinctly seen *above* the luminous cloud, while at times small but intense spots of light developed themselves in it. When the cloud, at 11.45 p.m., had moved in front of the mountain "Lille Malene," the light became more intense, and had the appearance of a lustrous white cloud of smoke rolling up the hill to north-east. When the cloud travelled over the hill, the light became yellow, and was bordered by a coloured rim. At 11.10 it shot three faint red streamers up towards the zenith, and then the whole disappeared.

The following phenomenon was observed by the writer of these lines:—On November 14, 1882, at 6 a.m., I observed an auroral band without streamers through Vega, the Great Bear, and the Twins, while another stood parallel with this further west. From the "Store Malene" I now saw a peculiar shining white cloud descend into the fjord below. It descended in long, straight, shining bands. In a few minutes the mountain in question, as well as "Hjortetakken" were completely hidden in the cloud. A little further east the cloud possessed greater intensity, while on the plain at the foot of the hill on which the observatory stands, two luminous gatherings were seen, which seemed to rest on the snow, with a strongly phosphorescent light. These two gatherings, which were at first isolated, now came in contact with the above described cloud with long luminous bands radiating from the latter. By opening the slit of the spectroscope as much as possible and simultaneously keeping foreign light from the eye, I beheld the auroral line faintly but clearly defined. The cloud now began to disappear without oscillation, when suddenly a number of horizontal openings formed in it, through which the mountain stood forth. In the next second all had disappeared.

I admit that, as regards the last described phenomenon of the lustrous cloud, it might be explained as being caused by the reflex of the auroræ which were simultaneously visible; but such an explanation is not applicable to the one first described. It would be very interesting to learn if other observers have noticed this form of the aurora. ADAM PAULSEN

Copenhagen

THE EFFECTS OF THE WEATHER UPON DEATH RATE AND CRIME IN INDIA

SOME time ago a very interesting series of articles, by Mr. Buchan, upon the connection between certain meteorological conditions and the zymotic diseases, as illustrated by the mortuary returns of the London district, appeared in NATURE. Happening to have undertaken, at the request of the provincial superintendent of census operations, certain investigations concerning the life statistics of the population of the North-West Provinces and Oudh, just about the time when Mr. Buchan's articles appeared, it occurred to me that it would be worth while to see whether any similar concomitant variations of meteorological conditions and causes of death could be detected in India. The results arrived at are so curious, and at the same time so definite, that I think they may be of interest to readers of this journal.

At starting, however, it should be observed that, though the mortuary returns of the province with which I am connected are probably the best in India, they are still very far from complete. The agency employed for registration is that of the village *chaukidár* or watchman, who is supposed to take note of all births and deaths which occur in his village (aiding his memory, if necessary, by variously cut notches on a stick) and to report these weekly at the nearest police station. From such an agency nothing like an exact account of the causes of death can be expected; hence in the detailed tables given below I have confined my attention to the four most obvious causes—small-pox, cholera, suicide, and wounds. Even as regards the number of deaths registered a considerable defect may confidently be anticipated, owing to lapses of memory on the part of the *chaukidár*. This defect has been found by Dr. Plauck, the Sanitary Commissioner, to amount to about 20 per cent. of the whole on the average of a large number of cases personally examined by him in various parts of the province. The proportion thus obtained is confirmed by a comparison of the deaths actually registered with the death rate arrived at in the last census report. During the five years, 1878-82 (the only ones for which complete returns are obtainable), the deaths registered appear, from figures supplied by Dr. Plauck, to have numbered 7,311,013. The average population during the five years having been about 45,000,000, this gives an annual death rate of 32·5 per thousand. Now in Mr. White's report on the census of 1881 it is shown that the distribution of the population according to age, and the observed death rate among certain tribes and castes suspected of practising infanticide, and therefore placed under strict police surveillance, point to 40 per mille as the probable rate of mortality for the general population. The unrecorded deaths therefore amount on the average to 7 5 out of 40, or 19 per cent. of the total—almost exactly the same defect as Dr. Plauck arrived at by his personal investigation of special cases.

It follows that, though the returns collected by the rude illiterate agency employed are not strictly accurate, the totals arrived at probably on the whole bear a nearly constant proportion to the true number of deaths, the population dealt with being sufficiently numerous to eliminate any individual peculiarities of the agents.

The death rate varies enormously from year to year, as may be seen from the table of the total number of deaths recorded, here given in full:—

Number of Deaths from all Causes Registered in the North-West Provinces and Oudh during the Five Years 1878–82

Year	Jan.	Feb.	March	April	May	June	July
1878	137,161	140,173	143,760	157,326	136,867	120,767	91,677
1879	75,387	62,837	71,874	87,302	100,040	83,802	73,120
1880	116,366	72,030	69,250	72,534	76,622	78,200	56,502
1881	95,226	91,011	97,829	124,831	115,683	86,083	81,609
1882	114,220	92,472	96,596	107,628	119,714	114,382	122,110
Total	538,360	458,523	479,309	549,621	548,926	483,234	425,018

Year	Aug.	Sept.	Oct.	Nov.	Dec.	Annual total
1878	113,701	120,607	138,997	127,656	93,032	1,521,724
1879	131,702	196,135	429,115	369,390	233,795	1,914,499
1880	74,127	87,618	91,218	99,459	93,264	987,190
1881	86,316	109,837	181,519	180,683	151,846	1,402,473
1882	151,779	159,604	156,065	128,040	122,517	1,485,127
Total	557,625	673,801	996,914	905,228	694,454	7,311,013

The deaths recorded average a little under a million and a half per annum, but in 1880 they were less than a million, and in 1879 nearly two millions. In that disastrous year one district or county, that of Aligarh, lost nearly half a million of its po lation. The chief difference between 1879 and 1880, from the meteorological point of view, was that in 1879 the monsoon rains were unusually heavy, while in 1880 they were so scanty that for a long time grave apprehensions were entertained of another famine, like that which followed the drought of 1877. The year 1877 (which does not appear in the table) was an extraordinarily healthy one, but the effect of the scarcity produced by the drought of that year is seen in the high mortality of the first six months of 1878.

The first rough generalisation suggested by the table is that dry years are healthy and wet ones unhealthy. That this is generally true is well known to residents in the country. Among the natives also I have heard it said that one must choose between health *plus* famine and abundance *plus* fever. It would nevertheless be false to infer that in India mortality is due to rain; for we have only to compare the figures for the several months to see that on the average, and in almost every single year, the month in which fewest deaths occur is July, which happens to be just the rainiest month of the twelve. Rain is no doubt one of the indirect causes of death; but it seems to produce unhealthy effects by increasing the humidity of the air and hastening the growth of rank vegetation, which, decaying at a time of the year when the air is almost perfectly still over the Indian plains, produces that noxious condition of the lower atmospheric strata known by the name *malaria*. Compared with the deaths from malarial fevers, those due to cholera, small-pox, and other epidemics count almost as nothing. Hence, though these epidemics have their particular seasons of maximum and minimum, their effect is completely hidden in the general mortality table under the great annual variation which culminates in October and November.

Besides rainfall, atmospheric humidity, and wind velocity, other meteorological causes which presumably have some effect upon health are the mean temperature and the daily range of temperature—the last, according to the prevalent opinion amongst Indian medical men, who are fond of attributing almost every ailment to nocturnal chills, being a most important cause. The next table gives approximate monthly mean values of all these meteorological elements for the North-West Provinces and Oudh, exclusive of the Himalayan districts, which are very sparsely populated.

Mean Values of Certain Climatological Factors in the North-West Provinces and Oudh

Month	Mean temp.	Daily range of temp.	Relative humidity	Rainfall	Wind velocity per diem
	°	°	%	inches	miles
January	59	28	62	0·8	54
February ...	64	28	57	0·5	71
March	75	29	46	0·3	83
April	85	32	37	0·2	90
May	90	28	43	0·7	93
June	91	20	52	3·8	108
July	85	14	75	11·4	95
August	84	14	77	9·5	80
September ...	83	16	74	6·6	70
October ...	77	27	62	1·3	47
November ...	67	32	55	0·1	35
December ...	60	30	61	0·2	40
Year... ...	77	25	58	35·4	72

Before proceeding to estimate the relative effects of these factors upon the death rate, it will be found convenient to convert the totals given in the first table into mean rates per annum. The mean number of deaths per annum for each million of population is 32,493, and this number is distributed over the months as follows, when the months are all reduced to the same length:—

Jan.	Feb.	March	April	May	June
2351	2201	2093	2480	2397	2181
July	Aug.	Sept.	Oct.	Nov.	Dec.
1855	2435	3040	4352	4083	3025

It has already been pointed out that the effect of the rainfall upon health is very indirect, and therefore need not be taken into account here. The relative effects of the other factors in the second table may be calculated approximately by the formula—

$$d = \alpha t + \beta r + \gamma h + \delta v.$$

Here d, t, r, h, and v respectively denote the variations of the death rate, the mean temperature, the range of temperature, the relative humidity, and the wind velocity each month from their mean annual values. From the twelve equations of this form, furnished by the monthly means, we get the following most probable values for the coefficients, viz.:—

$$\alpha = 79·7 \qquad \beta = 113·6$$
$$\gamma = 43·4 \qquad \delta = -35·6$$

If there be any approach to truth in the assumed proportionality between the variations of the death rate and of these climatological elements, it therefore appears that a mere rise of temperature within the limits observed produced comparatively little effect, one degree of increase in the mean temperature increasing the deaths about 80 per million per month, or rather less than one per thousand per annum. The variations of the diurnal range have a much greater effect, while the change of the death rate due to varying humidity is even less than that due to temperature changes.

The relation between the death rate and the movement of the wind is inverse, the proportionate increase of deaths being 35·6 per million per month for a decrease in the velocity of the wind amounting to only one mile in twenty-four hours. In the months of October and November, when so-called *malarial* diseases attain their maximum, the air is almost absolutely still; and there can be very little doubt that if a moderate breeze were occasionally to spring up at this time of the year, so as to dissipate the *malaria*, or at all events mix it with good air from other districts or from above, the effect would be an immediate decrease of the death rate.

As regards special causes of death, I have already stated that I have confined my attention to those cases in which the *chaukidár* may be trusted to make a correct diagnosis. Small-pox, a disease now happily almost banished from Europe, but still carrying off many thousands of victims annually in India, is one of these almost unmistakable causes. The average number of deaths from this disease during the five years was 59,240, distributed as follows:—

Jan.	Feb.	March	April	May	June
3195	3830	6611	12,561	13,790	9140
July	Aug.	Sept.	Oct.	Nov.	Dec.
4855	1924	742	366	536	1690

The deaths from this cause, numerous as they are, are fewest in the months when the general mortality attains its maximum. The meteorological causes which favour the spread of small-pox appear to be heat, drought, and possibly also an unusually high wind velocity, the solid particles which constitute the contagion being presumably blown about by the wind. The relative effects of these may be roughly computed from the totals for each quarter, using the formula—

$$n = N + \alpha t + \beta(100 - h) + \gamma v;$$

n being the recorded number of deaths in any month; N the number that would occur under the hypothetical conditions of a still, saturated atmosphere at 0° F.; and t, h, and v standing for the temperature, humidity, and wind velocity respectively. The coefficients thus found are $\alpha = 91$; $\beta = 237$; $\gamma = 97$; the condition most favourable to the propagation of small-pox appearing therefore to be dryness. The number N, for the unattainable conditions assumed, comes out negative.

Another disease which the village watchman may be trusted to recognise in most instances is cholera. Cases of severe diarrhœa are doubtless frequently returned as cholera, but this does not sensibly impair the value of the registers, since the two diseases are usually prevalent about the same time. The mortality from cholera is subject to an annual variation quite as distinct as that of small-pox, but there are two maxima, in April and August, with a slight diminution between these months. The averages for the five years are :—

Jan.	Feb.	March	April	May	June
317	338	1304	9027	6541	6344
July	Aug.	Sept.	Oct.	Nov.	Dec.
5735	8129	4839	4665	1514	426

From the records of the army, police, and jail departments, extending over a longer series of years, it appears that the maximum mortality from cholera usually occurs in the rainy season. The secondary maximum in April becomes the principal one in this table on account of the excessive prevalence of cholera in April 1880. This epidemic was popularly attributed to the immense number of Hindu pilgrims assembled at the great religious fair of Hardwár, the disease having been caught from some infected persons in the crowd and spread abroad over the country as the pilgrims returned to their homes. The Sanitary Commissioner with the Government of India, however, does not accept this view, but seems to attribute the disease or its dissemination to some occult atmospheric influence. Whatever may ultimately prove to be the nature of the disease, there can be little doubt that in the North-West Provinces it is to a great extent dependent upon heat and moisture, being almost unknown in the cooler months of the dry season. To estimate the relative effects of these two atmospheric conditions, we may employ the formula—

$$n = N + \alpha t + \beta h ;$$

the letters having similar significations to those mentioned with the previous formula. Combining the months in groups of four, commencing with December, we get three equations which give the following approximate results :— $\alpha = 281$; $\beta = 45$; $N = -20{,}076$. The principal effect is that due to high temperature ; while at the temperature assumed for N—zero F.—that number comes out negative. That is to say, in a perfectly dry atmosphere cholera would disappear at a temperature considerably above freezing, about 70° F., in fact, if we may judge from these tables. In the cold weather months, indeed, cholera never assumes epidemic proportions in the North-West Provinces ; but when the poison, whatever it may be, is widely disseminated, as in the beginning of 1882, after the great *mela* or religious fair at Allahabad, it remains nearly quiescent, manifesting itself only in a few sporadic cases until the commencement of the hot weather in April, when it breaks forth with alarming rapidity.

Deaths by violence are also, as a rule, unmistakable. In the Sanitary Commissioner's tables two causes of death are given which both come under this head—suicide and wounds—the latter presumably including only the results of murder and manslaughter, as there are separate headings for accidents and wild beasts. The average numbers of these deaths recorded each year are—

	Jan.	Feb.	March	April	May	June
Suicide ...	105	109	196	268	246	248
Wounds ...	105	94	105	119	125	128
Total ...	210	203	301	387	371	376
	July	Aug.	Sept.	Oct.	Nov.	Dec.
Suicides ...	246	242	269	250	151	100
Wounds ...	132	154	145	135	115	98
Total ...	378	395	414	385	266	198

Both series exhibit a distinct annual variation, notwithstanding some irregularities which would probably disappear if we had larger numbers to deal with, and in both the phases are similar, the minimum being reached in the middle of the cold weather, and the maximum in the hot season and rains. Both forms of death by violence are, in fact, manifestations of the same cause, irritability of temper ; for suicides in India are, as a rule, not the result of a fixed melancholia, three-fourths of the cases being those of young married women, who, finding life unbearable under the daily and hourly sting of the mother-in-law's tongue, end it at last by jumping down a well.

The monthly totals given in the last table may be approximately represented by the formula—

$$n = \alpha (t - x) + \beta h,$$

since they seem to depend both on temperature and humidity. In this formula x would be the temperature at which crimes of violence would disappear. Grouping the months in fours, commencing with November, we get three equations which give $\alpha = 7{\cdot}2, \beta = 2{\cdot}0$, and $x = 48{\cdot}4°$ F. Crimes of violence in India may therefore be said to be proportional in frequency to the tendency to *prickly heat*, that excruciating condition of the skin induced by a high temperature combined with moisture. Any one who has suffered from this ailment, and knows how it affected his temper, will readily understand how the conditions which produce it may sometimes lead to homicide and other crimes. And any one who has been in India in the cold weather and seen to what an abject condition the ordinary native is reduced by a temperature of 60° or so can believe that there is probably some truth in the arithmetical result above given, that about 48° crimes of violence would disappear, for at such a temperature nobody would possess a sufficient store of energy to enable him to commit crime of any graver description than petty larceny.

S. A. HILL

ALGÆ[1]

THE new work of Dr. Agardh, forms the third part of a series of monographs of algæ, two parts of which have already appeared. The first part contains the genera Caulerpa, Zomaria, and certain groups of Sargassum ; the second contains the Chondariaceæ and Dictyoteæ. The Ulvaceæ form the subject of the present monograph. This work should have special interest for algologists, from the circumstance that in it the author has expressed his views, and the reasons on which they are founded, concerning the much-debated question whether Bangia, Porphyra, Goniotrichum, and Erythrotrichia belong to the Florideæ or to the Ulvaceæ. The fact that Dr. Agardh still retains them among the Ulvaceæ is a sufficient proof that he is not convinced by the perusal of Dr. Berthold's work (noticed in NATURE, vol. xxvii. p. 385), and the statement of the latter that they belong to the Florideæ.

Dr. Agardh discusses the subject at some length, calmly and dispassionately ; and, considering his immense experience in the study of algæ, his opinion is deserving of much consideration. It may be as well to give the reader some idea of the arguments upon which the author has grounded his opinion. He relies principally, it will be seen, upon the assumed difference of the reproductive organs in the Ulvaceæ and in the Florideæ, namely, on the sporidia endowed with motion (zoospores) in the true Ulvaceæ ; and on the antheridia, cystocarps, and tetraspores of the Florideæ ; the antheridia and cystocarps being considered by Thuret and others as sexual, the tetraspores as asexual.

[1] "Til Algernes Systematik." Nya bidrag af J. G. Agardh (Tredje afdelningen). Lunds Arsskrift, tom. xix.
Dr. L. Rabenhorst's "Kryptogamen-Flora von Deutschland, Oesterreich, und der Schweiz." Zweiter Band : "Die Meeresalgen Deutschlands und Oesterreichs." Bearbeitet von F. Hauck. 4–6 Lieferung. (Leipzig: Eduard Kummer, 1883.)

Dr. Agardh points out that the organs with powers of motion, observed by Derbès and Solier, are scarcely to be referred to the Florideæ, because in their eruption from the plant, as well as in their movements, they have an appreciable analogy with the organs of Prasiola, described by the author in a new species, *P. cornucopiæ* (see Table III., fig. 74, *e, f, g*).

On the other hand, Dr. Agardh shows that the chief consideration which induced some algologists to remove Bangia and Porphyra from the Ulvaceæ to the Florideæ was derived from the quaternate division of the cells, which was thought to be analogous to the quaternate division of the tetraspores in the Florideæ. He points out that Janczewski and Thuret had observed that it was not tetraspores, but octospores, which resulted from the division in Porphyra; and he calls attention to the fact that the so-called octospores are themselves repeatedly divided into new generations of tetraspores and octospores, in the same manner as the cells or cell-contents in Prasiola, Tetraspora, Palmella, Monostroma, Ulva aureola (*Ilea fulvescens*), and some species of Enteromorpha divide; thus showing an analogy with these plants rather than with the Florideæ.

The author observes that if the organs of Porphyra be considered analogous with the tetraspores of the Florideæ, these organs, according to some authors, should possess different functions, the tetraspores being deemed neutral in the Florideæ, but the octospores sexual in Porphyra. If, he says, those organs which in Porphyra are called antheridia agree with the antheridia of the Florideæ; if, also, those 4-partite organs which constitute spores are to be compared with the tetraspores of the Florideæ; there still remain in Porphyra and Bangia no organs which can be considered identical with the capsular fruit of the Florideæ. If, therefore, those organs which form the principal characteristic of the Florideæ are absent, it is evident that Bangia and Porphyra are far inferior to the Florideæ, and that very distant affinities must be sought for them. Moreover, if those organs which are neutral in the Florideæ become sexual and female in Porphyra, this rather seems to indicate divergence than affinity.

With regard to Bangia, Dr. Agardh observes that the filaments of this plant growing together in patches, as already observed by Dillwyn and others, always vary in thickness and in appearance, and that this difference of appearance may have suggested the idea that they were of various kinds (male and female filaments). According to Dr. Agardh, these differences are merely differences of age; and the so-called special organs are to be considered rather as different states during the evolution of the fructification, than as distinct organs.

Reviewing the statements of different algologists with regard to the fructification of these plants, the author shows from their published works that much difference of opinion existed among them. Thus, according to Derbès and Solier, those organs in Bangia which they considered as male are said by them to be endowed with lively motion; while Thuret and Reinke, referring to the same organs, say that they are motionless. Again, the author observes that Janczewski, alluding to the octospores of Porphyra, says that they have an amœboid motion; Thuret, on the contrary, states that they are motionless.

After quoting Thuret's description ("Etud Phyc.") of the processes of fructification in Porphyra, Dr. Agardh cites the following passage referring to the antheridia: "La division s'arrête plus tôt pour les spores et se prolonge davantage pour les antheridies; mais il n'y a pas de différence fondamentale dans le procédé. On en a la preuve dans les cas anormaux, déjà mentionnés par M. Janczewski, ou le contenu d'une même cellule primitive se change, partie en spores, partie en corpuscules mâles." So remarkable does this statement appear to Dr. Agardh that he quotes it also in the note to p. 26, where he thus comments on it: "Quomodo ii, qui hoc observarunt, sibimetipsis persuaserint eam partem contentus, quæ organis perhibitis fœmineis constaret, sub stadio evolutionis paulo posteriore in organa mascula non transmutaretur, mihi non liquet."

Leaving this subject to the consideration of algologists, the more general features of the work may now be noticed.

Dr. Agardh arranges the Ulvaceæ under the following genera: 1, Goniotrichum; 2, Erythrotrichia; 3, Bangia; 4, Porphyra; 5, Prasiola; 6? Mastodia; 7, Monostroma; 8, Ilea; 9, Enteromorpha; 10, Ulva; and 11, Letterstedtia.

Of these genera Mastodia and Letterstedtia are natives of the Southern Ocean. Ilea, of which one species only is known, *I. fulvescens* (*Ulva aureola*, C. Ag.), is a small tubular plant which grows at the mouths of some Swedish rivers. The cells of which it is composed are arranged in series of fours, as in Prasiola, but the colour is dusky as in Dictyota.

The other genera, of which many species are natives of these shores, will have more interest for British algologists. *Prasiola marina*, Crouan, which Dr. Agardh unites with *P. stipitata*, has been recently found in Scotland and in Devonshire; and the *Ulva calophylla* of Greville, and *Ulva crispa*, have been removed to Prasiola.

Of the twenty species of Monostroma, five, namely, *M. bullosum*, *M. laceratum*, *M. quaternarium*, *M. latissimum*, and *M. wittrockii* have been found on our coasts. To these Dr. Agardh adds another species, *M. lactuca* (*U. lactuca*, C. Ag.), which he considers identical with *M. undulatum* of Thuret, and probably with *M. pulchrum*, Farlow, of the east coast of North America. While thus transferring the specific name *lactuca* to a Monostroma, the author excludes it from Ulva, where it has been a sourse of confusion.

With regard to Porphyra, Dr. Agardh agrees with Dr. Greville in considering *P. linearis* as a distinct species; and he mentions *P. amethystea* as a native of England. Harvey had stated that the latter had been found on the west coast of Ireland, but the plant appears to have been unknown to him, and has not been found until recently, when Mr. G. W. Traill met with it on the east coast of Scotland. The arrangement of the cells in the plant is very beautiful.

In accordance with the views of most algologists, *P. vulgaris* and *P. laciniata* are united by the author; but he has changed the name of the plant to *P. umbilicalis* ("L. Sp.," ed. 2, 1633), of which he describes several forms. In his views of the structure of this alga, Dr. Agardh is at issue with Janczewski and Thuret. The last-mentioned authors state that the vegetative structure of the plant is always monostromatic, and that it is in the fruitful parts only that the cells are arranged in two series. Dr. Agardh, on the contrary, says that the alga is at all times distromatic. A reference to Plate II., fig. 61, *t*, will show that the two strata seen in the transverse section do not exhibit that subdivision of the cells which constitutes the fruit.

Dr. Agardh agrees with M. le Jolis in removing the *Ulva linza* of Harvey to Enteromorpha, where it takes the name of *E. linza*. Of Ulva, seven species only are enumerated. Under *U. rigida* there are no fewer than twenty-four synonyms. While, however, the author deserves thanks for clearing away so many reputed species, he describes many forms of this very generally distributed alga.

Enough has now been said to show the interest this work should have for algologists. It is illustrated by four plates, beautifully executed, containing 124 figures. Although the title is Swedish, the work is written in Latin.

Of Rabenhorst's "Kryptogamen-Flora," Nos. 4, 5, and 6 of Part II., in which the marine algæ are described by M. Hauck, have recently appeared. Numbers 4 and 5 treat of the Florideæ, which are concluded in the sixth part. Then follow the Phæophyceæ; but before touching on these, a few points relative to some of the Florideæ call for observation.

M. Hauck tells us that in Gelidium the cystocarps are of two kinds—(1) those in which the placenta is basal, and have consequently only one series of gemmidia; (2) those in which the placenta is central, on both sides of which the gemmidia are placed. M. Hauck does not seem to be aware that the former were long ago separated by Dr. Agardh from Gelidium, under the name of Pterocladia, the typical species of which is *Pt. lucida*, a very common alga in the Southern Ocean. The *Gelidium capillaceum*, described at p. 190, is a true Pterocladia, and has been described as such by M. Bornet under the name of *Pt. capillacea*. M. Hauck mentions this name among the synonyms of *G. capillaceum*, and at p. 191, fig. 82, he gives us copies of M. Bornet's figures of the cystocarps of this plant, and also of Gelidium; thus showing the characteristic differences between the two algæ; it is therefore surprising to find that M. Hauck still retains the old name of the plant, and places it under the genus Gelidium.

The cystocarpic fruit of *Dasya punicea*, apparently unknown in the Adriatic, was found on our southern coast as long ago as 1859. Before that time a specimen bearing cystocarps was collected by Miss Catlow in Jersey, and Dr. Harvey gave to it the provisional name of *Dasya catlowviæ*. There is considerable difference in the aspect of the plants which bear cystocarps and those which bear stichidia; so much so, that they have been taken for distinct species. British specimens of this plant are much larger than those of the Adriatic.

M. Hauck describes the tetraspores of *Melobesia corallina* as "zweitheilig," and he refers to Solms' "Corallinenalgen des Golfes von Neapel," Table III., fig. 23. Now, on turning to this figure in the work of Graf Solms, it will be seen that the tetraspores are 4-partite. It is true that they have been described by MM. Crouan and Areschoug as dipartite, but, according to the observations of M. Rosenoff in his very interesting "Récherches sur les Melobésiées," p. 45, there seems good reason to believe that, although tetraspores are often found divided into two parts only, the complete number is four.

With regard to *M. macrocarpa*, M. Hauck is apparently right in uniting it with *M. pustulata*, and also in considering *M. corticiformis* as a synonym of *M. membranacea*.

In a former number of his work, M. Hauck had stated that the tetraspores of Nemaleon were unknown. They had, however, been described by Dr. Agardh in "Sp. Gen. et Ord. Algarum," vol. ii. p. 417, and again in the "Epicrisis," p. 507; but the author did not, in either work, state in which species he had found them. Some uncertainty, therefore, existed on this point; and Thuret was of opinion that up to his time there had been no trustworthy record of the discovery of the tetraspores of Nemaleon. It would have been easy to solve the doubt by an appeal to Dr. Agardh, who is always ready and willing to impart information, but no one seems to have thought of adopting this course. The writer is glad to be able to mention, on the authority of Dr. Agardh, that he (Dr. Agardh) found tetraspores on a plant of *Nemaleon multifidum* from Copenhagen, but he had met with them only once. It is hoped that this statement will finally settle the question.

The description of the second division of the marine algæ, Phæophyceæ, is begun at p. 282 with the Fucoideæ; these are followed by the Dictyoteæ, and after these follow the Phæozoosporeæ. Each order is preceded by a careful description of the structure and fructification of the plants included in it, and an enumeration of the genera; in the case of the Phæozoosporeæ, a short diagnosis of each family is inserted. We are glad to see, from the long list of synonyms appended to the description of many plants, that M. Hauck has greatly diminished the number of species, especially of those from the Adriatic.

British algologists will find in the later numbers of this work, as well as in those which preceded them, much that is interesting and instructive. The succeeding numbers will be welcome. It is hoped that they will be followed by a good index, which will add very much to the value of the work.

MARY P. MERRIFIELD

METEOROLOGICAL OBSERVATIONS FROM BEN NEVIS

A WEATHER REPORT from the Ben Nevis Observatory is now published daily, which gives the observations made at 9 a.m. and 9 p.m., these being the hours adopted by the Meteorological Societies of the British Islands, to which are added the highest and lowest temperatures, the amount of rain and snow in all cases where it is possible to measure it, the height of the snow on the plateau, measured by the snow gauge, the hours of sunshine, taken directly from the sunshine recorder, and the quantity of ozone, droughts, changes of wind, auroras, glories, halos, electrical and other phenomena, recorded as they occur. The record is strictly one of observations, and as these are made at the usual observing-hours, British meteorologists and all persons interested in the weather are thus afforded the means of comparing their own observations with those made at Ben Nevis Observatory, which is by far the most valuable high-level station we possess, as furnishing data of the first importance in the study of the weather changes of Europe. In the winter climate of the Ben, the problem of hygrometric observation is beset with formidable difficulties. With a view to the practical solution of these it is part of the winter's programme that Mr. Omond conduct a series of investigations with a hygrometer of a novel description specially designed by Prof. Chrystal for the purpose. In the meantime, and until the problem be solved, the word "Sat," meaning saturation, is entered in the wet bulb column in all cases when the wet does not read lower than the dry bulb, it being evident that in such cases the air is all but, if not altogether, saturated. Indeed, a saturated atmosphere at all temperatures may be almost regarded as a persistent feature in the climatology of the Ben. Occasionally, however, as recently happened about Christmas and the New Year, a sudden change sets in, the clouds clear away, the sun blazes out in a sky of marvellous clearness, and a dryness of air comes on such as is rarely if ever experienced at lower levels. In these circumstances the dry and wet bulb readings separate to a degree so extraordinary that Glaisher's tables are no longer of any use in calculating the humidities of the air. As the periods of sudden and intense dryness of the atmosphere are intimately connected with the anti-cyclonic systems prevailing at the time in north-western Europe, it is not improbable that a careful record and study of them will lead to a more exact forecasting of some of our most important weather changes.

By and by the observations, combined with those made by Mr. Livingstone at the low-level station at Fort William, will furnish the data for ascertaining what is the normal distribution of pressure, temperature, and humidity in the stratum of the atmosphere between the top of Ben Nevis and the level of the sea at its base. These being once determined, all deviations therefrom, whenever occurring, will be readily seen. When the departures from the normals to subsequent changes of weather have been further investigated and their relations more accurately determined, the high expectations formed regarding the part to be played by the high-level station on Ben Nevis in contributing important data towards the forecasting of the weather of the British Islands will doubtless be realised. It must not, however, be forgotten that this intensely practical problem is an excessively difficult one, requiring for its successful prosecution no small expenditure of time, labour, thought, and money.

NOTES

THE Royal Society at their last meeting elected the following five *savants* foreign members:—Anton de Bary (Strasburg), Carl Gegenbaur (Heidelberg), Leopold Kronecker (Berlin), Rudolph Virchow (Berlin), Gustav Wiedemann (Leipzig).

WE are informed that it has been arranged that Sir William Thomson will give, at Johns Hopkins University during the first twenty days of October next, eighteen lectures on "Molecular Dynamics."

CAPTAIN W. J. L. WHARTON, R.N., at present in command of H.M. surveying vessel *Sylvia*, has been selected to succeed Capt. Sir F. Evans, K.C.B., as Hydrographer to the Navy.

ON Tuesday afternoon, at Oxford, Convocation witnessed in the Sheldonian Theatre the most exciting scene that has been enacted in the University since the opposition to Dean Stanley as Select Preacher. Last summer Convocation passed by a small majority a vote of 10,000*l.* for a new physiological laboratory. The vote was opposed by the anti-vivisectionists and by some on the ground of economy. A memorial got up by Mr. Nicholson against vivisection having produced no effect on the Council, the opponents of Prof. Burdon Sanderson determined to oppose the decree brought before Convocation on Tuesday for empowering the sale of stocks for the 10,000*l.* voted last June. The decree was supported by the Dean of Christchurch, Dr. Acland, and the Warden of Keble, and was opposed by Prof. Freeman and Mr. Nicholson. After a stormy debate the vote was carried by 188 votes against 147. The result was received with enthusiasm, and Oxford is to be congratulated on it. To what shifts Dr. Sanderson's opponents were put may be seen from what the *Times* calls "the most astonishing speech" of Mr. Freeman the historian, "who afforded a curious example of the confusion of thought into which even intelligent men may be led by an over-indulgence in sentiment. It would be as reasonable, said Mr. Freeman, for the historian to illustrate the festivities of Kenilworth by an actual bull-baiting as for the physiologist to experiment upon living animals. Mr. Freeman, in his zeal to establish the scientific character of the historian, forgets the difference between description and discovery, and ignores the fact that the physiologist, at least under the existing law, makes his experiments not for the instruction of pupils, but with a view to discover what is as yet unknown. A more curious article in the indictment against vivisection we have not met with since the celebrated letter in which Sir George Duckett told the Royal Commission that he had no evidence to give, but that he considered vivisection 'an abomination introduced from the Continent going hand in hand with Atheism.'" The *Times* in its leader on the subject treats it sensibly and moderately. "All those who are open to argument have been long ago convinced that science cannot proceed on her beneficent way without the aid of experiments, some of which must be painful; and those who are not open to argument, and those who believe, like some of the wiseacres whose opinion is on record, that 'medical science has arrived probably at its extreme limits,' are not likely to be convinced by anything that can be said or by any facts that can be brought against them. Parliament, on the recommendation of one of the strongest Royal Commissions ever appointed, has legislated in the matter, and physiological experiment is now under limitations as severe as it is possible for it to be consistently with any kind of progress in discovery. Abuses are of the rarest occurrence. Men like Dr. Sanderson are not only humane, but they are conscious that public opinion is awake on the matter, and their discretion as to what should be done and what should not is absolutely to be trusted. It is to be hoped that the sensible action of Convocation will not only encourage the Waynflete Professor to proceed as his scientific conscience may guide him, but will convince the well-meaning but irrational opponents of scientific freedom that further action on their part would be not only vexatious but unsuccessful."

BY the election of Dr. J. H. Gilbert to the separate chair of Rural Economy, Oxford has gained a man of European reputation, whose advent to the professoriate all parties will welcome.

DR. P. P. C. HOEK, of Leyden, writes to inform us of the death of Prof. Dr. H. Schlegel, Director of the Royal Museum of Natural History at Leyden, on January 17 last. Schlegel was born in 1804 in Altenburg (Saxony). It was intended to make him a brazier, but on his paying a visit to Vienna about 1824, his love for natural history was awakened. He came to Leyden in 1825, and tried to obtain an appointment as traveller for the Museum of Natural History, of which Dr. Temminck was then superintendent. He did not receive that appointment, but stayed in the Museum as preparator. He remained in this position until he was nominated conservator in 1839. He was appointed to the post of Director of the Museum in 1858 after the death of Temminck. Schlegel was doctor *honoris causâ* of the Leyden University, member of the Royal Academies of Sciences of Amsterdam and Berlin, &c. The Leyden Museum of Natural History, well known to every zoologist, has become under Schlegel's superintendence one of the richest in existence. For descriptive zoology, and especially that of the vertebrata, (reptiles, birds, and mammals), Schlegel was a first authority; the number of papers and monographs published by him in these groups is very considerable, and their scientific importance great.

THE death is announced of M. Richard Cortambert, *fils*, at the age of forty-eight years. He was attached to the geographical department of the National Library, and, in company with his father, had published many geographical works.

ADMIRAL MOUCHEZ read a paper before the Paris Academy of Sciences at the sitting of February 4, in which he stated that it was impossible to make any observations with large instruments in the old establishment at present the headquarters of French astronomy. He proposes to erect a new observatory on a site in the vicinity of Paris. Admiral Mouchez states, moreover, that to find the money required it would be advisable to sell the new grounds which were annexed to the Observatory in the time of Leverrier. The extent of this land is about 28,000 square metres, and the Admiral states that the sale might realise 4*l.* per metre. This ground was given to the Government by the City of Paris, which sold it for the nominal price of 4*l.*; it is supposed that the Municipal Council will oppose the scheme, which has come to light quite unexpectedly.

BY the last mail from Iceland we have received a communication from Dr. Sophus Tromholt, dated Reykjavik, middle of December, in which he informs us that the weather had till then been mild and very unfavourable for his researches, in consequence of which he defers to the next mail giving to NATURE an account of his studies in the island. By the same mail apparently the reports which have lately been circulating in the Scandinavian press of terrific eruptions in the island have also arrived. It is stated in private letters that in November two enormous columns of smoke were seen in the direction of the great Vatnajökull, and that ashes had fallen in the Seidisfjord. According to the direction it seemed as if this eruption was far more easterly than that occurring in the spring. In connection herewith it may be of interest to call attention to the note published in NATURE (vol. xxix. p. 135), in which it is reported that on the night of

November 17 the snow in the valley of Storelo, in Central Norway, between 61° and 62° N., became covered with a layer of gray and black dust. It is, however, remarkable that Dr. Tromholt's communication contains no reference whatever to any volcanic eruption.

WITH reference to the Krakatoa eruption, Prof. Alph. Milne-Edwards read at the Paris Academy of Sciences, on January 28, a letter from a correspondent in Réunion, in which it is stated that the intensity of the sky-tints was always greatest where the showers of volcanic ashes had been observed. Thus the path of the volcanic cloud can be traced step by step, and its trajectory found to be that of an ordinary cyclone. M. Wolf showed how a study of the curves registered by the barometer establishes two atmospheric waves starting at the same time from Krakatoa, one towards the east and the other towards the west; the former to reach us had to traverse 11,500 kilometres, and the latter 13,500. M. Wolf showed that the rate of progress was that of sound, and on the basis of this and the distances, he found the eruption to have taken place on August 27, at 11h. 43m. a.m.

THE Birmingham Town Hall was crowded on Sunday night, January 27, to hear a lecture from the Rev. W. Tuckwell on "Natural History for Working Men." He dwelt upon the difference between the homes of the working man and his employer, the first being destitute of the beauty and the resource with which the latter overflowed. One resource at any rate he could recommend to them in the study of natural history. Illustrations were drawn from the modification of the sap in their window-plants, the rise of the fluid in their trees, the structure of the spiders' webs on their walls, the transformation of insects in their water-butts; from the heavenly bodies within their gaze, Mars with his polar ice-caps, Jupiter with his moons, the sun with his spots, the moon with her craters, the nebular clusters, and the falling meteorites, to show that enveloping and pressing on us everywhere were miracles of creative and developing energy, surpassing a thousandfold the wonders of human enterprise, and that we walked amongst them unheeding and uninquiring. Instances were given of working men who had been discoverers and happy workers in these subjects, some unknown to fame, others, like Charles Peach, Robert Dick, and Thomas Edwards, the heroes of widely read memoirs. Instructions were detailed for setting up aquariums, collecting fossils and insects, preserving plants, stuffing birds, buying microscopes or telescopes with one year's saving from the public-house. A good museum should be examined; and a visit to Oxford on the next bank holiday was proposed. Annual *soirées* were recommended, at which the collections and constructions of the past year might be exhibited. The lecture ended with a few words of religious feeling arising out of the subject, which were received with deep sympathy by the audience. Thanks were proposed by Mr. Jesse Collings, M.P., Mr. Lawson Tait, and Rev. E. F. MacCarthy. The lecture will shortly be published.

IN connection with the forthcoming International Health Exhibition, it is desired to illustrate as far as possible the relations of meteorology to health, and for this purpose a special sub-Committee has been formed. It is hoped that the Royal Meteorological Society will establish a typical climatological order station, provide the complete equipment, and supervise the same. This will be arranged on a level grass space about thirty feet square, which space will be railed in, and provided with a gate through which a limited number of the public can from time to time be admitted. The attendant will take daily observations from the instruments, which will be exhibited in diagrams, and a copy of them furnished to the editorial department of the Exhibition, for publication in the daily programmes and also as a *communiqué* to the press. It is hoped that a series of large diagrams illustrative of the climatal conditions prevailing in various parts of the world may be exhibited. Besides the collective exhibit above described, space will be provided for the exhibition of instruments by manufacturers, inventors, and others who may desire to show them. Attention is particularly directed to the fact that the Committee specially invite the exhibition of meteorological instruments bearing upon the relations of climatology to public health. The Committee also appeal to authors of papers upon the relations between health and disease, rainfall, percolation, evaporation, and flow from ground, and other subjects embraced by the Exhibition, and invite them to exhibit diagrams, models, and apparatus illustrative of their researches.

BULLETIN No. 3 of the Entomological Division of the U.S. Department of Agriculture (Washington, 1883), when stripped of the "red-tape" that appears to be even more necessary on official documents in the States than it is in this country, is of more than usual interest. The notorious "army-worm" appears in a new character, viz. as destructive to cranberries, which form an important feature in the productions of the States. Various additional enemies to forest-trees are treated on by Dr. Packard. A long chapter (by Drs. Anderson and Barnard) is devoted to the "cotton-worm," in which (in addition to interesting biological information) elaborate contrivances for distributing arsenical solutions are described. Dr. McMurtrie contributes an exhaustive report on the examination of raw-silk "grown" in the States. From a scientific point of view the most valuable article is a posthumous one, by the late Dr. J. S. Bailey, on the North American *Cossidæ* (or "goat-moths"), illustrated by two very excellent plates.

WE cannot speak too highly of the work and management of the Sheffield Free Libraries. One-quarter of their rate is mortgaged to meet the debt incurred at starting; yet more than one-seventh of its entire amount is spent in books. Practically this is more than one fifth of the available income; and since, besides the central library, there are three large active branches as well as a museum and observatory, it shows a careful economy in the expenses. The committee regret in their report that their income will not allow them to further increase their premises in both size and number. In many libraries the income is almost swallowed up in the expenses of a single costly establishment. The management of Sheffield, therefore, combined with the excellence of the collection of books which its catalogue displays, deserves support from any who feel an interest in intellectual progress or wholesome and harmless recreation.

THE Norwegian naturalist, Dr. S. A. Buch, has been commissioned by his Government to prosecute practical scientific researches as to the herring fisheries of Norway during the present year, according to the instructions of the Society for Promoting the Norwegian Fisheries in Bergen.

ON January 24, at 11.25 p.m., a splendid meteor was observed at Husqvarna in Sweden. The meteor passed rather slowly in a southerly direction, leaving a lustrous trail behind about a yard long. It was nearly the size of an ordinary cheese-plate. After a few seconds it burst with a loud report, emitting a light green lustre. The fragments seemed to turn red and soon vanished.

WITH the January number the Austrian *Monatschrift für den Orient* has increased its size, and introduced illustrations. It is also promised that scientific supplements will be occasionally issued.

MESSRS. HODDER AND STOUGHTON have issued a translation of the first volume (the only one yet published) of Dr. Rein's work on Japan—"Japan: Travels and Researches undertaken at the Cost of the Prussian Government"—of which we were able to speak in high terms in reviewing the original German edition. Altogether it is probably the most solid contribution which has been made to a knowledge of Japan and its people; the translation seems to us to be well done.

THE next evening lecture of the Society for the Encouragement of the Fine Arts will be delivered by Mr. Lennox Browne, at the rooms of the Society in Conduit Street, on February 14. It will be entitled "Science and Singing," and will be elucidated by vocal and other illustrations.

FROM the *Adelaide Express and Telegraph* of December 31, 1883, we learn that Mr. Clement L. Wragge was about to start an astronomical and meteorological observatory on his own account on the banks of the Torrens. Observations of the usual meteorological elements were to be commenced on Jan. 1, 1884. The meteorological instruments comprise mercurial barometers, a barograph, numerous self-registering and other thermometers by the best makers and Kew verified; besides rain-gauges, ozone tests, rain-band spectroscope, and other appliances used by Mr. Wragge at the Ben Nevis Observatory. He hopes to train an assistant, who will carry on the work during any prolonged absence. The house is to be called the Torrens Observatory, and is admirably situated on Stephens Terrace, Gilberton, two miles from Adelaide.

ON the proposal of M. de Lesseps, the Paris Geographical Society has decided to publish the biographies of all the French travellers of the present century.

THE *Journal of the Society of Arts* for February 1 contains two papers of special interest. One by Mr. J. G. Colmer, the Secretary to the Canadian High Commissioner, tells what the British Association will find in Canada on its visit in August next; the other is a paper of much practical value, by Mr. Thomas Fletcher, on coal-gas as a labour-saving agent in mechanical trades.

WE learn from a communication from Orkney that on January 27 at 3 a.m. the barometer fell to 27·508, and that the tide was unusually high. At Dundee the lowest record was 27·382 at 10.30 p.m. on the 26th, while the velocity of the wind is given at from fifty to sixty-five miles per hour. In Orkney a velocity of eighty-eight miles was recorded by the anemograph.

IT appears from the researches of M. Sokoloff that the water of the Neva at St. Petersburg, at a depth of 9 feet, is very pure when compared with the water supplied to other large cities. The matter in suspension in 1 cubic metre of water (in September and October) does not exceed 5·5 grm., and sometimes it is so small as to be less than 0·02 grm. The mineral matter dissolved varies from 31·0 to 38·1 grm., and the organic matters reach but 18·7 to 22·5 grm. The average for August and September is 20·4 grm. of organic matter and 31·6 of inorganic; for October, 21·7 and 33·9 grm. respectively.

CAPTAIN STUB, Corresponding Member of the Society of Arts at Smyrna, writes to Mr. Hyde Clarke that "the cold wave which was passing over America reached here last Sunday, January 21, and for Smyrna the cold was intense. I am told in exposed positions the thermometer went down to 10° below zero. At the point near the railway station I saw ice one inch thick. On the 24th the weather became milder."

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Dr. Harrison Branthwaite; a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. E. F. Shortt; a Quebec Marmot (*Arctomys monax*) from Virginia, U.S.A., presented by Mr. G. S. White; a Long-eared Owl (*Asio otus*) from Germany, presented by Master Owen Dallmeyer; a Water Rail (*Rallus aquaticus*), British, presented by Mr. T. E. Gunn; a West African Python (*Python sebæ*) from West Africa, presented by Capt. J. Grant Elliott; five European Tree Frogs (*Hyla arborea*) from France, presented by Miss E. Brunton; a European Tree Frog (*Hyla arborea*), South European, presented by the Rev. J. Stapledon Webber; a Rhesus Monkey (*Macacus rhesus*) from India, a Common Wolf (*Canis lupus*), European, a Fallow Deer (*Dama vulgaris* ♀), British, two Chattering Lories (*Lorius garrulus*) from Moluccas, two Vieillot's Firebacks (*Euplocamus vieilloti* ♂ ♀) from Malacca, deposited; a Sykes's Monkey (*Cercopithecus albigularis*), a Gray-cheeked Mangabey (*Cercocebus albigena* ♀) from West Africa, two Spotted Hyænas (*Hyæna crocuta* ♂ ♀) from South Africa, a Red-vented Parrot (*Pionus menstruus*) from Brazil, a Golden Eagle (*Aquila chrysaëtos*), a Tawny Eagle (*Aquila nævioides*), a White-tailed Eagle (*Haliaëtus albicilla*), a Cinereous Vulture (*Vultur monachus*), seven Knots (*Tringa canutus*), European, a Temminck's Snapper (*Macroclemmys temmincki*) from North America, purchased.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1664.—"Cette comète de 1664," remarks Pingré, in introducing the description of it given in his "Cométographie," "a singulièrement exercé les presses des Imprimeurs," and that this statement was justified will be evident to any one who may consult Lalande's "Bibliographie," the catalogue of the library in the Observatory of Pulkowa, or the "Repertorium der Cometen-Astronomie," by Dr. Carl of Munich; in the latter will be found references to some eighty works, either treating specially upon this comet, or in which it is noticed in more or less detail. And further, as Mädler observes: "Lubienietsky hat über ihn allein einen ganzen Quartband geschrieben, der freilich für unsere Zwecke sich auf einige Seiten reducirt;" the volume here referred to is the first of the "Theatrum Cometicum."

This comet appears to have been discovered in Spain as early as November 17. Huyghens observed it at Leyden on December 2, while the observations of Hevelius at Dantzic, which have been used exclusively in the determination of the orbit, commenced on December 14, and it was generally observed in France and Italy about the same time. Observations properly so-called do not appear to have been made in this country, and on scanning the long list of publications enumerated by Carl we find, in addition to a notice by J. Ray in the *Philosophical Transactions* for 1707, only two works named as having been printed here: (1) "An Astronomical description of a comet as it appeared in new England, in the year 1664;" and (2) "The blazing star, or a discourse of Comets. In a letter from J. B. to T. C. concerning the late comet." Flamsteed was then an ailing youth, and though given to astronomical exercises he has no reference to the comet in question. Indeed, in his account of his early life we read: "I had now completed eighteen years, when the winter (that of 1664-1665) came on and thrust me again into the chimney, whence the heat and the dryness of the preceding summer had happily once before withdrawn me;" and he thus attended rather to calculation from Street's "Caroline Tables," which he had just procured, than to observations.

The comet was not suffered to remain without notice by Samuel Pepys, and we find several references to it in his "Diary," which it may not be quite without interest to examine. Pepys records the old style dates, but we reduce them to the present reckoning. The first notice of the comet is on December 27, and runs thus: "Mighty talk there is of this comet that is seen a' nights; and the King and Queene did sit up last night to see it, and did it seems. And to-night I thought to have done so too; but it is cloudy, and so no stars appear. But I will endeavour it." On the night of December 26 the comet would rise in London just before eleven o'clock, and would be on the meridian at two o'clock at an altitude of less than nine degrees, in R.A. 126°·4, and declination 30°·0 south, distant from the earth 0·193. The apparent length of the tail (37°) mentioned by Carl, assigns a real length of 43,000,000 miles, if it were in the line of the radius-vector. On December 31 we read: "My Lord Sandwich this day writes me word that he hath seen (at Portsmouth) the comet, and says it is the most extraordinary thing he ever saw." On January 3 Pepys says: "I saw the comet, which is now, whether worn away or no I know not, but appears not with a tail, but only is larger and duller than any other star, and is come to rise betimes, and to make a great arch, and is gone to quite a new place in the heavens than it was before; but I hope in a clearer night something more will be seen." At eight o'clock on the evening of January 3 the comet was in R.A. 47°·5, declination 1°·5 south, distant from the earth 0·276; the moon was at full two days previously, so that the tail might have been in great measure overpowered by her light in the indifferent state of the sky. Pepys has no further reference to the comet till March 11, when the "Diary" says: "To Gresham College, where Mr. Hooke read a second very curious lecture about the late comet; among other things proving very probably that this is the very same comet that appeared before in the year 1618, and that in such a time probably it will appear again, which is a very new opinion; but all will be in print." We do not remember to have met with other reference to this opinion of Hooke's, though probably such must exist; and it is not easy to explain upon what grounds he founded the idea. The comet referred to was the third of 1618, which, to use Pingré's phrase, almost exercised the printing-press as much as that of 1664. It was observed by Harriot at Sion House, Isleworth, or, as it was then called, Thistleworth.

GEOGRAPHICAL NOTES

OUR readers may have noticed that Dr. Holub had met with unexpected difficulties at the Cape in the prosecution of his journey into the African interior, the Cape authorities insisting on payment of the full duty on the traveller's scientific equipment. It will be seen from the following communication, which has been sent us for publication, that the difficulty has been happily and promptly settled:—"Downing Street, February 2, 1884.—Sir,—I am directed by the Earl of Derby to acknowledge the receipt of your letter of the 29th ult., relative to the exploring expedition undertaken by Dr. Holub in South Africa; and I am to acquaint you, for the information of Sir Joseph Hooker, that a telegram has been sent to the officer administering the Government of the Cape of Good Hope, requesting that special concessions may be made in respect to the Customs duties, and that support may be afforded to Dr. Holub in the prosecution of his enterprise. A despatch to the same effect will follow by the outgoing mail.—I am, &c. (signed), ROBERT G. W. HERBERT,—The Assistant Director, Royal Gardens, Kew."

IN the *Bolletino* of the Italian Geographical Society for January an account is given of a curious manuscript recently presented to the Society by Count Pietro Antonelli. It forms a bulky codex of 125 sheets of parchment, consisting mostly of formulas and magic incantations written in the old Giz (Ethiopic) language with a large admixture of Amharic. Amongst the contents is also the *Aud Neges't*, or Royal Circular, comprising sixteen circles, each of which occupies a whole page of the codex. All are divided into sixteen segments, each containing some text on the various incidents of human existence, which are afterwards expounded in greater detail. Then come thirty chapters, each divided into fifteen lines, every one of which contains some sentence or aphorism. The donor has received the King Humbert gold medal for the scientific work accomplished by him in the Italian settlement of Assab and neighbouring district. The same number of the *Bolletino* contains a description of the interesting collection presented last year to the prehistoric ethnographic museum at Rome by M. van Oordt of Leyden. This collection comprises a beautiful series of amulets, musical instruments, costumes and all kinds of personal ornaments used by the Maronites of the Lebanon, the Druses of Hauran and other Syrian populations. Some have a considerable intrinsic value, while others are noteworthy for their rarity and the elegance of their forms and ornamentation. One of the most remarkable objects is the girdle worn by rich Bedouin and Druse brides, consisting of a broad many-coloured silken sash with a large silver clasp nearly oval at both extremities. It is opened by means of a needle, and embellished with conic filigree buttons and silver chains, from which are suspended little globules, crescents, and other charms.

THE *Sydney Morning Herald* of December 27, 1883, says:—An exploring party, under the leadership of Mr. Charles Winnicke, an experienced explorer and bushman, has just made a successful journey through a large portion of unknown country in the interior of Australia. The party was provided with camels and horses, but the latter were never required. Mr. Winnicke made a start from Cawarrie station, on the Warburton River, in latitude 28° S., and traversed the country to the north as far as latitude 27°, effecting a connection with previous explorations near Goyder's Pillars. A most remarkable natural feature in the Tailton Range was discovered by Mr. Winnicke during his Herbert River explorations. Several long stages without water were encountered a few days after the party left Cawarrie station, and a distance of 200 to 300 miles had to be traversed across the highest sand ridges in Australia before water could again be obtained. Many more long stages of between 100 and 200 miles without water were travelled. In many instances the sand ridges, which were from 300 to 400 feet high, and very steep, had to be crossed at right angles. Two large rivers and an extensive range were discovered near the Queensland boundary, and altogether Mr. Winnicke succeeded in mapping about 40,000 square miles of unknown country, which will help to fill in another large blank space on the map of Australia.

MR. O'NEILL, who arrived at Mozambique on February 4, after having traversed 1400 miles of unexplored country, situated between Mozambique and Lake Nyassa, has discovered Lake Amarambu, the existence of which was previously unknown, and which he declares to be the true source of the Pienda (?) River. Mr. O'Neill reports Lake Shirwa to be smaller than has been represented. On his return Mr. O'Neill followed the Likelungo Valley, which he found to be well populated.

DR. CHAVANNE will start in a few days on his expedition to the interior of Africa, undertaken for the Belgian "Institut National de Géographie." He will employ the first eight months of his time in drawing up an accurate chart of the Congo; and then penetrate from Leopoldville to the north to explore the hitherto unknown districts lying in that direction and the water-courses. It must depend on circumstances whether he will effect his return along the Nile, by Zanzibar, or by the Congo. The provisional chart of the Congo, which was published a short time since in America, is now sold here.

IN vol. xix. of the *Isvestia* of the Russian Geographical Society we find the results obtained by M. Grinevetsky during his journey across Novaya Zemlya in the spring of 1878. The country is a plateau, about 450 feet above the sea-level, with deep valleys in which several lakes are concealed. The rivers cut deeply into the plateau. The south-eastern winds blow freely on the plain, denuding it of its snow covering. Three different parts may be distinguished in the southern island of Novaya Zemlya: the northern part, which is covered by mountains quite unknown, is bounded on the south by the Pukhovaya River. The middle part is covered by five or six parallel chains of hills, the highest summits of which reach 800 feet; they run north-west, close to the western coast, having a wide plateau to the east. The southern part is a plateau not more than 450 feet high, and M. Grinevetsky doubts very much if there are mountains 2000 feet high, as has been stated. One observation of M. Grinevetsky is worthy of notice. It is most probable, he says, that there are two varieties of reindeer in Novaya Zemlya. One of them inhabits the southern island, and the other, which does not mix with the former, inhabits only the northern island; it is said by the hunters to be much like that of Spitzbergen. In fact the Russian hunters have found very often on Spitzbergen a kind of reindeer with cut ears, which, they are persuaded, comes from Novaya Zemlya. In the Report of the Polar Commission in the *Isvestia* of the Russian Geographical Society (1871) reasons were given for believing, along with Baron Shilling, in the existence of an archipelago to the north-west of Novaya Zemlya (the feebleness of the cold sea current in Barents Sea, and the large quantities of mud and gravel seen on the floating ice north-west of Novaya Zemlya). The remark of the hunters was also referred to, and the opinion expressed that, if such an archipelago existed, the Novaya Zemlya reindeer really might cross the sea during favourable years, reach this archipelago, and thence continue their migrations to Spitzbergen. The discovery of Franz Josef Land renders this supposition still more probable, especially if the Franz Josef archipelago extends farther to the east, which extension seems most probable, on account of the feebleness of the polar current that enters Barents Sea, which surely would be much stronger if the space between Novaya Zemlya and the North Pole were occupied entirely by an open sea. The observation of M. Grinevetsky again raises this question: Is it true that the Novaya Zemlya reindeer afford so many distinct affinities with the Spitzbergen reindeer as to be considered as belonging to the same sub-variety? And if so, how explain these affinities without admitting (as the hunters do) that the reindeer in his migrations goes from Novaya Zemlya over to Spitzbergen, availing himself of the archipelagos scattered between the two islands?

In Nos. 9 and 10 of vol. x. of the *Transactions of the Berlin Geographical Society*, is an address on the wild tribes of Madagascar, by Herr J. Audebert, who divides them collectively, both those of Malayan (the Hovas) and those of African descent, according to their mode of life, into three classes: the inhabitants (1) of the coast; (2) of the woods; (3) of the grassy lands and steppe-like wastes of the southern interior. Of all the races the Sakalavi are first in point of number, power, and civilisation. The aborigines, or Malagasy proper, are generally of a dark complexion, though those of direct Arabian descent are very clear-skinned, with hard features, broad, often also high forehead, eyes wide apart, nose flat, lips prominent, but not swollen, mouth broad, with splendid teeth. The long rather woolly hair is worn in innumerable plaits woven, in the case of the women, into crowns, vaccine ears, snail-shells, &c., smeared with tallow and ashes into the hardness of stone, and very malodorous. In the grassy interior cattle-rearing is the principal industry; on the coast fishing and the cultivation of rice. In the woods the people live on roots, tubercles, and honey.—Next follows an interesting though brief account of Dr. Stecker's chequered travels, of nearly three years' duration, through Abyssinia. About the middle of February, 1881, when Dr. Rohlfs left Debra Tabor, Dr. Stecker made his way to the Tana Lake, which he travelled round, sending a detailed map of it, executed on the spot, to the German African Society. At Zabul, the recently-acquired seat of King John, Dr. Stecker drew a plan of the grand and interesting chain of mountains traversing the eastern part of Abyssinia, but both report and map failed to reach the German African Society, whither they were directed. Dr. Stecker was bent on penetrating into Koffa, but on account of war tumults and King John's refusal to give him permission, was obliged to abandon his design. He, however, joined the three kings, King John, the King of Shoa, and the Negus Tekla Haimanot into the Eastern Gala lands of Komboltsha, Antsharo, Tshaffa, Rikke, and Argobba, and was thus enabled to make first acquaintance with a tract of country never before trodden by a European.—Some interesting particulars of travels in South America are taken from a letter of Dr. G. Steinman to Dr. W. Reiss, dated November 5, 1883.—The stones collected by Herr P. Güssfeldt on the north-west slopes of Aconcagua, at a height of from 5500 to 6100 metres have been analysed by Prof. J. Roth of the Academy of Sciences, and the result has established beyond all further doubt the fact that Aconcagua is a volcano.

THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[1]

A TRUE mountain chain is the result of a local plication of the earth's crust, and its external form, in spite of sometimes enormous denudation, bears a close relation to the contours produced by the original uplift. Tried by this standard, hardly any of the heights of Britain deserve the name of mountains. With some notable exceptions in the south of Ireland, they are due not to local but to general upheavals, and their outlines have little or no connection with those due to underground movement, but have been carved out of upheaved areas of unknown form by the various forces of erosion. In the course of their denudation the nature of these component rocks has materially influenced the elaboration of their contours, each well-marked type of rock having its own characteristic variety of mountain forms. The relative antiquity of our mountains must be decided not necessarily by the geological age of their component materials, but by the date of their upheaval or of their exposure by denudation. In many cases they can be shown to be the result of more than one uplift. The Malvern Hills, for example, which from their dignity of outline better deserve the name of mountains than many higher eminences, bear internal evidence of having been upheaved during at least four widely separated geological periods, the earliest movement dating from before the time of the Upper Cambrian, the latest coming down to some epoch later probably than the Jurassic period. The oldest mountain fragments in Britain are those of the Archæan rocks, and of these the largest portions occur in the north-west of Scotland. Most of our mountains, however, belong to upheavals dating from Palæozoic time, though the actual exposure and shaping of them into their present forms must be referred to a far later period. Two leading epochs of movement in Palæozoic time can be recognized. Of these the older, dating from before the Lower Old Red Sandstone and part at least of the Upper Silurian period, was distinguished by the plication of the rocks in a dominant north-east and south-west direction, and the effects of these movements can be traced in the trend of the Lower Silurian ridges and hollows to the present day. In Wales two types of mountain-form exist—the Snowdon type, and that of the Breconshire Beacons. In the former the greater prominence of the high grounds arises primarily from the existence of masses of volcanic rocks, which from their superior durability have been better able to withstand the progress of degradation. In the latter the heights are merely the remaining fragments of a once continuous tableland. The Lake District presents a remarkable radiation of valleys from a central mass of high ground. It might be supposed that these valleys have been determined by some radiating system of fractures in the rocks; but an examination of the area shows them to be singularly independent of geological structure. So entirely do they disregard the strike, alternations, and dislocations of the rocks among which they lie that the conclusion is forced upon us that they have been determined by some cause wholly independent of structure, and before the present visible structure was exposed at or could affect the surface. This could only have happened by the spread of a deep cover of later rocks over the site of the Lake mountains. The former presence of such a cover, which is demanded for the explanation of the valleys, can be inferred from other evidence. The Carboniferous Limestone on the flanks of the Lake District is so thick that it must have spread nearly or entirely over the site of the mountains. But it was overlaid by the Millstone Grit and Coal-measures so that the whole area was probably buried under several thousand feet of Carboniferous strata which stretched continuously across what is now the north of England. At the time of the formation of the anticlinal fold of the Pennine Chain the site of the Lake District appears to have been upraised as a dome-shaped eminence, the summit of which lay over the tract now occupied by the heights from Scafell to Helvellyn. The earliest rain that fell upon this eminence would gather into divergent streams from the central watershed. In the course of ages, after possibly repeated uplifts, these streams have cut down into the underlying core of old Palæozoic rocks, retaining on the whole their original trend. Meanwhile the whole of the overlying mantle of later formations has been stripped from the dome, and is now found only along the borders of the mountains. The older rocks yielding to erosion, each in its own way, have gradually assumed that picturesqueness of detail for which the area is so deservedly famous. The Scottish Highlands likewise received their initial plications during older Palæozoic times their component rocks having been thrown into sharp fold, trending in a general north-east and south-west direction. But there is reason to believe that they were in large measure buried under Old Red Sandstone, and possibly under later accumulations. No positive evidence exists as to the condition of this region during the vast interval between the Old Red Sandstone and the older Secondary rocks. We can hardly believe it to have remained as land during all that time, otherwise, the denudation, vast as it is, would probably have been still greater. Not improbably the region had become stationary at a base-level of erosion beneath the sea; that is, it lay too low to be effectively abraded by breaker-action, and too high to become the site of any important geological formation. The present ridges and valleys of the Highlands are entirely the work of erosion. When they began to be traced the area must have presented the aspect of a wide undulating tableland. Since that early time the valleys have sunk deeper and deeper into the framework of the land, the ridges have grown narrower, and the mountains have arisen, not by upheaval from below, but by the carving away of the rest of the block of which they formed a part. In this evolution, geological structure has played an important part in guiding the erosive tools. The composition of the rock-masses has likewise been effective in determining the individuality of mountain-forms. The mountains of Ireland are distributed in scattered groups round the great central plain, and belong to at least three geological periods. The oldest groups probably took their rise at the time of the older Palæozoic upheaval, those of the north-west being a continuation of the Scottish Highlands, and those

[1] Abstract of second lecture given at the Royal Institution, February 5, by Archibald Geikie, F.R.S., Director-General of the Geological Survey. Continued from p. 325.

of the south-east being a prolongation of those of Wales. Later in date as regards the underground movements that determined their site, are the mountainous ridges of Kerry and Cork. These are local uplifts which, though on a small scale, are by far the best examples in Britain of true mountain structure. The Old Red Sandstone and Carboniferous rocks have there been thrown into broad folds and troughs which run in a general east and west direction. In some cases, as in the Knockmealdown Mountain, the arch is composed entirely of Old Red Sandstone flanked with Carboniferous strata. But in most instances an underlying wedge of Lower Silurian rocks has been driven through the arch. As not only the Carboniferous Limestone, but the rest of the Carboniferous system covered the south of Ireland and participated in this plication, the amount of denudation from these ridges has been enormous. On the Galty range, for example, it can hardly have been less but may have been more than 12,000 feet. The third and latest group of Irish mountains is that of Mourne and Carlingford, which may with some probability be referred to older Tertiary time when the similar granitic and porphyritic masses in Mull and Skye were erupted.

The tablelands of Britain strictly include the mountains, which are in general only prominences carved out of tablelands. But there are still large areas in which the plateau character is well shown. Of these the most extensive and in many respects the most interesting is the present tableland or plain of Central Ireland. As now exposed, this region lies upon an undulating eroded surface of Carboniferous Limestone. But it was formerly covered by at least 3000 or 4000 feet more of Carboniferous strata, as can be shown by the fragments that remain. The present system of drainage across the centre of Ireland took its origin long before the ancient tableland had been reduced to its present level, and before some of the ridges, now prominent, had been exposed to the light. The Moors and Wolds of Yorkshire present us with a fragment of a tableland composed of nearly horizontal Jurassic and Cretaceous rocks. The Lammermuir Hills and Southern Uplands of Scotland form a broad tableland which has been formed on a deeply eroded surface of Lower Silurian rocks.

THE MONK FISH

NATUREN has recently supplied its readers with some interesting details concerning the so-called "monk-fish" of the Sound, which may be regarded as the genuine forerunner of the sea-serpent of modern times. Its capture and appearance were deemed worthy of record in Arild Hirtfeld's great "History of Denmark," published in 1595, while portraits of the sea-monk embellished the works of various Scandinavian and German natural history writers of the middle of the sixteenth century. Among these, Guillaume Rondelet, in his great folio work, "Libri de Piscibus Marinis," first claimed the special privilege of giving to the world a facsimile of the authentic likeness of the monk. This, we are assured, had been taken from life for, and in the presence of, a nobleman, who had caused one copy to be made for the Emperor Charles V., and another for Margaret, Queen of Navarre, by whom it was presented to the author. Hirtfeld does not profess to have been brought into such close connection with the original, but he and the historians, Krag and Stephanius, agree in reporting that a fish, bearing the semblance of a human head with a monk's shaven crown, and having torn or mutilated limbs indistinctly defined under a scaly covering, was, in the year 1550, captured in the Sound, in a herring-fisher's net, and brought to the King of Denmark, who immediately gave orders that it should be buried deep underground, "to hinder indiscreet talk among the ignorant, whose minds are always perturbed by what is new." The speedy burial of the monster did not allay the excitement caused by its apparition, and Rondelet found, to his extreme annoyance, that his Swiss friend, Gesner, and other philosophers then in Rome, were in possession of other reputed original likenesses of the monk, differing from his own. This circumstance, he admits, inclined him to suspect that the artist had added "this or that according to fancy to make the fish seem more wonderful than it was in reality." He even confesses that some of the portraits have no more resemblance to a human head than might be detected in a frog or a toad; that the extremities look like fins, and that the so-called monk's gown is more like a dark seal's skin than a scaly armour. From these and other corrections, coupled with Gesner's mention of a fish's tail having formed part of the monk's body, Prof. Steenstrup infers that the "monk-fish" was an unusually large specimen of the Loligo or Squid family, whose caudal extremity, bearing probably bruises or other marks on the skin, had acquired in the imagination of the spectators the semblance of a head and neck with torn-off arms, while the arms of the cephalopod had served to represent lacerated extremities. A comparison of the numerous conflicting contemporaneous descriptions of the Danish "sea-monk" and of the later "*Kraken*" of the old Norwegian Bishop Pontoppidan might possibly be not wholly useless in the present day in checking an over hasty confidence in the truth of every fresh tale of encounters with sea-serpents, as recorded by credulous seafaring men. We may, in the meanwhile, refer all who are interested in sea-monsters to the July number of *Naturen*, in which they will find a faithful representation of Rondelet's monk-fish, while the September number of the same journal gives reproductions of two characteristic Japanese pictures, in one of which a solitary boatman is battling in a stormy sea with a formidable creature, evidently a highly magnified form of octopus, one of whose arms has been severed as it encircled man and boat, while the other arms are represented as striving to draw their prey nearer to the huge head with its protruding eyes. In the second picture, which, if less forcible, is more realistic we see in the wondering and terrified expression of the assembled men and boys the surprise and alarm excited by the appearance at a fishmonger's stall of two octopus arms, not unlike suspended serpents. The terror of the spectacle has communicated itself to domestic animals—a dog hiding himself, while a cat is taking rapid flight up the roof of the house.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The Examiners for the Radcliffe Travelling Fellowship give notice that the examination will commence on February 20 at 10 a.m. in the University Museum. The Examination for the Burdett-Coutts Geological Scholarship will commence on March 3 at 10 a.m.

Mr. Robert Stockdale, of Giggleswick School, has been elected to a Hastings Exhibition in Natural Science at Queen's College.

CAMBRIDGE.—The following are the words spoken by the Public Orator in presenting Dr. Hans Gadow (formerly of the British Museum), Curator of the Strickland Collection of Birds, for the complete degree of M.A. *honoris causâ*:—

"Dignissime Domine, Domine Procancellarie et tota Academia: Anni proximi sub finem (iuvat recordari) fabulam illam Aristophanis quæ Aves nominatur cum voluptate maxima prope omnes spectavimus. Hodie vero, ad studia nostra severiora redeuntes, nihil auspicatius esse arbitramur, quam annum novum honore in illum collato signare qui omnium avium genera et naturas quasi propriam provinciam sibi sumpsit explorandam. Illum igitur senatoribus nostris hodie merito adscribimus, qui Pomeraniæ maritimæ in parte orientali a gente antiquissima oriundus in celeberrimis Germaniæ Academiis zoologiæ, palæontologiæ, mineralogiæ, studiis operam suam feliciter impendit; qui quarto abhinc anno in Britanniam idcirco est vocatus, ut aves in Museo Britannico conservatas summa cura describeret; qui in nostra denique Academia nuper non modo de vertebratis quæ dicuntur animalibus prælectiones habuit doctissimas, sed etiam thesauris nostris ornithologicis custodiendis cum fructu nostro maximo est præpositus. Inter antiquos quidem avium a volatu cantuque rerum futurarum omina ducebantur; nos meliora edocti hodie in hoc viro Procancellarii novi auspiciis veram avium scientiam laude debita exornamus, ex initio tam felici omnia fausta in futurum augurati. '*Date candida cives Omina, et inceptis dextera cantet avis.*' Vobis præsento virum et de studiis ornithologicis et de Academia nostra optime meritum, HANS GADOW."

Mr. W. F. R. Weldon, B.A., St. John's College, has been appointed Demonstrator of Comparative Anatomy.

Mr. Francis Galton, F.R.S., has been appointed Rede Lecturer for the present year.

Prof. W. J. Sollas, M.A., late Fellow of St. John's College, First Class in the Natural Sciences Tripos, 1873, and Mr. P. H. Carpenter, M.A., Trinity College, First Class in the same Tripos, 1874, have been approved for the degree of Doctor of Science. The able original works in Geology and Zoology by both these gentlemen are familiar to all students.

LONDON.—At King's College, Prof. W. Grylls Adams, F.R.S., will continue the course of lectures on Light, and the Scientific Principles involved in Electric Lighting, during the remainder of the session. A course of practical work in Electrical Testing and Measurement with especial reference to Electrical Engineering will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week—on Mondays, at 2 p.m.—and the Laboratory will be open on Wednesday and Friday from 1 to 4.

SCIENTIFIC SERIALS

THE monthly parts of the *Journal of Botany* for 1883 contain many useful and interesting papers. Among the more important must be regarded Mr. J. G. Baker's synopsis of the genus *Selaginella*. This is not yet completed, but already extends to nearly 100 species, many of them now described for the first time. This is understood to be an instalment of a complete monograph by Mr. baker of the Vascular Cryptogams, excluding ferns, a work eagerly demanded by botanists.—The additions to the phanerogamic flora of Great Britain are not yet completed; and the palm of recent discoveries must be awarded to Mr. Arthur Bennett. In this year's record he describes and figures two, one of them, *Potamogeton Griffithii*, new to science, from a lake in Carnarvonshire. The other, *Naias marina*, is a native of the "Broads" of Norfolk. This is rendered more interesting by the discovery, by other botanists, of another species of *Naias*, *N. alagnensis*, also during the present year, in Lancashire. It is not many years since the genus was first found in Britain; and the only species hitherto known, *N. flexilis*, has been gathered only in Scotland and Ireland.—The structure and distribution of the Characeæ are still engaging attention from Messrs. H. and J. Groves and others; and of this cryptogamic order, another species, *Chara Braunii*, has also been added to the flora of Great Britain.—Mr. H. Boswell also describes two new British mosses, *Bryum gemmiparum*, from Breconshire, and *Sphagnum torreyanum*, from Shropshire.—Messrs. R. M. Christy and H. Corder contribute an interesting paper on the cross-fertilisation of *Arum maculatum*.—Numerous other articles and short notices of more local and special interest fill up the number.

THE second part of vol. xiv. of *Pringsheim's Jahrbücher fur wissenschaftliche Botanik* contains two important articles on cryptogamic botany:—Dr. A. Fischer, on the occurrence of crystals of gypsum in the Desmidieæ shows that they are of very wide distribution in the family, as well as in other freshwater algæ such as *Spirogyra*, though by no means universally present. He believes it to be simply a product of excretion in the process of metastasis, whether present in the form of crystals or dissolved in the cell-sap. Dr. O. Müller, on the law of cell division in *Melosira arenaria*, offers an important contribution to the life-history of the diatoms. By a most careful series of observations he establishes the law that "the larger daughter-cell of the nth generation divides in the following or $(n+1)$st generation, while the smaller daughter-cell always divides only in the $(n+2)$nd generation," by an argument which is too long to go into here. He deduces from this law the reason of the comparatively rare occurrence of the auxospores, by which the original size of the species is restored after the continued degradation which it necessarily undergoes in the process of division.—B. Fritsch contributes also a paper on coloured granular constituents of the cell-contents.

THE second part of vol. iv. of *Engler's Botanische Jahrbücher* for 1883 contains a continuation of its very valuable review of the more important works on systematic and geographical botany which appeared in 1882.—The other papers are:—By T. Wenzig, on the genus *Fraxinus*.—By F. Moewes, on hybrids of *Mentha arvensis* and *M. aquatica*.—By E. Warming, on the order Podostemaceæ.

Archives of the Physical and Natural Sciences, Geneva, December 15, 1883.—Meteorological *résumé* of the year 1882 for Geneva and the Great Saint-Bernard, by M. A. Kammermann, Assistant-Astronomer.—On the ancient lake of the Soleure district (coloured map), by M. Alph. Favre. The existence of this lacustrine basin confirms the conclusion arrived at by other geological studies, that during the early post-Glacial epoch a far greater portion of Switzerland was under water than at present.—Descriptive notice of the meteorological observatory installed on September 1, 1882, at Sentlis, canton of Appenzell, 2467 metres above sea-level.—On the periodical oscillations of the ground, determined by the spirit-level (fifth year, 1882-83), by M. P. L. Plantamour.—On the theory of dynamo-electric machines, by M. R. Clausius. These machines having in their practical development outstripped the theory of their construction, an attempt is made in this elaborate paper to expound a theory more in harmony with the results already obtained than are any of the mathematical formulas hitherto employed to represent them.

Rendiconto of the Sessions of the Accademia delle Scienze di Bologna for the year 1882–83. Nov. 19, 1882.—Memoir on the "null envelopes" of the second class in a given system of points affected by given coefficients, showing how, from the general formula, others may be deduced, rendering more evident the property of the envelopes, and solving some questions connected with the momenta of the second order of said system, by Prof. Ferdinando P. Ruffiani.—On three sicephalous monsters, and more particularly on the seven-month Janus recently born in Bologna, by Prof. Luigi Calori.—Note on the extremities of the motor nerve fibres in the striated muscles of the torpedo (*Torpedo marmorata*) treated with bichloride of gold and cadmium, by Prof. G. V. Ciaccio.—Microscopic researches on the traces of electric sparks incised on glass, by Prof. Elmilio Villari.—On the electric figures of condensers, by the same author.

November 26.—A systematic classification of the genus Puccinia, by Prof. Cocconi and Dr. F. Morini.—On a case of hypertrophic hepatitis, by Prof. C. Taruffi.—Symptomatic and anthropometric studies on the cretinism prevalent in the Valle d'Aosta, Piedmont, by the same author.—Some new researches on the artificial reproduction of the spleen, by Prof. Guido Tizzoni.—On the results of the measures hitherto adopted to improve the soil and climate of malarious districts in Italy, by Dr. Paolo Predieri.—A new contribution to the study of Addison's disease, by Prof. Ferdinando Verardini.

January 14, 1883.—On a fossil cetacean (*Orca cetoniensis*) recently discovered at Cetona in Tuscany, by Prof. G. Capellini.—A study of some reactions of phosphuretted hydrogen gas, by Dr. Alfredo Cavazzi.

January 28.—On a rapid method for determining the lunar motions, by Prof. A. Saporetti.—New researches on the anatomy and pathology of the placenta in mammals, by Prof. G. Escolani.

February 11.—Notes on the history of geodesy in Italy from the earliest times down to the second half of the present century, by Prof. P. Riccardi.—Experimental researches on the hypertrophy and partial regeneration of the liver, by Dr. V. Colucci.—On the relative length of the neck in both sexes, and on the best method of making these anthropometric measurements, by Dr. G. Peli.—On the preventive inoculation of contagious pleuro-pneumonia for cattle by means of intravenous injection of the virus, by Prof. A. Gotti.—Anatomical researches on five bovine monstrosities, by Prof. G. P. Piana.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 10.—"Experimental Researches on the Electric Discharge with the Chloride of Silver Battery." By Warren De La Rue, M.A., D.C.L., Ph.D., F.R.S., and Hugo Müller, Ph.D., F.R.S.

Plasticity and Viscosity of Strata.—During our experiments we have often been struck by the evident plasticity of strata whose form at times becomes modified when they meet with an obstacle or are influenced by other causes, as, for example, the crossing of other strata produced by a separate discharge.

One of our tubes, No. 9, with a residual hydrogen vacuum, has a diaphragm in the centre ¼ of an inch, 0·63 cm., thick, through the centre of which there is a hole ¼ of an inch, 0·63 cm., in diameter. To the end of the tube is attached a potash absorption chamber, the heating and cooling of which causes a change in the number of strata; when the number of strata increases they approach closer and closer to the diaphragm, and occasionally one threads itself through it, as if squeezed through, and its form is gradually changed thereby.

A tube, No. 368, Fig. 1, with a hydrogen residue gives evidence of the viscosity of a stratum.

At right angles is a tube of smaller diameter; in this tube is a stopper having a loop underneath from which is suspended by two silk fibres, *s*, a piece of decarbonised iron, *n n'*. The stopper when greased turns quite smoothly, and by rotating it the needle can be easily placed in any direction with regard to the tube.

In the first place the tube was placed in the magnetic meridian, and the needle of iron wire, *n n'*, in the same direction; tested by means of a very small magnet, both ends were equally attracted and not repelled, showing that the needle had been thoroughly decarbonised; this was done by heating it to redness for many hours in peroxide of iron, prepared by burning its oxalate.

The discharge was in the first instance passed from the ring to the point, so that the needle was in the dark space; no magnetism

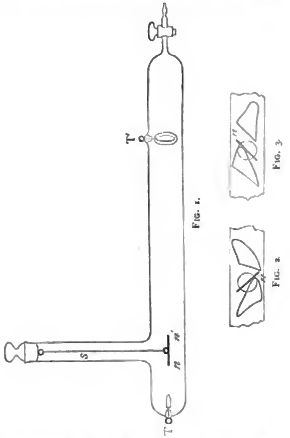


Fig. 1. Fig. 2. Fig. 3.

was developed in the needle, which would have been the case if the discharge had had a spiral motion as we have often observed and described to be sometimes the case. It was indeed with the object of ascertaining this fact that the apparatus had been made.

The needle was now placed at right angles to the tube, and the point made positive; after a few trials at different exhausts a beautiful tongue-shaped stratification was obtained, and it was then possible by altering the amount of the current to make the apex of a stratum impinge on one or the other end of the needle, Figs. 2 and 3; on whichever end the stratum touched, that end was pushed away by it, showing clearly that the balance of forces which hold together the molecules composing a stratum are sufficient to render it viscous, and unyielding to a small resistance.

Geological Society, January 23.—R. Etheridge, F.R.S,, vice-president, in the chair.—George Henry Nelson and John Philip Spencer were elected Fellows of the Society.—The following communications were read:—On the Serpentine and associated rocks of Porthalla Cove, by J. H. Collins, F.G.S.—Outline of the geology of Arabia, by C. M. Doughty. Communicated by Prof. T. G. Bonney, F.R.S. The author described the general outline of the geology of a considerable district of the western part of Arabia, over which he had travelled. It was not in his power to enter into details, especially as regarded the sedimentary rocks, because the circumstances under which his journey was undertaken made it impossible to bring back specimens. There was, however, considerable simplicity in the geological structure of the country. The igneous rocks consisted of granites and basalts, the latter breaking through the former. The sedimentary rocks, which are newer than the granites and, in fact, rest upon them, consist of—(*a*) A yellowish sandstone, with stains of a reddish or greenish colour and veins of ironstone. In this, for example, the rock-tombs, &c., of Petra have been excavated. These substances, in the author's opinion, may be traced as far as Medina, and occur all about Kasîm. They often weather in a singular way; pebbles are scarce in them; fossils he had not seen. (*b*) The limestone contains bands of flint, and appears to be identical with that which occurs in Palestine, and is, he thinks, probably of Cretaceous age. (*c*) Of much later date is a coarse flat gravel which overspreads a considerable tract of country, as, for example, at Mount Seir in Edom, altogether about 250 square miles. The flints are doubtless derived from the limestone, and are often polished by drifting sand. It occurs on plateaux at very considerable elevations above the sea, sometimes forming the highest ground in the neighbourhood; and sections had shown this gravel to be more than 20 feet deep. In it the author had discovered two or three flint weapons of palæolithic type, rude, but very like those of Hoxne or St. Acheul. The granite by its aspect and mode of occurrence recalls that of Sinai. It is cut by dykes of basalt; and now and then the author had observed other intrusive igneous rocks, which be must be content to classify as traps. The dykes of basalt, however, were not the only modes of occurrence of this rock; there were considerable flows of basaltic lavas and occasional small craters. These volcanic districts bear the name of Harra; the principal are the Aneyrid, the Khaybar, and the Kesshub. The last lies between Nejd Arabia and the Mecca country. These masses of lava, &c., are comparatively modern; eruption, indeed, has in one or two localities occurred in historic times, and steam has been seen to issue from certain craters.

Physical Society, January 26.—Prof. Clifton in the chair.—New member, Yung Free, Secretary of the Chinese Legation.—Prof. Clifton announced that Lady Siemens had presented a portion of the late Sir William Siemens's library to the Society.—The meeting, which was at first a special meeting to consider the resolution that it is expedient for the past presidents of the Society to be permanent vice-presidents, having agreed to this resolution, was constituted an ordinary meeting, and Professors Ayrton and Perry described and exhibited their new ammeters and voltmeters, also a non-sparking key. The well-known ammeters and voltmeters of the authors used for electric light work are now constructed so as to dispense with a constant, and give the readings in amperes and volts without calculation. This is effected by constructing the instruments so that there is a falling off in the controlling magnetic field, and a considerable increase in the deflecting magnetic field. The deflections are thus made proportional to the current or E.M.F. measured. The ingenious device of a core or soft iron pole piece adjustable between the poles of the horseshoe magnet is used for this purpose. By means of an ammeter and voltmeter used conjointly, the resistance of part of a circuit, say a lamp or heated wire, can be got by Ohm's law. Professors Ayrton and Perry's non-sparking key is designed to prevent sparking with large currents. It acts by introducing a series of resistance-coils determined experimentally one after the other in circuit, thereby cutting off the spark.—Dr. C. R. Alder Wright, F.R.S., read a paper on the electromotive force set up during interdiffusion, being the result of experiments made by himself and Mr. C. Thompson to determine the effect of varying densities of solutions used in voltaic cells on their E.M.F.'s. The observations were made by constructing the cells of pure materials and opposing them so that the differential E.M.F.'s could be measured by galvanometer or quadrant electrometer, when solutions of different densities were employed. The following general conclusions were reached: (1) In any two fluid cells containing solutions of two metallic salts and plates of the respective metals contained therein, an increase of strength in the solution surrounding the plate acquiring the higher potential in virtue of the normal action of the cell causes an increment in the potential difference between the two plates; and the opposite effect is produced by an increment in the strength of the solution surrounding the other plate. (2) A law of summation holds, expressible thus: the effect of the sum of a series of changes in the strengths of the solutions in a two-fluid cell is equal to the algebraic sum of the effects of each change severally. The author considered this law very fully; and pointed out that "diffusion cells" act at least partly after the fashion of thermo-couples transforming into electric energy a certain amount of sensible heat.

Anthropological Institute, January 22.—Anniversary meeting.—Prof. Flower, F.R.S., president, in the chair.—The following gentlemen were elected officers and Council for the year 1884:—President: Prof. W. H. Flower, F.R.S.; vice-presidents: Hyde Clarke, John Evans, F.R.S., Francis Galton, F.R.S., Lieut.-Col. H. H. Godwin-Austen, F.R.S., Major-General Pitt-Rivers, F.R.S., E. B. Tylor, F.R.S.; director: F. W. Rudler, F.G.S.; treasurer: F. G. H. Price, F.S.A.; Council: J. Beddoe, F.R.S., S. E. B. Bouverie-Pusey, E. W. Brabrook, F.S.A., C. H. E. Carmichael, M.A., W. L. Distant, C. I. Elton, B.A., A. W. Franks, F.R.S., J. G. Garson, M.D., Prof. Huxley, F.R.S., Prof. A. H. Keane, B.A., A. L. Lewis, Sir J. Lubbock, Bart., M.P., R. Biddulph Martin, M.P., Henry Muirhead, M.D., J. E. Price, F.S.A., Lord Arthur Russell, M.P., Prof. G. D. Thane, A. Thomson, F.R.S., Alfred Tylor, F.G.S., M. J. Walhouse, F.R.A.S.—The President delivered an address on the aims and prospects of the study of anthropology, which we gave last week.

EDINBURGH

Royal Society, January 21.—Robert Grey, vice-president, in the chair.—Prof. Crum Brown communicated a paper on distant vision, by Dr. Maddox. Dr. Maddox finds that accommodation for a distant object in the case of most persons is naturally connected with a slight convergence of the optic axes, so that the intersection of the optic axes is nearer than the object looked at. At a certain distance, different in different persons, and probably varying in the same person from time to time, the optic axes naturally converge at the distance focused for. When a nearer object is looked at, the point of intersection of the optic axes is beyond the object. In ordinary vision these differences between the distance of convergence and of accommodation are not observed, because the effort for single vision easily overcomes them, and forces the optic axes into the portion corresponding to the accommodation.—Mr. John Aitken read a paper on the dark plane in dusty air, a full report of which was given in our last issue.—Mr. Aitken also read a note on the recent sunsets.

CAMBRIDGE

Philosophical Society, January 28.—On the microscopic structure of a boulder from the Cambridge Greensand found near Ashwell, Herts, by Prof. Bonney.—On critical or apparently neutral equilibrium, a note on Mr. Greenhill's paper, *Camb. Phil. Proc.*, 1883, by Mr. J. Larmor.—On the normal vibrations of a thin isotropic shell, bounded by confocal spheroids, by Mr. W. J. Ibbetson.—On the isochromatic curves of polarised light seen in a uniaxial crystal cut at right angles to the optic surface, by Mr. C. Spurge.—Tables of the number of numbers less than n and prime to it, and of the sum of the divisors of n, and the corresponding inverse tables up to $n = 3000$, by Mr. J. W. L. Glaisher.

PARIS

Academy of Sciences, January 21.—M. Rolland in the chair.—Reflections on M. P. Bert's last communication regarding his new method of anæsthesis in surgical operations, by M. Gosselin. Although somewhat inconvenient in practice, the author still considers that the innovation presents certain advantages, while supplying a fresh argument to those who recommend moderate and progressive inhalation, rather than a large dose administered all at once. In his reply M. Bert submits that the objections raised to his method on the ground of the cumbrous nature of the apparatus are greatly exaggerated in the case of public hospitals. He further urges that it appears to be the only process in which surgeons are relieved of all personal responsibility in administering anæsthetics.—On the preparation in large quantities of artificial virus (bacilli of splenetic blood) attenuated by rapid heating (continued), by M. A. Chauveau. Here the author explains the conditions essential to the successful performance of this important and difficult operation. The subject is treated at length under the following heads:—(1) on the degree of heat required for the complete attenuation of the artificial virus; (2) on the heating process; (3) on the practical value of this system of prophylactic inoculation.—Extract from a letter by Baron Nordenskjöld on the remarkable optical effects observed during the last two months at sunset and sunrise in Sweden, presented by M. Daubrée. The author suggests that the phenomenon cannot be attributed exclusively to the dust discharged during the recent eruptions in Sunda Strait. Small particles of dust contained in the snow which fell near Stockholm at the end of last December were found on analysis to contain a considerable quantity of carboniferous matter, which burnt in the dry state with a flame, and left a reddish residuum containing oxidised iron, silica, phosphorus, and as much as 0·5 per cent. of cobalt and nickel.—Observations of the Pons-Brooks comet made at the Brunner 6-inch equatorial (0·160m.), Observatory of Lyons (continued, by M. F. Gonnessiat.—On the multipliers of linear differential equations, by M. Halphen.—On the approximate values assumed by an integral polynome when the variable quantity varies within definite limits, by M. Laguerre.—Note on the shading of a sphere, by M. J. Cotillon. The author here attempts a reproduction of the shaded sphere traditionally said to have been constructed at the École Polytechnique on the theoretical indications supplied by Monge.—On the electric conductibility of greatly diluted saline solutions, by M. E. Bouty. M. Berthelot, who insists on the importance of the results obtained by M. Bouty, points out that, according to the new law established by his numerous experiments, the electric resistance of greatly diluted solutions is determined, not by the atomic weight, but by the chemical equivalent of the bodies.—On the repulsion of two consecutive portions of the same electric current, by M. Izarn.—On the development of the nacreous crystals of sulphur, by M. D. Gernez.—Determination of the equivalent of chromium by means of the sesquioxide of its sulphate, by M. H. Baubigny.—Telegraphic despatch regarding the liquefaction of hydrogen addressed to M. Debray by M. Wroblewski. On this communication, which was worded: "Hydrogen cooled by boiling oxygen has been liquefied by expansion," M. Debray offers some remarks, and shows how it entirely confirms the remarkable observations made by M. Cailletet on the expansion of hydrogen.—On the products of reduction of erythrite by formic acid, by M. A. Henninger.—On an aromatic diacetone, by M. E. Louise.—Quantitative analysis of the moisture of amylaceous substances (starch, fecula, &c.), by M. L. Bondonneau.—On the classification of the plumicole Sarcoptidæ (sub-family of the Analgesinæ), by MM. E. L. Trouessart and P. Mégnin.—On the Cipolino marble of Paclais, Loire-Inférieure, by M. Stan. Meunier. From a careful study of this remarkable calcareous formation the author considers that even more than the blue marble of Antrim it may be regarded as a type of metamorphic rock by contact.—On the nature of the deposits observed in the water of contaminated wells, by M. E. Gautrelet. To the organisms examined under the microscope the author gives the name of *Stercogona tetrastoma*, and for several reasons concludes that they are the true typhic microbe.—On the remarkable atmospheric disturbances produced by the Krakatoa eruption, by M. E. Renou.—On the twilight effects observed on December 27 on the summit of the Puy de Dôme, by M. Alluard.—The recent remarkable sunsets and sunrises compared with those observed in various parts of Europe during the summer of 1831, by M. A. Angot.

January 28.—M. Rolland in the chair.—Spectral study of the group of telluric bands in the brightest regions of the solar spectrum, which were discovered by Brewster and collectively called α by Angström, one illustration, by M. A. Cornu. A protracted study of the bandlets of lines in this mysterious α band has suggested a practical method for distinguishing by simple inspection the lines of telluric from those of solar origin. It has also enabled the author to establish the intimate relation between this group and the A and B Fraunhofer bands, while the origin of the group itself must be referred to absorption by the oxygen of the air.—Remarks on Faraday's electrochemical law in connection with the law discovered by M. Bouty regarding the conductibility of greatly diluted saline solutions, by M. Wurtz.—On the atmospheric disturbances attributed to the Krakatoa eruption, and on the storm of January 26, by M. C. Wolf. The storm was announced the day before by great oscillations of the magnetic curves, especially those of the declinometer. The most remarkable feature attending it was its sudden cessation about one o'clock a.m. when the velocity of the gale fell at once from 38m. to 12m. per second.—On the physical disturbances that have taken place during the last few months, by M. Faye.—On the period of most frequent occurrence of solar spots in recent times, according to the data supplied by M. R. Wolf of Zurich, by M. Faye. The maximum (424) seems to have been reached during the first six months of 1882.—Remarks on the official topographic chart of Algeria, scale 1 : 50,000, the first twelve sheets of which have been presented to the Academy, by M. F. Perrier.—On the employment of titrate mixtures of anæsthetic vapours and air in the administration of chloroform, by M. Richet.—Note on the dissemination, assimilation, and determination of phosphoric acid in arable lands, by M. P. de Gasparin.—On the mean movement of the first satellite of Saturn (Mimas), based on ninety-one observations made at Toulouse since October 24, 1876, by M. B. Baillaud.—Observation of the Pons-Brooks comet made at the Observatory of Meudon (one illustration), by M. E. L. Trouvelot.—On the reduction of a continuous fraction of a fraction satisfying a linear equation of the first order with rational coefficients, by M. Laguerre.—Further reduction of the limits furnished by Descarte's rule of signs, by M. D. André.—On the distribution of the potential in liquid masses limited by two parallel planes, by M. Appell.—Relation between the power and resistance applied to the two points of attachment in a continuous spring break, regard being had to the elasticity of the spring, by M. H. Léauté.—On the reciprocal action of two electrified spheres, by M. Mascart.—On the Skrivanow electric pile (pocket model), by M. D. Monnier.—On the variations of electromotor force in accumulators, by M. E. Reynier.—On a method of determining the longitude of a place, the latitude and astronomic time being known, by the observation of the true altitude of the moon at a given moment beforehand, by M. Ch. Rouget.—Report on the fresh experiments made with the marine gyroscope on board the ironclad *Le Turenne* in the harbour of Brest on November 11 and 16, 1883, by M. Edm. Dubois.—On a new method of preparing the permanganate of barytum, by MM. G. Roussean and B. Bruneau.—On a nitrous colloid derived from amidobenzoic acid, by M. E. Grimaux.—On some remarkable properties of the lutidine derived from coal tar, by M. Oechsner de Coninck.—On the operculum of the gasteropods, by M. Houssay.—On the proportion of incompletely oxidised phosphorus contained in the urine, especially under certain nervous conditions, by MM. R. Lépine, Eymonnet, and Aubert.—Researches on the intensity of the chemical phenomena of respiration in superoxygenised atmospheres, by M. L. de Saint Martin.—Researches on abnormal menstrual discharges, by M. J. Rouvier.—On the barometric disturbances produced by the Krakatoa eruption (second note), by M. E. Renou.—On the barometric disturbances observed on August 27, 1883, at Montsouris, by M. Marié-Davy.—On the causes (1) of the production of atmospheric electricity in general; (2) of electricity in thunderstorms; (3) of electricity of sheet-lightning, by M. G. le Goarant de Tromelin.—On an auroral and crepuscular display of light observed at the island of Réunion, in the Indian Ocean, on September 8, 1883, by M. Pélagaud.

BERLIN

Physiological Society, January 11.—Prof. Kossel discussed the methods which had hitherto been adopted in order to become acquainted with the transformations of nitrogenous substances in the animal body in the course of their passage from the well-known starting point, the albumen, to the likewise well-known final products, urea, uric acid, and creatine. The way which, in the opinion of the speaker, was most likely to lead to good results was to seek in the tissues the chemical combinations which, in accordance with their composition, stood midway between the albumen and its final products. In relation to this point, the analyses of nitrogenous substances occurring in the animal body had already yielded some definite data to work on. The proportion of carbon to nitrogen (C : N) had, namely, been found to be, in the albumen, 100 : 30; in urea, 100 : 233; in creatine, 100 : 66; in hypoxanthine and xanthine, 100 : 93; and in guanine, 100 : 116. It appeared evident, therefore, that the substances creatine, hypoxanthine, xanthine, and guanine were mediate products in the process of the transmutation of the albumen, with the discovery of which in the tissues Prof. Kossel had been busied. The bases hypoxanthine, xanthine, and guanine were not found in an isolated state in the tissues, but compounded with albumen and phosphoric acid into the complicate molecule, nuclein, a subject to which the speaker had devoted searching inquiry. There were different forms of nuclein which varied probably according to the share the bases had in their composition. All of them, however, agreed in having common reactions. Nuclein had already, by its discoverer, been brought into close relationship with the cell-nucleus, and it would be of great consequence if it could be conclusively proved that the cell-nucleus consisted exclusively of nuclein, as in that case the changes of the cell-nucleus occurring under different physiological conditions would be accompanied by chemically demonstrable quantitative changes in this nuclein substance. The quantitative analysis of the nuclein could, namely, be worked out by determining the xanthine or guanine bases. In this case, however, it was necessary to ascertain beforehand that the tissue examined contained no free xanthine or guanine besides the nuclein. A second method for determining the quantitative nuclein was through determining the amount of phosphoric acid in the composition. Phosphoric acid occurred in the body in three different combinations, namely, as inorganic phosphoric salt, in lecithin, and in nuclein. Inorganic phosphoric acid was to be extracted by diluted acids, lecithinic phosphoric acid by hot alcohol. The phosphoric acid then remaining would belong to the nuclein, and could serve for its quantitative determination. Prof. Kossel had now ascertained that the blood of mammalia contained no nuclein, while on the other hand the blood of birds did. The muscles contained little nuclein, the brain somewhat more; still more was found in the liver, and most of all in the spleen. In all these successive cases the nuclein substance kept about equal pace with the presence of cell-nucleus. Nuclein was also, however, to be met with in substances which contained no cell-nucleus; in the yolk, for example, and in the milk. Possibly in this case there might be chemical proof of granules without their having come morphologically to view. In pathological processes, by which cell-nucleus becomes excessively developed in tissues which otherwise contained no cell-nucleus, as was the case in leucæmia or sarcomatous tumours in the muscles, Prof. Kossel had invariably found an increase of nuclein in corresponding quantities.—Dr. W. Wolff explained some microscopical preparations which he had set up in the demonstrating hall. In one of these preparations was seen a stage in the development of the nerves in the tail of the larva of a frog. These nerves consisted of primitive fibres ramifying as far as the finest fibrelets. At a farther stage cells were seen attaching themselves to these at the thicker parts. Next appeared the nerve-sheath, and finally the marrow. Other preparations demonstrated the growth of the bones of frogs which took place only at the periosteum and at the ends of the diaphyses. By treatment with chromic acid and with two different aniline colours, Dr. Wolff had stained the cartilages a beautiful blue, and the osseous tissue red, and was therefore able readily to follow the development of the latter.

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THURSDAY, FEBRUARY 14, 1884

MR. RUSKIN'S BOGIES

PROFESSOR RUSKIN'S utterances are perhaps to be taken least seriously when he is himself most serious, and probably he was never more in earnest than in his jeremiad on modern clouds, delivered at the London Institution on the 4th and 11th inst. Probably none of the readers of NATURE have been terrified by the storm cloud of the nineteenth century, but should it be otherwise we hasten at once to their relief. Twenty years before the date fixed by Mr. Ruskin for the first appearance of his portentous "plague-cloud," the writer of the present article commenced a series of observations on the forms and structures of clouds, followed a few years later by such daily charts of wind and weather as could be constructed from the data, somewhat meagre, that were then aceessible. As might be expected, cyclone and anti-cyclone were then as they are now. The dimensions and densities of the cloud layers have not altered, neither has our moral degeneracy nor the increased smoke of our manufacturing towns developed any new form of cloud. Neither (until the phenomenal sunrises and sunsets of the last three months) has Nature, in painting the clouds, employed upon her palette any fresh tints, whatever artists may have done. Further, we have not observed, nor met with any one, except Mr. Ruskin, who has observed, that the wind during the last thirteen years has adopted a "hissing" instead of a "wailing" tone, or that the pressure anemometer indicates that the motion of the air has become more tremulous than heretofore.

Admiration ought ungrudgingly to be bestowed on one who has done good service as an art critic and as a contributor to English literature. The sympathy, moreover, which, denied to those who are in advance of their age, is naturally accorded to the archaic type of mind, is enhanced by the attractiveness of a personality whose idealism is as lofty as that of Mr. Ruskin. But we maintain that there is a further sentiment which contributed to the applause which Mr. Ruskin's audiences bestowed upon him. Speaking generally, "broadly and comfortably," as he would say, Mr. Ruskin is not a representative man, yet he represents a certain spirit of Philistinism (for it merits this name), which is far from being unpopular, and which shows itself in opposition to scientific culture. He is the spokesman of that mental attitude which misinterprets the province of science and affects to misunderstand the plainest utterances of the physicist. "The first business," he says, "of scientific men is to tell you things that happen, as, that if you warm water it will boil." "The second and far more important business is to tell you what you had best do under the circumstances —put the kettle on in time for tea." "But if beyond this safe and beneficial business they ever try and explain anything to you, you may be confident of one of two things—either that they know nothing (to speak of) about it, or that they have only seen one side of it, and not only have not seen, but usually have no mind to see, the other. When, for instance, Prof. Tyndall explains the twisted beds of the Jungfrau to you by intimating that the Matterhorn is growing flat, or the clouds on the lee side of the Matterhorn by the winds rubbing against the windward side of it, you may be pretty sure the scientific people do not know much (to speak of) yet either about the rock beds or the cloud beds. And even if the explanation, so to call it, be sound on one side, windward or lee, you may, as I said, be nearly certain it will not do on the other. Take the very top and centre of scientific interpretation by the greatest of its masters. Newton explained to you—or at least was supposed to have explained—why an apple fell [*sic*], but he never thought of explaining the exactly correlative but infinitely more difficult question how the apple got up there." One would have supposed that even the lecturer must be aware that modern science is at least as much occupied with the last as with the first of these problems. Mr. Ruskin has not yet done with Prof. Tyndall;—in other words, he can nowhere suppress his dislike of scientific thought. "When I try to find anything firm to depend on, I am stopped by the quite frightful inaccuracy of the scientific people's terms, which is the consequence of their always trying to write Latin-English, and so losing the grace of the one and the sense of the other." "I am stopped dead because the scientific people use undulation and vibration as synonyms. 'When,' said Prof. Tyndall, 'we are told that the atoms of the sun vibrate at different rates, and produce waves of different sizes, your experience of water waves will enable you to form a tolerably clear notion of what is meant.' 'Tolerably clear,' your toleration must be considerable then. Do you suppose a water wave is like a harp string? Vibration is the movement of the body in a state of tension, undulation that of a body absolutely lax. In vibration not an atom of the body changes its place in relation to another; in undulation not an atom of the body remains in the same place with regard to another. In vibration every particle of the body ignores gravitation or defies it; in undulation every particle of the body is slavishly submitted to it." And more of the same sort. We should not weary the reader with these quotations were it not too true that much of the poetry which Mr. Ruskin adores, and much of the art of which he is the apostle—not a little in short of the poetry and art of our day—are full of this anti-scientific Philistinism, whose ideal is ever in harsh contrast to the real, and which from its antagonism to the facts of Nature is the great producer of bogies. One has only to go through any picture exhibition to see plenty of those clouds which Mr. Ruskin persuades himself occur in Nature, which, "irrespective of all supervening colours from the sun," are intrinsically "white, brown, grey, or black"; "argent or sable, baptised in white, or hooded in blackness."

We recommend those who sympathise with Mr. Ruskin to study some of those little books which are beginning to be the delight of our children. Such readers may never attain the scientific spirit, yet they may possibly catch a few chords of that great song in which there is complete harmony between the Universe of Nature and that of poetic and artistic sentiment, whose faint beginnings will alone be heard in this plague-stricken century.

Against cloud-classification the stars in their courses have hitherto fought, and Mr. Ruskin in his continues the battle. Grievous are the wounds which he inflicts

Let us see how he heals them. "Every cloud is primarily definable—'visible vapour of water, floating at a certain height in the air.'" It is thus distinguished from that "form of watery vapour" which "exists just as widely and generally at the bottom of the air as the clouds do on what for convenience' sake we may call the top of it." Mr. Ruskin hopelessly confuses vapour with water-dust, and this confusion leads him into some amusing difficulties. He asks whether it is "with cloud vapour as with most other things, that are seen when they are there, and not seen when they are not there, or has cloud vapour so much of the ghost in it that it can be visible or invisible as it likes, and might, perhaps, be all unpleasantly and malignantly there just as much when they did not see it as when they did?" To this he answers "comfortably and generally" that "on the whole a cloud is where we see it, and not where we do not see it," and that we must not allow the scientific people to tell us that rain is everywhere, but palpable in one place, impalpable in another. He presently returns to his point. He has defined a floating or sky cloud, and defined the falling or earth cloud (which by the way had been altogether excluded by his first definition from his category of clouds). "But there is a sort of thing between the two which needs another sort of definition, namely, mist." The definition of this intermediate substance, however, Mr. Ruskin does not supply, being content with asking what difference there is between clear and muddy vapour. This division of clouds has at least the merit of brevity, although it is subsequently complicated by a further division into "two sorts of clouds, one either stationary or slow in motion, reflecting unresolved light, the other fast-flying and transmitting resolved light. [Really, clouds at a distance and clouds overhead.] As regards the difference in the nature of these, Mr. Ruskin merely "hints to us his suspicion that the prismatic cloud is of finely comminuted water or ice, instead of aqueous vapour";—it is difficult to understand what he supposes the former kind of cloud to be composed of.

During the forty years previous to 1871, according to the certificate of Mr. Ruskin, the clouds, thus divided and cross-divided, appear to have behaved themselves in a peaceable and orderly manner. Even the "thunder-cumulus" (English-Latin, by the way) did "its mighty work in its own hour and in its own dominions, not snatching from you for an instant or defiling with a stain the abiding blue of the transcendent sky, or the fretted silver of its passionless clouds" We may remark that these "good, old-fashioned, healthy storms" frequently had rather extensive dominions: *e.g.* on August 13, 1857, one of these storms was simultaneously felt over many thousand square miles, and extended from the Land's End to John o' Groat's, besides covering a very extensive district on the north-western parts of the European continent. The deportment of the great bogy meteor, "storm-cloud or more accurately plague-cloud," of the nineteenth century is exceedingly different. From one part of Mr. Ruskin's description of this phenomenon we imagined that he might allude to the sheet of stratus commonly occurring in winter anti-cyclones, a sheet which occasionally covers upwards of 60,000 square miles, with scarcely a rift in its surface, the greatest vertical thickness of the cloud being only 300 or 400 feet. But this illusion was soon dispelled. For we find that "in the plague-wind the sun is choked out of the whole of heaven all day long by a cloud which might be a thousand miles square and five miles deep." One would scarcely have expected so dense a cloud mass merely to turn the sun red, but Mr. Ruskin is angry with it for not doing so: "That thin, scraggy, filthy, mangey, miserable cloud, for all the depth of it, could not turn the sun red as a good business-like fog did with a hundred feet or so of itself." Further, it is accompanied by a terrible wind by which "every breath of air is polluted half round the world" [*sic*]. Mr. Ruskin omitted to mention the effects of this plague-wind on agricultural or vital statistics. "It is a wind of darkness," also "a malignant wind." Further, "it always blows tremulously, making the leaves of the trees shudder as if they were all aspens but with a peculiar fitfulness which gives them an expression of anger as well as of fear and distress." Further, "it pollutes as well as intensifies the violence of all natural and necessary storms." Here again some explanation is sorely needed, since we should much like to know whether during the plague-wind barometric gradients become steeper, or whether the force of the wind in relation to the gradient is greater than usual.

Enough for the present of such bogies; although we fear that we have by no means done with them until our literary men will master the simplest elementary primers. But not enough of Mr. Ruskin, whom we could ill spare. His English is often delicious; always in his most dyspeptic diatribes amusing. And we can all appreciate his concluding advice that we should "bring back our own cheerfulness and our own honesty; and cease from the troubling of our own passions," and (not least we think of all) "the insolence of our own lips." A good recipe: add a dash of humility and of respect for the opinions of wiser men;—and all may yet be well, even though our return to the paths of rectitude should fail to dissolve the "mangey" clouds, and quench the fevered wind of a storm-harried and woe-worn era.

W. CLEMENT LEY

SPINOZA

Ethic. By Benedict de Spinoza. Translated from the Latin by William Hale White. (London: Trubner and Co., 1883.)

IF proof were requisite that the standard of value in philosophy is different from that which obtains in the estimation of scientific research, it would only be necessary to point to the case of Spinoza. There is probably no thinker of the nature of whose work there obtain conceptions more hopelessly irreconcilable; there is certainly none about whose position there is more general unanimity. To refer to the more recent of his English critics, Prof. Caird and Mr. Frederick Pollock are at one in assigning to Spinoza most important functions in the development of philosophical inquiry. Yet there is scarcely a single point in his system as to which their respective interpretations are not mutually exclusive. But as regards the broad feature which makes Spinozism deeply interesting to students of science in the strict sense there can be no doubt. The application of the method of geometry to philosophical problems finds its counterpart in the prevailing, and apparently by no means diminishing, disposition to bring certain questions of metaphysics within the scope of scientific inquiry. That any one should have rejected the current method of metaphysics in favour of a geometrical investigation into the nature of God and existence, cannot be otherwise than significant to persons who seek to determine the psychological problem of the nature of consciousness by physiological means. Hence it is that there are some students who think that, if any philosophy were possible, it were that of Spinoza, and others who say that in the work of Mr. Spencer and Prof. Clifford they find the inheritance which Spinoza left behind him.

Mr. Hale White has done his difficult work well. The translation is executed with great care, and the style of the original has been reproduced with some success. That English readers of Spinoza have entertained very loose notions of his real teaching has been due in no small measure to the very inaccurate translation which has hitherto passed current. The present volume should do much to improve the popular conception of Spinoza's system.

At the risk of repetition of what has already been insisted on in these columns, it is right to contrast the position of the naturalists who accept Spinoza's application of scientific methods to metaphysical questions, with the procedure of Kant and those who are currently described as Neo-Kantians. It is the more desirable to revert to this topic because, although there is much complaint that the Neo-Kantians do little (if anything) more than repeat Kant's criticism of the naturalist (or, as he would have described it, dogmatic) doctrine, there is but little evidence that this criticism has been considered, much less met. People go on reasoning upon the old lines about the relation of mind to body and of God to the world as if Kant (to borrow a phrase from another branch of learning) had never obtained a rule calling upon them to show cause why there should not be a new trial of all such questions. It cannot be sufficiently borne in mind that at the present time there are only two courses open in this reference to conscientious thinkers. Either they must abstain altogether from the discussion of an increasing number of problems which are suggested by scientific inquiry, or they must be at the pains, however irksome, to master the nature of the sceptical doubts which Kant brought to bear upon the possibility of these problems. And it may be added that to single them out for elimination is not so easy a task as might be supposed. Probably the real reason why the study of Spinoza's ethics is attended with so much difficulty is that the extraordinary instinct which guides men of the highest genius in inquiries in new and unknown regions raised doubts in his mind which the investigations of Kant subsequently exhibited as the consequences of a more profoundly sceptical point of view. That difficulties arise when men reflect upon the nature of God was for Spinoza, as for Kant, due to the impossibility of reasoning on such matters as if they were ordinary facts of experience. In Spinozism the geometrical method culminated in the abrupt cessation of thought of this kind, just as in Hume empiricism ended in the paralysis of speculation. Had Spinoza pressed his distinction between different kinds of knowledge further, his system must have become in a greater or less degree sceptical in its tendencies—sceptical in the sense in which Kant was sceptical as a preliminary to reconstruction, or in which, to take the case of a very recent scientific writer, the late Prof. Clifford was a sceptic when he completed his analysis of experience with his theory of ejects. The difference between the three cases is that Kant clearly saw the origin and nature of the difficulties raised by himself, and made the inquiry the preliminary to a radically different discussion of the issues raised in philosophy and science alike. It were well if the fact were less left out of account that the rule obtained by Kant for a new trial of these issues has never yet been discharged.

R. B. HALDANE

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Krakatoa Eruption

THE Council of the Royal Society has appointed a Committee for the purpose of collecting the various accounts of the volcanic eruption at Krakatoa, and attendant phenomena in such form as shall best provide for their preservation and promote their usefulness.

The Committee invite the communication of authenticated facts respecting the fall of pumice and of dust, the position and extent of floating pumice, the date of exceptional quantities of pumice reaching various shores, observations of unusual disturbances of barometric pressure and of sea-level, the presence of sulphurous vapours, the distances at which the explosions were heard, and exceptional effects of light and colour in the atmosphere.

The Committee will be glad to receive also copies of published papers, articles, and letters bearing upon the subject.

Correspondents are requested to be very particular in giving the date, exact time (stating whether Greenwich or local), and position whence all recorded facts were observed. The greatest practicable precision in all these respects is essential.

All communications are to be addressed to

G. J. SYMONS,
Chairman Krakatoa Committee

Royal Society, Burlington House, W., February 12

The Remarkable Sunsets

THE following facts in reference to the unusual sunsets, as witnessed in the United States, will I hope be of sufficient value to your readers to justify an insertion in the pages of NATURE.

The place from which I write is 1063 feet above sea-level, 40° 48′ 47″ N. lat. and 81° 53′ 37″ W. long. from Greenwich. The main features of the exhibition here have been the crimson glow—the first and after-glow, with other accompanying colours, closely corresponding with those in England and Europe. Hence I need not occupy your pages with a special description.

I have on record seven cases, nearly all the weather would permit one to see. These occurred on November 27, December 9, 10, 25, and 28, and on January 13 and 17.

The first and second glow have extended in two or three instances, though faintly, to the zenith, and the first has occasionally been reflected on the eastern sky. On December 28, the most brilliant exhibition in the series, an arch was formed in the east, the colours red and yellowish green, very soft, and much blended. The crimson glow on the sky flooded the western sides of buildings with an unearthly light, and cast faint shadows across the snow. The appearance of the after-glow, when the sun had reached a certain angle in its decline, favours the view that it is a reflection of the first. If this be true, it is not necessary to admit so great an elevation of the reflecting matter above the earth, and thus removes a serious difficulty in explaining the glow by known causes.

In no case here has the sun during the day or at setting appeared green. On December 28 and January 13 Venus has appeared a beautiful green through the complementary crimson. This fact became important only when it was discovered that the green remained after the crimson had disappeared. The light of the planet was struggling through some medium invisible to the eye, but which arrested the other colours.

Another important point. The glow has been seen without the slightest trace of cirrus clouds behind it. Three times faint ribbon-like stripes of cirri appeared in the first glow, but in the second the gorgeous crimson has generally been projected against the clear blue sky.

The writer has seen no notice of observations on the appearance of the sun and sky during the day, and especially the afternoon, before the brilliant sunsets.

The peculiar appearance of the atmosphere in the vicinity of the sun attracted his attention on the day the first remarkable sun glow occurred. The sky was perfectly clear except around the sun, which was embedded in a soft haze that extended out some 6° or 8° on every side. Yet a distant boundary could not be assigned to the haze, so gradually did it shade into the blue of the sky. The sun was obscured so that the eye could look at it for a moment and outline its disk. Covering the sun with the hand the haze adjacent glowed like a furnace, the light diminishing rapidly as the eye swept outwards.

Two or three remarks, naturally spring from this appearance. 1. The haze was not an ordinary cirrus cloud. It had no distinct bounding surfaces; it was invisible everywhere except near the sun. 2. There was, of course, no more of the matter forming the haze around the sun than elsewhere. 3. It was capable of reflecting intensely the light that fell upon it at a large incident angle, nearly 90°. 4. The reflection of light in a high degree by any substance at a large incidence would indicate a liquid. But the clearness of the sky showed the absence of condensed vapour. And yet there was something in the air around the sun—and no more there than anywhere else—which was then, some three hours farther east, flinging its gorgeous crimson over earth and sky, and which, three hours later, would drape the earth and sky of the observer in the same beautiful colours. And what was that something? That is doubtless the great question, and I can only echo, What was it? If the answer be "Vapour of water in some peculiar state," then it is wondrous strange that water, subject as it always has been to almost every conceivable change in the air, should rarely if ever before have assumed this peculiar state! Besides, the prevalence of this phenomenon around the globe, manifesting the same characteristics everywhere, requires some marked and probably unusual cause.

As to the volcanic theory, it has some good points. It gives an unusual explanation for an unusual occurrence.

It might be expected that a convulsion which would ingulf islands and mountains, and send the throbbings of ocean around the globe, would leave some tokens of its presence on the more sensitive air.

The difficulty of accounting for the suspension of solid particles for months in air of extreme rarity may be avoided by admitting the effects to be due mainly to gases ejected in the eruptions. Most of these being condensible by extreme cold would occupy definite strata and not rise to an extreme height.

The sinking of Krakatoa and the admission of sea water to the awful and fiery gulfs below, would, it seems, set free immense quantities of chlorine from the salt water. As this gas is readily absorbed by pure water it may have condensed around its molecules the vapour of the air, and thus become capable of reflecting the light in a higher degree.

Of course these are suppositions, consistent as far as we know with law; and they may stand among other probabilities till clearer light confirms or rejects them.

In a communication to NATURE, December 13, p. 149, Prof. C. Piazzi Smyth advances the idea that one of the conditions of the red sunsets was the *dryness* of the *lower atmosphere*. The hygrometric condition of the air here on the days the crimson sunsets were seen, is given in the following table, taken from the monthly reports of the writer to the U.S. Signal Office. The two columns give the mean temperature of the dry and wet bulb thermometers (F.) for three observations each day, at 7.32 a.m., 2.32 and 9.32 p.m.

Dates		Dry bulb	Wet bulb
November	27	29°	26·8
December	5	40	38
,,	9	36·6	32
,,	10	36	33
,,	25	29·5	26
,,	28	23·6	22·2
January	13	37	33
,,	17	23·2	21·2

A mere inspection of the table shows that the dew point was high, and the percentage of possible moisture in the air quite large. Whether this weird and beautiful play of colours around the dying day is due to watery vapour in the air time will show; here it has certainly not been due to any *deficiency* in the vapour of the lower strata. O. N. STODDARD

Wooster, State of Ohio, United States, January 18

Unconscious Bias in Walking

THE following little experiment seems to show that if the majority of people are, as Mr. Darwin argues, left-legged, they would circle to the left in a mist, as Mr. Larden says they do. I would call myself normal, my left leg being the stronger. That is to say, like the majority, I jump from the left, rest my weight standing on the left (a glance at a photograph album shows this to be normal) and generally cross my right over my left whilst sitting. Having put myself in a dark empty room, I could not satisfy myself as to which way I circled, there not being space enough, but when I artificially lamed myself by putting a few tin tacks in my slipper, I circled strongly in the direction of the sound foot. From what had been said in NATURE on the subject at the time, I expected the for-the-time-being longer and stronger limb to circle round the other. The fact seems to be that there is a bias towards the stronger, most-leant-upon limb, irrespective of length. It is worth noting that, if the object causing pain be placed under the inside of, say, the right foot only, the experimenter will lean on the outside of that foot and circle to the right.

In the matter of left-leggedness I have requested several right-handed people to feign lameness. Every one of them has limped with the right foot; and, on being asked to do so, has found difficulty in imagining the left lame, and acting as if it were. May it not be because the right leg is somewhat weaker that canes are carried in the right hand?

But although left-leggedness *quâ* strength seems normal, the reverse seems to hold good *quâ* skill: one pushes a door to with the right, feels his way down a dark stair with the right, kicks a football with the right. A friend of mine, a skilful athlete, particularly known as a jumper, at first expressed astonishment that there should be any doubt as to the left leg being the stronger. On reflection he added: "I'm not sure, however; figures in skating are easier on the right." This nine figure-skaters out of ten will assent to. It is to be expected, if my theory is correct. The right leg is more easily controlled, guided, and kept in position—in a word, the more skilful limb; and at the same time the left being the better kicker, the impulse is better given.

It seems to me that mounting a horse from the near side is not a mere fashion (except for the left-handed minority). The stronger leg is put in the stirrup and gives the lift, whilst the more skilful leg is thrown over the animal's back.

It would be interesting to know which foot it is, if any in particular, which Indian servants use for prehensile purposes; also whether the higher quadrumana are right or left hind-handed.

I have noticed that persons walking in the street dwell longer on the one foot than on the other, and I remember once arguing that in-toed persons with a rolling gait were the only people who were not lame. I have been trying to observe this seriously for some days, and believe it to be so, but as the mind naturally invents a beginning and an end for a continuous motion it may be imagination. W. G. SIMPSON

5, Randolph Cliff, Edinburgh, February 6

The Ear a Barometer

THE phenomenon described by my friend Mr. Boys, on p. 333, is pathological, and not physiological. He is clearly suffering from slight obstruction of the Eustachian tube, a canal which leads from the inner side of the tympanic cavity into the posterior fauces. Its natural relief is, as he very accurately describes, by the act of swallowing, which temporarily distends the tube. He can test its perviousness by holding his nose with his fingers and forcing air into the nasal cavity. Physicians are in the habit of placing an ordinary stethoscope over the ear, causing the patient to go through the act of deglutition, and listening for the "click" of escaping air. Mr. Boys will see, as a physicist, that, if the access of air on either side of the tympanum were free, increase or decrease of atmospheric pressure would make no difference.

14, Dean's Yard, February 10 W. H. STONE

WITH regard to the letter of Mr. C. V. Boys in NATURE of February 7 (p. 333), I should like to make a remark or two on the matter, in which I have had practical experience. I am in the habit of running between Rugby and London daily, and pass through six different tunnels on the route. The Leighton tunnel is divided into three parts, the down fast line being single, and the space between the rails and the walls of the tunnel very small. On entering this, if in the first three coaches next to the engine, a sudden expansion of the tympanum is felt. I have been led to account for this phenomenon as follows: The engine acting as a piston forces the air before it through the tunnel, and so causes a partial vacuum, which extends to the first three or four coaches. After that the air has had time to rush in and fill the empty space, and this explanation is rendered almost certain by the fact that at the end of the train of twelve or fourteen coaches no aural effects are observable, thus demonstrating that the sudden propulsion of the air through the tunnel is compensated for before the middle of the train has entered. In Kilsby tunnel nothing has been noticed by myself. I account for the pressure alteration in the above manner, the engine and the tunnel-mouth closely fitting, and so are fairly comparable to a piston within a cylinder. The effects decrease from the engine to the end of the train, and are practically unobservable in the last few coaches.

Rugby, February 9 GEORGE RAYLEIGH VICARS

Diffusion of Scientific Memoirs

ALLOW me a few final words on this curious case. I spoke of the *Trans. C. P. S.*, 1849-54, in which Stokes' papers were "buried," as "almost inaccessible." This expression was challenged by the ex-Secretary of the Society, and I replied that the question could be decided by statistics alone. I indicated what statistics were required, and waited some weeks for them. The present Secretary then gave me the less essential part of the desired information, and I proceeded to make the best I could of it. Now I am told that I misunderstood his object, and that he practically admits what his predecessor challenged.

I also stated that my copy of the *Proc.* was very imperfect, and that I had not received any *Trans.* I was then told that "publications" were given only on application. If so, I replied, I should have had all, or none. To this there is no answer. P. G. TAIT

Coll. Edin., February 9

Wind Sand Ripples

SOME time ago, whilst reading an account in NATURE of very ingenious and interesting experiments by Prof. G. H. Darwin on sand ripples, my memory was recalled to some very beautiful sand ripples caused by the action of wind, seen by another person and myself on the west coast of Ireland, near Bundoran. The locality was a sand ridge twenty or thirty feet above highwater mark, and beyond the influence of either sea or river action; the ripples extended over a space of twenty yards or more. At the time there was a fresh breeze, with frequent squalls, blowing across this ridge. This ripples moved before the wind at the rate of about a foot in three or four minutes, but faster during the squalls, retaining all the time (I watched them an hour or more) perfect uniformity of shape and size. The distances were roughly measured by sticking up in the sand bits of wood at, as nearly as could be guessed, one foot apart, in a line with the direction of the wind. The ripples were about three inches from summit to summit, and the depth of trough three quarters of an inch.

The time was carefully noted with a watch. The forward movement of the ripples was evidently caused by the sand being drifted from their weather sides, and deposited on their lee, and thus there was a progressive movement to leeward, more or less rapid according to the increase or diminution of the wind force.

4, Addison Gardens, February 9 JOHN RAE

Animal Intelligence

THE following anecdote, received the other day from Russia, may possibly interest your readers:—"The following was narrated to me by Mohl's brother, on whose estate it took place. The carcass of a cow was laid out in the woods to attract the wolves, and a spring-trap was set. Next morning the forester found there the track of a bear instead of a wolf on the snow; the trap was thrown to some distance. Evidently the bear had put his paw in the trap and had managed to jerk it off. The next night the forester hid himself within shot of the carcass to watch for the bear. The bear came, but first pulled down a stack of firewood cut into seven-foot lengths, selected a piece to his mind, and, taking it up in his arms, walked on his hind legs to the carcass. He then beat about in the snow all round the carcass with the log of wood before he began his meal. The forester put a ball in his head, which I almost regret, as such a sensible brute deserved to live." J. M. HAYWARD

Sidmouth, February 9

Circular Rainbow seen from a Hill-top

CLIMBING, several summers ago, with three friends among the Coolin Hills in Skye, I was fortunate enough to witness phenomena similar to those described by Mr. Fleming in last week's NATURE (p. 310). Our shadows were apparently thrown against the precipitous side of a deep corry, distant 200 feet or perhaps more. They vanished and reappeared as thin mists passed through the corry, the sun shining continuously. We could not see each other's shadows unless close. The distance apart at which they became visible I do not clearly remember, but know it was approximately as one of my friends, Mr. W. A. Brown, writes:—"So long as we kept a few yards apart each could only see his own shadow, but when two were within arms' length a double shadow was visible to each, and on getting still nearer the shadows merged into each other." My estimate of the angle subtended by the diameter of the rainbow is 15°, that of my friend 10°. He adds, however, "I may be very far out in this." J. M. WHITE

Spring Grove, Dundee, February 5

REFERRING to Mr. Fleming's letter in NATURE of January 31 (p. 310), I would state that many years ago, before Pontresina, in the Grisons, was so resorted to as it is now, I walked up the Piz Languard early one fine morning with an old smuggler and chamois hunter—the terms are synonymous on the frontier—named Colani. On the summit of the peak is a ledge of rock, on which I lay down for twenty minutes' sleep. I had been asleep but a few minutes when Colani woke me, and, with excuses and an expression of fright on his face, begged me to come with him to see something which he had never seen in his life before. We moved to the western edge of the peak. Below us were some thin clouds of mist curling about like vapour from a large cauldron. On these clouds appeared a circular rainbow and within it, as though in a gilded frame, were two figures—in fact, the shadows of ourselves.

"There are two of them now," cried Colani, and it was not until I told him to take off his hat and wave it, as I did mine, and he saw the action repeated by the figures, that he began to feel assured they were not "Geists." It was not the "Arch St. Martin," a Romansch name for a rainbow, which had frightened him, though it was the first time he had seen a circular one, but the appearance of the dark solitary figure had awakened his conscience, for some of his smuggling adventures had not been without bloodshed. The details of the phenomenon were the same as those described by Mr. Fleming, with the exception, perhaps, that the figures were more vivid and the whole spectacle of longer duration, owing to an unclouded sun.

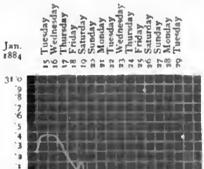
A similar appearance has lately been seen on the Tonja'e Range in Nevada, by Mr. R. A. Marr, of the Coast and Geodetic Survey. I subjoin his description of it, taken from a recent number of the *Mail*. T. R. MAYNARD

The Black Forest, February 7

"Suddenly, as I stood looking over the vast expanse beneath me, I saw myself confronted by a monster figure of a man standing in mid air before me, upon the top of a clearly-defined mountain peak, which had but the thin air of the valley below for a resting place. The figure was only a short distance from me. Around it were two circles of rainbow light and colour, the outer one faintly defined as compared with the inner one, which bright and clear and distinctly iridescent. Around the head of the figure was a beautiful halo of light, and from the figure itself shot rays of colour normal to the body. The sight startled me more than I can now tell. I threw up my hands in astonishment, and perhaps some little fear, and at this moment the spectre seemed to move towards me. In a few moments I got over my fright, and then, after the figure had faded away, I recognised the fact that I had enjoyed one of the most wonderful phenomena of nature. Since then we have seen it once or twice from Jeff Davis Peak, but it never created such an impression upon me as it did that evening when I was doing service as a heliotroper all alone on the top of Arc Dome."

The Storm of January 26

During this storm there was a remarkable depression of the barometer, it falling to 26·9, as shown in the accompanying chart. The lowest depression last year was 28·2 on Nov. 25. Lurgybrack lies in lat. 54° 56′ N., and long. 7° 42′ W. It is 225 feet above the Ordnance datum level. A nearly similar depression was observed at Letterkenny, 140 feet above the Ordnance datum level. The wind veered round from the north-west by north and east to the south, and from the latter by west to north. The storm was succeeded by a fall of snow, which has now melted away.



G. Henry Kinahan

Lurgybrack, Letterkenny, Ireland, January 29

EARTHQUAKE DISTURBANCES OF THE TIDES ON THE COASTS OF INDIA

For some years past tidal stations have been established at various points on the coasts of India, from Kurrachee round *viâ* Cape Comorin and Adam's Straits to Calcutta, and on to Rangoon and Moulmein; also beyond these points, eastwards at Port Blair in the Andaman Islands, and westwards at Aden; but not anywhere in the Island of Ceylon, which happens—unfortunately for the interests of science—to be outside the administration of the Government of India. At each of the tidal stations an observatory has been established, containing a self-registering tide-gauge, and all requisite meteorological instruments, with a clerk in charge who tends the instruments, sets the driving clocks to true time—usually received telegraphically from Madras—and sends in daily reports to the supervising officer. That officer exercises a general superintendence over all the tidal stations, inspects them periodically, collates and analyses the observations, and deduces from them the values of the "tidal constants" for each port or point of observation; these constants enable future tides to be predicted, and tide tables to be prepared for the guidance of mariners; they are also otherwise valuable, in that they have thrown light on the question of the earth's rigidity, and on various other matters of scientific interest.

The operations have been carried on in connection with the Great Trigonometrical branch of the Survey of India. Major A. W. Baird, R.E., has been the supervising officer from their commencement in 1873 up to the present time, with the exception of an interval of a little more than a year, when he was on furlough in Europe, and Capt. J. Hill, R.E., first, and afterwards Major M. W. Rogers, R.E., officiated for him.

At certain of the Indian stations the registrations have twice indicated that the normal tides had been greatly disturbed by supertidal waves: first, on the occasion of the earthquake in the Bay of Bengal on December 31, 1881; and secondly, during the volcanic eruptions in the Island of Krakatoa, between Sumatra and Java, which occurred on August 27 and 28 last. The first disturbances do not appear as yet to have attracted much attention out of India; a full account of them is given in the General Report on the Operations of the Survey of India for 1881-82, and also in the *Proceedings of the Asiatic Society of Bengal* for March 1883. The second are now famous all the world over, not merely because of the havoc they are known to have produced on the spot and at the time, but also because of the effects they are believed to have produced on the condition of the atmosphere long afterwards and in far distant quarters of the globe. A report on the tidal disturbances at Indian stations which were caused by the eruptions at Krakatoa has been drawn up by Major Baird, and sent to me for communication to the Royal Society, and an abstract of it was read at the meeting of the Society on January 31.

I now propose to indicate certain points of similarity and others of dissimilarity between the recorded effects of the disturbing forces on the two occasions; for fuller details the reports themselves must be referred to.

The usual effect of an earthquake or volcanic eruption occurring at an island or under the bed of the sea is the transmission in all directions of an "earth-wave" and a "sea-wave"; the former travels with much greater rapidity than the latter, and may reach points which the latter does not reach; or it may die away and cease at points far short of those attained by the latter; which of the two will travel the greater distance depends generally on the structure and homogeneity of the strata through which the earth-wave is transmitted, and on the depth of water and configuration of the bottom over which the sea-wave passes.

On the occasion of the earthquake of December 31, 1881, the "centre of impulse" was situated under the bed of the ocean in the western portion of the Bay of Bengal; the shock of the earth-wave was very violent in the Andaman and Nicobar Islands, and along the entire length of the Madras coast up to Calcutta, and also far inland; it was followed by a succession of sea-waves which the tidal diagrams show to have arrived after the earth-wave, at an interval ranging from half an hour at Port Blair (in the Andamans), the nearest station, to six hours at Dublat (in Sangor Island at the mouth of the River Hooghly), the furthest station at which such waves were certainly registered. At Rangoon, Moulmein, and various points in the Mergui Archipelago, the earth-wave was distinctly perceptible, though its shock was here much less violent; but no trace of a sea-wave has been met with at any of the tidal stations in this quarter; the belt of islands and shoals which extends from Cape Negrais to the Island of Sumatra, practically dividing the Bay of Bengal into two portions, must have formed a barrier to the sea-waves, for though great and numerous at Port Blair, they died away in the deep sea beyond, and in no case reached the eastern coast line.

The position of the earthquake in the Bay of Bengal was necessarily not a matter of observation as at Krakatoa; but it has been inferred by Major Rogers from the following facts. The moment at which the shock of the earth-wave was felt happens to have been recorded with considerable accuracy at three places, two on the west coast of the Bay, viz. the Madras Astronomical Observatory and the tidal station at False Point; the third on the east coast, Kisseraing, a principal station of the Great Trigonometrical Survey, where Major Rogers was actually at the moment observing a distant station in the field of the telescope of his theodolite. He reports that "he saw the earthquake before feeling it," for he first became sensible of its occurrence by noticing the object which he was observing appear to rise and fall in the telescope; he immediately examined the spirit-levels of his instrument, found they were violently agitated, and made a note of the time. Subsequently he ascertained that the shock he felt and those recorded at Madras and False Point must have occurred almost simultaneously, due allowance being made for the differences of longitude. Therefore, assuming the earth-wave to have travelled from the centre of impulse with the same velocity in all directions, the centre would be near that of the triangle joining the three points of observation, but probably a little to the south, towards the line joining Port Blair and Negapatam, the stations at which the tidal disturbances were the greatest.

Having thus ascertained the probable position of the centre of impulse, Major Rogers proceeded to ascertain the probable time of the earthquake. Here again he was favoured by his facts. It so happened that his assistant, Mr. Rendell, had just completed an inspection of the tidal station at False Point, and was at work on a line of levels a few miles away, when he felt a violent shock of earthquake; he noted the time; the clerk at the station also felt the earthquake, and noted that the observatory was much shaken; afterwards it was found that at the time recorded by Mr. Rendell the pencil of the tide-gauge had been vibrating very sensibly on the diagram; the vibration must have been caused either by the shaking of the observatory, or by a forced sea-wave such as is sometimes produced momentarily in shallow waters by a passing earth-wave. The great sea-wave which was transmitted from the centre of impulse arrived 3 hours 18 minutes afterwards. Now there can be no question that the vibration mark on the diagram correctly registers the moment at which the earth-wave reached False Point; Major Rogers therefore conjectures, with much probability, that a similar very prominent vibration mark on the Port Blair diagram registers the moment of the arrival of the earth-wave at Port Blair; thirteen minutes after the time thus registered Major Rogers felt the earthquake at Kisseraing, and as the distance between the two points is 400 miles it may be inferred that the earth-wave travelled with a velocity of about 1800 miles an hour. With this velocity, the distance of the assumed centre of impulse from either of the three surrounding stations, and the time of the occurrence of the earth-wave at either station, Major Rogers calculates the time of the original disturbance when both the earth-wave and the sea-wave were initiated. Comparing this time with that of the arrival of the sea-wave at his stations, he obtains the following velocities for the sea-wave: to Port Blair 360 miles an hour, to Madras and Negapatam 240, to False Point 180, and to Dublat 120. The average depth of the sea is known to diminish in every instance of diminished velocity.

The sea-wave here specifically referred to was the first and generally the greatest of the supertidal waves; its amplitude from trough to crest was a maximum, 36 inches, at Negapatam, and 30 inches at Port Blair; it was always positive, the crest preceding the trough and raising the sea-level. The latter point is to be specially noticed because the first result of the great eruption at Krakatoa was the reverse of this, namely, a negative wave or general lowering of the sea-level at the stations of observation, as will be shown more fully further on. Secondary sea-waves followed the first, disturbing the normal tides for some hours; their greatest duration was twenty-five hours at Port Blair, the nearest tidal station to the centre of impulse. A single earth-wave of a few seconds' duration is all that appears to have been perceived at the tidal stations; possibly, therefore, the whole of the tidal disturbances were due to a single earthquake.

Proceeding now to the eruptions at Krakatoa, we find that while there is no uncertainty as regards their locality, and there is evidence of one great eruption far exceeding all the others in violence, there is as yet no certain information of their number nor of the times at which any of them, even the greatest, occurred. No earth-waves appear to have reached India; but sea-waves of more or less magnitude were transmitted to all the tidal stations on both coasts of the peninsula, and not alone to those on the east coast, as on the former occasion; they were also transmitted far beyond, to Aden, the Mauritius, and the south-east coast of Africa, as shown in Major Baird's report. Lately it has been announced that traces of the sea-waves have been discovered at French tidal stations on both coasts of the Atlantic.

The principal facts set forth by Major Baird are the following:—

1. Distinct evidence of tidal disturbance was met with at twelve of the seventeen Indian tidal stations, including all which were fairly placed to receive the force of the impulse from Krakatoa; but, as in the previous instance, no disturbance was perceived at the stations on the east coast of the Bay of Bengal.

2. The first result of the great eruption at Krakatoa was a negative supertidal wave, or general fall of the sea-level, at Major Baird's stations and also at the Mauritius.

3. This negative wave was succeeded by a great positive wave, at an interval ranging from seventy-five minutes at Negapatam, the station nearest Krakatoa, to twenty-four minutes at Aden, the most distant station.

4. Supertidal waves of greater or less magnitude were registered at the Indian stations some hours before the negative wave of the great eruption, showing that there must have been antecedent minor eruptions. They appear at Aden about three hours before the negative wave, and eighteen hours before at Negapatam, showing that the explosions were at first comparatively feeble, affecting only the nearer stations; but afterwards they increased in intensity and became sensible even at Aden, a distance of over 4000 miles.

5. Waves of amplitudes ranging from a maximum of 22 inches at Negapatam to a maximum of 9 inches at Aden were registered at all the more favourably situated stations. The first was the positive wave immediately succeeding the primary negative wave, and it was generally of a greater amplitude than any other wave, but in a

few instances it was succeeded by greater waves. The succeeding waves maintained considerable amplitudes—not less than half the maxima values—for about twelve hours, appearing at intervals of one or two hours apart at all the more prominent stations. They were succeeded by wavelets gradually diminishing in size, but continuing for some time, being traceable on the diagrams for August 29 and 30, the second and third days after the great eruption. It is noticeable that they ceased first at Port Blair and Negapatam, the two nearest stations, and last at Aden, the farthest station.

6. Loud reports, resembling the firing of distant guns, were heard at Port Blair on August 26 and 27, and being supposed to be signals from a vessel in distress a steamer was sent out in search of the vessel; similar reports were heard on the 26th in Ceylon.

These facts show that the great eruption at Krakatoa was preceded by minor eruptions sufficiently powerful to produce effects which were sensible at a distance of upwards of 4000 miles; also that it was probably followed by minor eruptions, to the influence of which the long-protracted continuance of tidal disturbance is due.

The time at which the great eruption occurred is still not known with any precision. Major Baird has endeavoured to calculate it from the following data: he was informed by Her Majesty's Consul in Java that the first great (positive) wave reached Batavia at 12h. 10m. local time on the afternoon of August 27; as the distance from Krakatoa by sea is 105 miles, and the average depth of the sea about 186 feet, he infers from the table of the velocity of free tide waves passing over seas of different depths, in Sir George Airy's article on "Tides and Waves" in the *Encyclopedia Metropolitana*, that the wave must have taken about two hours to reach Batavia, and therefore that it must have started at 10.5 a.m. Krakatoa time, allowing five minutes for the difference of longitude. Another estimate has been recently furnished by General Strachey in a paper—read before the Royal Society—on the "Barometrical Disturbances which passed over Europe between August 27 and 31"; General Strachey connects these disturbances with the great eruption at Krakatoa, and infers, from the recorded evidence of the times of transit of the barometric waves over the European observatories, that the initial barometric rise occurred at 9h. 24m. Krakatoa time on the morning of August 27. Now we have seen that the first effect of the great eruption on the ocean was the production of a negative wave which preceded the great positive wave by an interval of seventy-five minutes at Negapatam, and twenty-four minutes at Aden; if then we assume that the interval was somewhat more than seventy-five minutes at Krakatoa itself—as is to be inferred from the fact that wherever registered it increases as the distance from the centre of impulse diminishes—General Strachey's and Major Baird's determinations will be seen to corroborate each other very closely; indeed, considering the absolute independence of the two methods of deduction, the facts of observation being in one instance derived from the atmosphere, in the other from the ocean, the coincidence between the results is very striking.

Major Baird has calculated the velocities with which the great positive wave travelled from Krakatoa to the more important of his own stations, and also to Port Louis in the Mauritius, and Port Elizabeth in South Africa.[1] Starting with the assumption that the wave left Krakatoa at 10·5 a.m., August 27, local time, he finds that it attained its maximum value, 467 statute miles per hour, in transit to both Port Louis and Port Elizabeth. Considerable interest attaches to this determination, in that it is identical with Sir George Airy's tabulated value of the velocity of a free tide-wave passing over an ocean 15,000 feet deep, which is supposed to be the average depth of the ocean in this direction; moreover, the fact that the same velocity is obtained for both the ports, and that the nearer of the two is only 3400 miles from Krakatoa, while the other port is 5450 miles distant, indicates that there is probably no material error in Major Baird's adopted time of starting. The velocity of the wave in all other directions is less, viz. to Galle 397 miles, to Negapatam 355 miles, and to Aden 371 miles. The velocities are necessarily computed on the assumption of a uniform rate of progress from the origin to the point reached; but each of the slower waves must have coincided with the wave which impinged on Ports Louis and Elizabeth for a considerable distance in the early portion of its course, and it must then have travelled with the same high velocity; afterwards, on passing over shallower seas, the velocity must have much diminished, and very possibly it may have fallen to the smaller velocity values which Major Rogers has calculated for the sea-waves in the Bay of Bengal, on the occurrence of the earthquake of December 31, 1881.

The Admiralty chart of the Eastern Archipelago shows that Krakatoa is situated at the focus of what may be regarded as a parabolic figure, formed by the contiguous portions of the coasts of Java and Sumatra; the axis of the figure is directed towards the Indian Ocean. Thus the waves generated by an eruption at Krakatoa would be mostly propelled towards that ocean, both directly and by reflection from the coasts; but near the apex of the parabola there is an opening, the Straits of Sunda, through which a great wave passed, carrying widespread destruction for some distance beyond along the contiguous coasts. This wave may have impinged with great force on the south-west corner of the Island of Borneo, which is on the prolongation of a straight line drawn from Krakatoa through the Straits. But it did not reach Singapore, where a tide-gauge is established, and which is within a third of the distance of the nearest Indian station from Krakatoa; the Master-Attendant at Singapore reports that the gauge shows "no difference whatever in the tide." This is obviously due to the fact that the wave which passed through the Straits of Sunda had but a shallow sea to advance over towards Singapore, and its course must have been greatly impeded by numerous islands and shoals and the narrow straits and passages between them. For similar reasons, and because the axis of the parabola in which Krakatoa is situated is pointed towards the Indian Ocean, it is probable that the effects of the eruptions were not conveyed to anything like so great a distance along the numerous groups of islands to the east and into the Pacific Ocean.

J. T. WALKER

[1] For these ports he employs the data published in NATURE, vol. xxviii. p. 626.

THE INDIAN SURVEY[1]

THIS is the fifth report of the amalgamated Department of Surveys under the Government of India. It is divided into two parts with an appendix. Part I. gives a summary of the operations of the great trigonometrical, the topographical, and revenue survey parties; also of the geographical, geodetic, and tidal, and levelling operations. Part II. describes the operations at the Head-Quarters Offices, viz. the Surveyor-General's Office, the Revenue Survey Office, the Lithographic Office, the Photographic Office, and the Mathematical Instrument Department, all in Calcutta; and of the Trigonometrical Survey Office in Dehra Dun. Index charts, coloured maps, and sketches showing the present state of this very important department accompany this report; to which is prefixed, as frontispiece, a "Specimen of *Heliogravure* by Major Waterhouse's Process," which invites the

[1] "General Report on the Operations of the Survey of India during the year 1881-82." Prepared under the superintendence of Lieut.-General J. T. Walker, C.B., R.E., F.R.S., &c., Surveyor-General of India. (Calcutta, 1883.)

special attention of photographers and engravers. An appendix, separately paged, of 120 pages, completes the volume, and consists of extracts from the narrative report of the executive officers in charge of the survey parties and operations.

This report is distinguished from previous ones by announcing the completion of the great triangulation on the lines originally marked out in 1830 by Col. Everest, which affords the Surveyor-General, in his introductory statement, an opportunity of giving a brief but interesting history of this great undertaking from its commencement in the year 1800, in Southern India, by Major Lambton, on the recommendation of the Hon. Col. Wellesley, afterwards the Duke of Wellington. The object of this so-called "Mathematical and Geographical Survey" was then stated to be "to determine the exact positions of all the great objects best calculated to become permanent geographical marks to be hereafter guides for facilitating a general survey of the peninsula," and further, that in the interests of general science it would have to be executed with the utmost possible precision, and be supplemented by astronomical determinations of position, with a view to the requirements of geodesy.

The operations between the years 1800 and 1825 may be briefly described as consisting of a network of triangulation over Southern India, and through the middle of which a principal chain of triangles was carried in a meridional direction from Cape Comorin up to Sironj in Central India. This chain forms that which is now known as Lambton and Everest's Great Arc. Col. Lambton died in 1823, and was succeeded by Col. Everest, who, two years afterwards, proceeded to Europe, spending four years in supervising the construction of new instruments—great theodolites, astronomical circles, standards of length, and compensation bars for base-line measurements, for employment in extending and revising the Great Arc, the importance of which was recognised by all men of science in Europe.

Returning to India in 1830, Col. Everest recommended the abandonment of the network system of triangulation and the substitution instead of what he called the "gridiron" system, consisting of meridional chains of triangles tied together at their upper and lower extremities by longitudinal chains. The meridional chains were to be constructed at intervals of about one degree apart, while longitudinal chains would follow the parallels of Calcutta, Bombay, and Madras, and thus run at intervals of from five to six degrees apart. The external chains of the gridiron would of course follow the British frontier lines and the coast lines, and all grounded on ten base lines measured with the Colby apparatus of compensation bars and microscopes. This programme of operations was approved by the Government of India and Court of Directors, and has furnished the guiding lines on which the principal triangulation has been executed during the period of almost exactly fifty years which has since elapsed. For geodetic purposes, the amount of principal triangulation is now ample. Outside the limits of India proper, the recently completed chain of principal triangles, called the eastern frontier series, is a valuable contribution to geodesy and geography.

Thus the great work of the principal triangulation of India is now an accomplished fact. Commenced in 1800, under the auspices of the Madras Government, it was carried on, almost alone, by Major Lambton, until 1818, when the Marquis of Hastings, then Governor-General, placed it under the control of the supreme Government, and Capt. Everest was appointed assistant to Major Lambton. In 1832 additional officers were appointed, and by the year 1840, when the northern section of the Great Arc was completed, the *personnel* sufficed for the equipment of six triangulation survey parties, which number has been uniformly maintained from that time onwards until gradually diminished on the completion of the successive chains of triangles. The operations have been uniformly and consistently supported by successive Governments of India with equal liberality and constancy, and to whom it must be a source of much satisfaction to know that this great work of permanent peaceful usefulness will assuredly take the highest rank as a work of scientific labour and skill.

It is stated that there are 3472 principal stations. On the plains they are constructed in the form of towers, rising from 20 to 40 and even 60 feet above the ground, and usually about 16 feet square at base, with an isolated central pillar for the instruments to rest on. On hills and mounds and other eminences the central pillar, always of masonry, is raised 2 to 4 feet above the ground level, and is surrounded with a platform of earth and stones. Mark-stones, engraved with circle and central dot to define precisely the station point of observation, are inserted at the surface and at the base of the pillar. The stations, scattered over 338 British districts and native states, are placed under the protection of local officials, each of whom is required to send annual reports of the condition of the stations within his district. Repairs are effected when necessary, and if so maintained by future generations of officials, the duration of the stations should be coeval with the hills and plains on which they stand, and be of lasting utility.

The field operations of measurements of base-lines and angles of the principal triangulation being completed, the simultaneous reduction of the vast number of such facts, acquired over all India, by many individuals and during a period of many years, to a harmonious whole, was obviously impossible. Thus it became necessary to divide the triangulation of India proper into five sections; and even then the simultaneous reduction of the numerous facts of observation collected together in each group was a work of enormous labour, necessitating, as stated by the most eminent living authority (Col. Clarke, C.B., *Geodesy*, p. 257), "the most elaborate calculations that have ever been undertaken for the reduction of triangulation by the method of least squares." The final results of the first section are given in vols. ii., iii, and iv. of the "Account of the Operations of the Great Trigonometrical Survey of India," published in 1879 (vol. i. is devoted to base-lines, and vol. v. to pendulum operations); those of the second section in vol. vi., published in 1880, and those of the third in vols. vii. and viii. will be shortly published. The simultaneous reduction of the fourth section is now completed. The final reduction of the last section has not yet commenced, nor has the recently completed eastern frontier series.

The requirements of geodesy necessitate astronomical observations for the determination of latitude and azimuth and electro-telegraphic observations for the determination of differences of longitude at several stations of the principal triangulation. These have already been completed to a considerable extent; and further operations of this nature are in progress by two small astronomical parties attached to the geodetic branch of the department, and by whom all the operations subservient to geodetic science should be completed in the course of a few years. An extensive series of pendulum observations for investigations of gravity and the figure of the earth, taken chiefly at stations of the principal triangulation, has been completed and connected with the groups of corresponding observations in other parts of the globe. Long lines of spirit levels have been, and are still being carried on in connection with the principal triangulation, from the sea to the base-lines in the interior, and from sea to sea across the peninsula; they rest on determinations of the mean sea level, which have been and are being made at tidal stations on the coasts, and which promise to furnish most important data by means of which our knowledge of the constitution of the earth's mass may be extended.

Reference can only be here made to the report for most interesting information as to the progress of the thirteen topographical parties, the two *Mouzawar*, or village survey parties, and the six cadastral or field survey parties, whose duties now include, as an experiment, the reecording of particulars about each field; thus reducing the cost of preparing the "Record of Rights" for the Board of Revenue. The geographical reconnaissance and trans-Himalayan explorations are replete with curious information to every student of nature, and of the habits and customs of the frontier hill tribes and peoples. The perusal of this report increases, if possible, our good opinion of the skill and devotion to duty of the several officers, and of the marked ability of the administration of this department by General Walker, and which it is most pleasing to find so handsomely acknowledged by the Government of India.

ZOOLOGY AND BOTANY OF ALASKA[1]

THE United States Revenue cutter *Corwin* went on a cruise in 1881 to Alaska and the Arctic Ocean. The main object of the voyage was to search the various accessible portions of the Arctic coasts for traces of the *Jeannette* and two missing whaling vessels which were lost the same season that the *Jeannette* entered the ice. Leaving St. Michael's on June 21, Behring's Sea was crossed to St. Lawrence Island and Plover Bay on the Siberian coast; then the *Corwin* went along this coast through the Straits and north-west to the vicinity of Nordenskjöld's winter quarters, where a sledge party, which had been left there earlier in the season to search the coast in that district, was taken on board; it then returned to St. Lawrence Island and St. Michael's. After a short delay it again proceeded to the Arctic, touching at all the islands in Behring's Straits, visiting in succession the entire Alaskan coast line from Behring's Straits to Point Barrow, including Kotzebue Sound, and on the Siberian shore from the Straits to North Cape. It also cruised along the edge of the ice pack, visiting Herald and Wrangel Islands—almost unknown masses of land—and, returning homewards, some time was spent at Ounalaska in the Aleutian Islands fitting for the voyage to San Francisco, which was reached in October.

As one of the results of this cruise, we have a series of notes and memoranda, medical and anthropological, botanical and ornithological, published by order of the House of Representatives at Washington.

The medical and anthropological notes of Alaska are by Dr. Irving C. Rosse. The health of the ship's crew was fairly good throughout the voyage, very careful precautionary measures being observed: for the usual habit of deluging the decks above and below every morning with water, a system of scraping and dry scrubbing was substituted with excellent results, and the decks were only wetted once or twice a month on fine days. Good water was procured nearly everywhere in the Arctic, and it is noted as of unusual excellence at Cape Thompson and at Herald and Wrangel Islands. The weather was mostly wild, with snow and hail; in the latter part of June at St. Michael's the sun was found almost overpowering, although the thermometer registered but 60°. Dr. Rosse gives a sketch of the diseases peculiar to the aboriginal population, especially of an epidemic of pneumonia which prevailed at Ounalaska. He declares "that there is an absolute consensus of opinion both among the executive and medical officers of late Arctic expeditions in regard to the judicious use of alcoholic beverages," and that though himself of abstemious habits, yet the facts observed "warrant him in testifying to the undeniable good effects of whisky when served out to the crew after unusual fatigue and exposure." On reaching St. Lawrence Bay, Siberia, a native speaking a little English was at his own request taken on board; the bustle and stir brought on a state of sleeplessness, and his state of mind was not improved on seeing the collection of skulls on board, nor by the chaff of the forecastle men, who tried to persuade him he was to be brought to San Francisco as an anatomical curiosity. As a result he stabbed himself dangerously in the left chest, and then leaped overboard; a boat being alongside, he was promptly rescued. The knife was found to have entered several inches, and blood and air were escaping from the wound. The symptoms were such that, writes Dr. Rosse, "the patient ought to have promptly perished, notwithstanding the treatment," but in a few days the patient was landed at Plover Bay, where he recovered sufficiently to start on foot for his home over a rugged mountain way 150 miles distant. "Wounds seem to heal uncommonly well in the Arctic, a fact doubtless owing to the highly ozonised condition of the atmosphere, and the absence of disease germs and organic dust."

Dr. Rosse's anthropological notes on the natives met with are of some importance, though his conclusions based on these may not always be acceptable. Referring to the prevalence of tattooing among the Esquimaux women, he gives a figure of strange design seen on the cheeks of a woman of St. Lawrence Island. Some drawings of crania are given, but we have failed to find any detailed account of them.

The botanical notes on Alaska are by John Muir. There is no line of perpetual snow on any portion of the Arctic regions known to explorers. Every summer the snow disappears not only from the low sandy shores and boggy tundras, but also from the mountain tops; for nearly three-fourths of the year the plants lie buried under it, but they awake up in June and July to a vigorous growth, and on the drier banks and hills about Kotzebue Sound, Cape Lisbourne, and elsewhere, many species show but little climatic repression, growing during the long summer's day tall enough to wave in the wind, and to unfold a rich profusion of flowers. A list of the species found at the following localities is given—St. Michael's, Golovin Bay, Kotzebue Sound, and Cape Thompson, where a new species of Erigeron was found (*E. muirii*, Gray). On Herald Island sixteen species of flowering plants were gathered. At Wrangel Island, from an area of about half a square mile, twenty-seven species of flowering plants were collected; they all occurred in separate tufts, leaving the ground between them bare and raw as that of a newly ploughed field. Some portions of the coast, however, farther south, presented a greenish hue, as seen from the ship, at a distance of eight or ten miles, owing no doubt to vegetation growing under less unfavourable conditions than at the point the *Corwin* touched at.

The birds of Behring's Sea and the Arctic Ocean are described by Mr. E. W. Nelson; many of the breeding quarters of North American birds are given, and details are also added of some of the rarer forms met with. A fine adult male Siberian Wagtail (*Motacilla ocularis*, Swinhoe) was taken at Plover Bay the last day of June; it was in perfect breeding plumage. A specimen of *Lanius cristatus* was picked up dead on Wrangel Island. Strictly an Asiatic bird, it must have reached this distant spot during some storm, and died of starvation or exposure. A fine adult female, in breeding plumage, of *Eurinorhynchus pygmæus*, was taken at Plover Bay, and several others were seen. A specimen of *Rhodostethia rosea* in immature plumage was obtained at St. Michael's, and reference is made to three fine specimens secured by Mr. Newcomb during the drift of the *Jeannette*, which are now in the Smithsonian collection, one of which still retains its extremely rich peach-blossom pink so characteristic of this the most beautiful of the gulls.

[1] "Cruise of the Revenue Steamer *Corwin* in Alaska and the North-West Arctic Ocean in 1881. Notes and Memoranda, Medical and Anthropological, Botanical and Ornithological." (Washington: Government Printing Office, 1883.)

A list of the fishes known to occur in the Arctic Ocean, north of Behring's Straits, by Tarleton H. Bean, is appended. The list is based exclusively upon specimens in the United States National Museum, and is acknowledged to be incomplete; it only contains twenty-one species, eight others being added as "properly belonging to the fauna." No details beyond the localities where found are given.

SOUND-MILLS

AFTER the notable researches of Crookes on radiation, which culminated in the discovery of the radiometer, or light-mill, it was a natural transition of thought which suggested to several minds almost simultaneously the possibility of devising an apparatus which should rotate under the influence of sound-waves as does the radiometer under the influence of the rays of light and heat. Such instruments were indeed devised independently about six years ago by Lord Rayleigh, by Prof. Alfred M. Mayer of Hoboken, by Mr. Edison, the well-known inventor, by Prof. Mach of Prague, by Dr. A. Haberditzel of Vienna, and by Prof. V. Dvorák of the University of Agram (in Croatia). These researches, though of great scientific interest, have been somewhat overlooked in the rush of scientific inventions during the intervening years. During the course of the past year, however, Dr. Dvorák has given to the world, in the pages of the *Zeitschrift der Instrumentenkunde* (vol. iii. Heft 4), a detailed account of his experiments, together with figures of various pieces of apparatus hitherto undescribed. We propose to give a *résumé* of the principal points of Dvorák's researches.

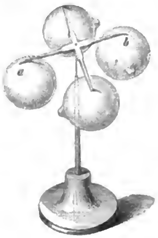


Fig. 1.

Fig. 2

Four kinds of sound-mills are described by Dvorák, two of them depending on the repulsion of resonant-boxes or cases, and two others on different principles.

The first of these instruments is depicted in Fig. 1, and consists of a light wooden cross, balanced on a needle point, carrying four light resonators made of glass. These resonators are hollow balls of 4·4 cms. diameter, with an opening of 0·4 cm. at one side. They respond to the note g' (=392 vibrations). When the note g' is forcibly sounded by an appropriate tuning-fork, the air in each of the resonators vibrates in response, and the apparatus begins to rotate. As a resonator will respond when placed in any position with respect to the source of sound, it is clear that one single resonator properly balanced should rotate; and this is found to be the case, though, naturally, the action is more certain with four resonators than with one.

Before proceeding to the other forms of sound-mill devised by Dvorák, it may be well to explain briefly the cause of the phenomenon, and to describe Dvorák's particular method of exciting the appropriate sound Dvorák has pointed out, as indeed has been done elsewhere both by Lord Rayleigh and by Prof. A. M. Mayer, that, when sounds of great intensity are produced, the calculations which are usually only carried to the first order of approximation cease to be adequate, because now the amplitude of motion of the particles in the sound-wave is not infinitely small as compared with the lengths of the sound-waves themselves. Mathematical analysis shows that under these circumstances the mean of the pressures in the condensed part and in the rarefied part of the sound-wave is no longer equal to the undisturbed atmospheric pressure, but is always greater. Consequently at all nodal points in the vibrations of the air in tubes or resonant-boxes the pressure of the air is greater than elsewhere; and therefore any resonator closed at one side and open at the other is urged along bodily by the slight internal excess of pressure on the closed end. The apparatus, Fig. 1, therefore rotates by reaction, in the same way as Hero's primitive steam-engine rotated, though the reaction is due to a different cause.

To produce vibrations of sufficient intensity Dr. Dvorák employs heavy tuning-forks mounted on resonant-cases, and excited electrically. For this purpose he places between the prongs of the fork an electromagnet constructed on the following plan. Two plates of iron separated by a sheet of paper are used as a core. They

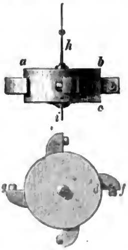


Fig. 3.

are cut of such a breadth as to lie between the prongs without touching them. This core is overwound with insulated copper wire, as shown at E, Fig. 2, and the electromagnet is then mounted by a bent piece of wood, *abc*, upon the sounding-box, K, of the fork. The wires are connected in a circuit with a battery, and with the electromagnet of a self-exciting tuning-fork of the same note. Dr. Dvorák is extremely particular about the arrangements of the resonant-boxes of his tuning-forks. They must not touch the table, the arm *a b c* being clipped at about the point *b* in a firm support. Moreover the resonant-boxes themselves require to be specially tuned, for all are not equally good. Dr. Dvorák points out that, beside the tone of the fork, and the tone of the air column in the cavity of the box, there is also a tone proper to the wood of the box itself, which in most of the forks used in acoustic researches is too base, the wooden walls being too thin. To hear this tone the prongs of the fork should be damped by sticking a cork between them, and the cavity should be filled with cotton-wool, while the wooden box is gently struck with the knuckle or with a cork hammer. It is important that the wood-tone should be tuned up to coincidence with the tone of the fork and with that of the air in the cavity. Dr. Dvorák himself used the box depicted further on in Fig. 6, in which drawing F is the socket into which the stem of the fork was screwed. The wood was tuned by planing it away at the top and bottom, while the air cavity was tuned by enlarging the circular opening in front. In the later researches the box stood on four feet made of india-rubber tubing. The note of the fork so mounted was very strong. At 40 cms. distance it would set the sound-mill in motion.

Dvorák's second apparatus, a "rotating resonator," consists of a short cylindrical box, constructed of stiff glazed paper, having four projections, shown in plan and elevation in Fig. 3, each of which bears at its side a short open tube of paper. It is, in fact, a resonator with four openings, arranged so that it can be hung upon a silk fibre. A fine needle projects also below to steady the

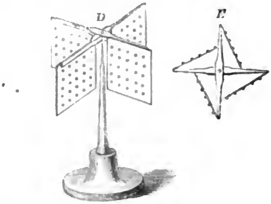


FIG. 4

motion during its rotation, which occurs whenever the apparatus is brought near to the sounding-fork. For the note g' the dimensions were: diameter, 7 cms.; height, 3·6 cms.; diameter of openings, 0·6 cm.

The third apparatus is the "sound-radiometer" described by Dvorák before the Imperial Viennese Academy in 1881. Its cause of action is less readily explained, though its construction is even more simple. Its form is shown in Fig. 4, D; there being, as before, a light cross of wood, pivoted by a glass cap upon a vertical needle. To the four arms of the cross are cemented four pieces of fine white card, about 0·08 cm. thick, perforated with holes which are depressed conically at one side, and raised at the other. These holes may be made by punch-

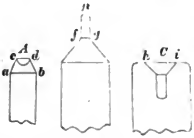


FIG. 5.

ing the card upon a lead block with a steel perforating-punch of the form shown in Fig. 5, A, the dimensions of which are: $ab = 0·38$ cm.; $cd = 0·2$ cm. The holes should be from 0·6 to 0·65 cm. apart from one another. When a card so perforated is held in front of the opening of the resonant-box of the tuning-fork it is repelled if the smaller ends of the conical holes are toward the box; or is attracted if the wider openings are toward the box. A better, but less simple, way of perforating the cards is by the use of the conical steel punch shown in Fig. 5, B, and the matrix, Fig. 5, C. The angle of the cone is 55°, and the narrow projecting nose of steel is 0·2 cm. The card should be damped, laid on the matrix C, and the hole pierced by two or three blows upon the die. Dr. Dvorák prefers this plan: it throws up a high burr or edge behind the conical hole, and such perforations are more effective. The cards may be varnished, and are then mounted upon the cross. The rotations are more rapid if the cards are set on obliquely in the fashion shown in Fig. 4, E, the burred sides being outwards. Cards with twenty-five perforations so mounted rotate briskly when the "mill" is set in front of the resonant-box.

The fourth apparatus of Dvorák is called by him an "acoustic anemometer." It is shown in Fig. 6. This is merely a little "mill" of simple construction, the vanes being small pieces of stiff paper or card slightly curved. The sounding-box previously described is placed a little way from it, and between them is held an ordinary Helmholtz's resonator, with its wide mouth, b, turned toward the box, and its narrow opening, a, toward the mill. From what has been previously said it will be understood that the internal increase of pressure in the resonator at a has the effect of driving a jet of air gently against the sails of the mill, which consequently rotates. Dr. Dvorák also suggests that this two-aperture resonator may be replaced by one having but one aperture, as shown at R, with its

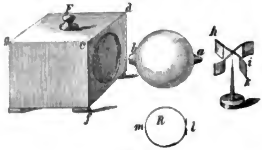


FIG. 6.

open side, l, turned towards the mill. This resonator is formed of a glass ball cut away at one side and cemented to a glass plate having a small hole at the centre. It may be remarked that when the air ejected from the mouth of this resonator is examined by the method of mixing smoke with it, and then viewing it through slits cut in a rotating disk, the currents are seen to consist of a series of vortex-rings.

A second kind of "acoustic anemometer" may be made by taking a card pierced with too conical holes, as previously described, and placing this between the resonant-box and the "mill." The latter rotates in the wind which passes through the conical holes.

Space does not admit of a comparison being drawn between these instruments and those of Mayer, Mach, and others, which are very closely akin in their design and mode of action, interesting though such a comparison might be. Nor can we here compare the action of these instruments with the "phonomotor" with which Mr. Edison literally accomplished the feat of talking a hole through a deal board. But this remarkable machine was a purely mechanical toy, which converted the vibrations of the voice, by means of a very finely-cut ratchet-wheel, into a motion of rotation round an axis.

SILVANUS P. THOMPSON

NOTES

IN the last week British science has sustained a great loss in the death of Mr. Thomas Chenery, the editor of the *Times*. During his all too short reign the leading journal of Europe has been in strict harmony with the real progress of humanity, instead of being merely a chronicle of "politics" and "society," and day by day it has been wonderful to watch with what continuous well-balanced vigour and skill the general public has been made interested in the victories achieved in the domains of science, literature, and art, as only a daily journal can interest it.

Never before in the history of daily journalism in any country did science receive the recognition which Mr. Chenery accorded to it. Mr. Chenery was not only a great scholar, but the nearest approximation to an admirable Crichton that we have known, and in this we find the secret of his skill as an editor. So many-sided was he that whether teaching Arabic at Oxford as Lord Almoner's Professor; taking his part in the revision of the Old Testament; acting as Special Correspondent in the trenches in the Crimea; at his post as Editor of the *Times* or in private life, he won the admiration of all who knew him by his deep knowledge and splendid modesty. He was a perfect friend, and gained the respect and love of all who came into contact with him.

DR. JOHN HUTTON BALFOUR, Emeritus Professor of Medicine and Botany in the University of Edinburgh, Regius Keeper of the Royal Botanic Garden, and Queen's Botanist for Scotland, died on Monday at Inverleith House, Edinburgh. He was born in 1808. Dr. Balfour was the father of Prof. Bayley Balfour, whose appointment to the vacant Chair of Botany at Oxford we announce to-day. We hope to say more about the late Prof. Balfour next week.

THE death is announced of the distinguished American geographer, Prof. Arnold Henry Guyot. He was born at Neuchâtel, Switzerland, on September 28, 1807. He studied at Neuchâtel, Stuttgart, and Carlsruhe, and at the last-named place formed a close friendship with Agassiz, with whom he studied natural science. In a tour through Switzerland in 1838 he first discovered the laminated structure of the ice in glaciers, and showed that the motion of the glacier is due to the displacement of its molecules. Agassiz, Forbes, and others afterwards confirmed these discoveries. For seven successive summers Guyot now investigated the distribution of erratic boulders, tracing them on both sides of the Central Alps, in Switzerland and Italy, over a surface 300 miles long and 200 miles wide, and delineating eleven different regions of rocks. Their vertical limits and the laws of their descent were determined by means of more than 3000 barometrical observations; and the characteristic species of rock of each basin were tracked step by step to their source. In the United States he was employed by the Massachusetts Board of Education to deliver lectures in the normal schools of the State, and before the teachers' institutes, and by the Smithsonian Institution to organise a system of meteorological observations. In 1855 Guyot was appointed Professor of Physical Geography in the College of New Jersey at Princeton, which post he retained till his death. He was awarded a medal for his researches at the Vienna International Exhibition of 1873.

THE Royal Society has appointed a committee, consisting of Sir F. Evans, Prof. Judd, Mr. Lockyer, Mr. R. H. Scott, General Strachey, and Mr. G. J. Symons, with power to add to their number, to collect the various accounts of the volcanic eruption at Krakatoa, and attendant phenomena, in such form as shall best provide for their preservation and promote their usefulness; and a sum of 25*l*. has been placed at their disposal for this purpose. In connection with this we direct attention to the letter of Mr. Symons in our Correspondence Columns.

THE following note has been sent us from the Meteorological Office:—"We have received notice of the establishment of a system of storm and weather warnings on the Spanish coast. The warnings are based upon observations received from stations reporting daily by telegraph to the Marine Observatory at San Fernando, which is superintended by Capt. C. Pujazon of the Spanish Navy. This institution also issues a daily weather report and chart."

THE "Johns Hopkins University Circulars" have become an important medium for communicating briefly the results of research in all departments in connection with the many-sided institution which issues them. Doubtless they are to be found at the leading scientific centres in this country, and are always well worth looking into. The number for January contains a brief report of the meetings in connection with the departure of Prof. Sylvester from America; how highly he was appreciated there is evident from the following:—On the afternoon of December 20 the academic staff of the University met in Hopkins Hall, by invitation of the President, and after a brief review by Dr. Story of the mathematical lectures here given from 1876 to 1883, and a like review by Dr. Craig of the contributions printed in the *American Journal of Mathematics*, Prof. Gildersleeve read the following paper, which, on motion of Prof. Rowland, was adopted by the meeting as an expression of their respect and good will. "The teachers of the Johns Hopkins University, in bidding farewell to their illustrious colleague, Prof. Sylvester, desire to give united expression to their appreciation of the eminent services he has rendered the University from the beginning of its actual work. To the new foundation he brought the assured renown of one of the great mathematical names of our day, and by his presence alone made Baltimore a great centre of mathematical research. To the work of his own department he brought an energy and a devotion that have quickened and informed mathematical study not only in America, but all over the world; to the workers of the University, whether within his own field or without, the example of reverent love of truth and of knowledge for its own sake, the example of a life consecrated to the highest intellectual aims. To the presence, the work, the example of such a master as Prof. Sylvester, the teachers of the Johns Hopkins University all owe, each in his own measure, guidance, help, inspiration; and in grateful recognition of all that he has done for them, and through them for the University, they wish for him a long and happy continuance of his work in his native land; for themselves the power of transmitting to others that reverence for the ideal which he has done so much to make the dominant characteristic of this University."

AN ascent of Ben Nevis was made on Monday by Mr. C. D. Cunningham, a member of the Alpine Club, accompanied by M. Emile Rey, a Swiss guide, and John Cameron, the well-known guide at Fort William. There were about six inches of snow on the ground from the commencement of the new road to the Red Burn. Here considerable difficulty was experienced in crossing the Burn and arriving on the top of the opposite bank, owing to the great quantity of snow which had drifted into the watercourse. From the well to the summit the ground, covered with deep snow, was hard frozen, making the task comparatively easy. Mr. Omond and his companions at the Observatory appeared in good health and spirits, and entertained the party in the most hospitable manner. The ascent occupied three hours thirty-five minutes, and the descent two hours.

THE estimates submitted to the Dominion Parliament include (says a Reuter's telegram from Ottawa) the sum of 25,000 dollars for the expenses connected with the meeting of the British Association at Montreal this year.

THE German Cholera Commission has sent a fifth report from Calcutta, dated January 5. Dr. Koch seems to have really discovered special cholera bacilli. The Commission was further occupied with the investigation into the causes of the great decrease in cholera mortality in Calcutta, where the percentage of deaths per thousand has diminished from ten to three. This diminution is attributed to the improvement of the water supply.

THE Nautical Meteorological Office of Sweden maintains at present nineteen stations at which meteorological observations are made on a large scale, twenty stations for measuring the fall of rain and snow, and sixteen hydrographical observatories. Weather journals were last year received from eleven men-of-war and fifteen merchantmen. The Meteorological Office in London having requested that of Sweden to forward as complete journals as possible of the meteorological phenomena of the North Atlantic Ocean between August 1, 1882, and September 1, 1883, the Office has made a careful abstract of these journals for this purpose.

THE consistory of the Upsala University has voted a sum of about 200*l*. for the purchase of objects of natural history for the University collected by the *savants* of the *Vanadis* Expedition round the world, now taking place.

On January 14 a "green" moon was observed at Kalmar in Sweden. At about 5 p.m., just after the sun had set, leaving an intense purple glow on the sky—more intense than the late sun-glows—the moon came out of a layer of heavy clouds in the east. A few seconds after—the disk being then perfectly clear—a light haze gathered around it, partly veiling it, which immediately changed the bright silver colour to an emerald green. The phenomenon lasted for three minutes, when the disk again by degrees assumed its former brightness. A similar phenomenon was observed near Stockholm on January 17 at about 8 o'clock in the morning. It lasted about three minutes.

THE Council of the Royal Meteorological Society have arranged to hold, at 25, Great George Street, S.W., by permission of the President and Council of the Institution of Civil Engineers, on the evening of March 19 next, an Exhibition of Thermometers. The Committee will also be glad to show any new meteorological apparatus invented or first constructed since last March; as well as photographs and drawings possessing meteorological interest.

A SPECIAL meeting of the Committee of the Sunday Society was held on Monday afternoon, February 4, at 9, Conduit Street, W., Prof. W. H. Corfield, M.D., in the chair. The Honorary Secretary submitted a Report on the recent voting as to the future political action of the Society, from which it appeared that 391 had voted in favour of making the Sunday opening of museums a test question at elections of Members of Parliament, and that 470 voted against this proposal; 853 voted in favour of making the question the subject of an annual motion in the House of Commons, and only 11 voted against this proposal. Resolutions were subsequently passed pledging the Society to action in accordance with these results.

LIKE its better known namesake in the metropolis, the Royal Institution, Liverpool, has done much to popularise scientific knowledge during the present century. So far back as 1820 it first gave a permanent home to a scientific society in Liverpool, by admitting the Literary and Philosophical Society to share its roof, for the purpose, say the Minutes, "of extending the knowledge of arts and sciences." Since then the number of societies with scientific aims has steadily grown in Liverpool, and the number of members composing them to some extent increased as steadily. The accommodation of the Institution is found to be limited, and the idea of devoting the whole of the available space for the purpose of meetings is beginning to take definite shape, and was supported by Mr. Morton, F.G.S., in his presidential address last week. A very large part of the building is occupied by the museum, which was formerly the most important in Liverpool; for many years not less than 30,000 persons visited it on free days annually; this number was maintained up to 1868–69, when it all at once fell off; last year the number was only 4489, of whom only 1019 visited the natural history collections. This diminution of interest was coincident with the opening of the Free Public Museum. In 1817 the Institution disposed of the mammalia, reptiles, fishes, crustacea, polyzoa, and corals in the museum, and it is thought desirable that the remaining collections of interest and *local character* should be absorbed into the Corporation Museum. The Institution has schools which are in an exceedingly prosperous condition, and its library has a large collection of standard works in natural science.

IN a letter on the remarkable sunsets from Mr. S. E. Bishop, dated Honolulu, January 15, the writer mentions the important fact that the reddish haze was seen 4000 miles west of Panama on September 3 from the barque *Southard-Hurlburt*.

THE Worshipful Company of Clothworkers has been pleased to grant a donation of 21*l*. to the National Health Society, 44, Berners Street.

A PROPOSITION has been presented to the Municipal Council of Paris to give the name of Darwin to a new street about to be opened.

THE Hotel Dieu, Paris, having Gramme machines and steam-engine, the Administration of the Assistance Publique has decided to introduce experimentally the use of Edison incandescent lights in the halls inhabited by patients. The Hotel Dieu is the largest and the leading French hospital.

THE French Minister of Public Instruction will organise in Paris an exhibition of the objects which have been collected at Cape Horn by the *Romanche*. The collection is composed of 170 cases of valuable specimens of mineralogy, geology, and zoology, as well as living plants which will be acclimatised as far as possible in French forests.

THE International Association of Electricians, of which we have announced the creation in Paris, will hold its monthly sittings at the rooms of the Society of Geography. The first took place at the beginning of this month. The first part of the *Transactions* of the Association has reached us.

A NEW popular scientific paper has been published in Paris entitled *Le Mouvement Scientifique*.

THE Aristotelian Society for the Systematic Study of Philosophy will meet henceforth in the rooms of the Royal Asiatic Society, 22, Albemarle Street, W.

SHORTLY before sunset on Tuesday evening when the whole of the population of Notaresco, in the Abruzzo, had retired within doors on account of the intense cold, a shock of earthquake was felt, of such severity that the people rushed headlong into the streets and remained there until after midnight. The shock was also felt at Atri, Guilianova, Avellino, and Città Sant' Angelo. A violent earthquake also occurred on the 10th inst. in the district of Birvari, Province of Bitlis, Turkey. A large number of houses and other buildings were thrown down.

MOUNT ETNA has, since Saturday, entered into an eruptive stage by throwing out ashes from the topmost crater. Strong earthquake shocks in the districts around the mountain preceded the outbreak.

AN unusually bright meteor was seen in Western Germany on January 28, about 7.30 p.m. At Barmen its motion seemed to be from east to west, while at Neuwied south to north was the direction. Its brilliancy is generally compared to that of the full moon.

AT the last meeting of the Berlin Anthropological Society, Prof. Nehring reported on the discovery of a cave near the village of Holzen (Brunswick), which is of special interest, inasmuch as there is strong evidence of cannibalism among the ancient cave men of that place, the first time that such evidence is forthcoming concerning the prehistoric inhabitants of what is now Germany. In Belgium and Spain similar evidence had been found, but had been dismissed as doubtful. The bone remains of the Holzen cave are not completely calcined; at the same time there is proof that the bones were opened to get at the marrow. But the strongest evidence of cannibalism was furnished by the arrangement in which the bones were found. Besides these bones and bone implements, roughly worked bronzes were found. At a lower level numerous lemming bones were found, which, with regard to the age of the cavern, seems to point to the Glacial epoch. In the debate following Prof. Nehring's report, Prof. Virchow raised some doubts regarding the cannibalism of the cave dwellers.

A MEETING of delegates of Natural History Societies in the east of Scotland (including the counties of Fife, Perth, Forfar, Kincardine, and Aberdeen) was held in the lecture-room of the Perthshire Natural History Museum, Perth, on Nebruary 9, to consider the question of federation alluded to in NATURE. The following societies were represented:—Aberdeen Natural History Society, Alford Field Club and Scientific Society, Arbroath Horticultural and Natural History Association, Dundee Naturalists' Society, Dundee Naturalists' Field Club, Kirkcaldy Naturalists' Society, Largo Field Naturalists' Society, Montrose Natural History and Antiquarian Society, and the Perthshire Society of Natural Science—being all but four of the Societies in the above mentioned counties. Two of these four societies considered that their objects did not quite entitle them to join the proposed federation, at least for the present; and from the other two no response had been received. After deliberation it was resolved to federate the societies under the title of "The East of Scotland Union of Naturalists' Societies." The objects of the Union are the promotion of good and systematic work by the various societies in it, and of friendly intercourse amongst their members; its affairs are to be conducted by a council of representative members, two being elected by each society. The president is to be a man of scientific eminence, connected with the district; and it is to hold an annual general meeting at the headquarters of the various societies in rotation, and other meetings in such places in the district as may be agreed on. The Union starts with a membership of about 1300. It was determined that the first general meeting should be held in Dundee on June 6 and 7 next. Dr. Buchanan White, F.L.S., was elected President, and Mr. F. W. Young, F.R.S.E., Hon. Secretary of the Dundee Naturalists' Society, was appointed Secretary.

WE learn from *Science* that Mr. Joseph Wharton of Philadelphia writes to the *Public Ledger* of that city (January 22) that he has found volcanic glassy dust in fresh, clean snow of recent fall. The snow, melted under cover in the porcelain vessel it was gathered in, showed at first no sediment; but after a time, and aided by a gentle rotatory movement which brought all to the deepest point, a slight deposit appeared. By pouring off most of the water, and evaporating the remainder, a little dry dust was obtained, which, even to the naked eye, showed, in the sunlight, tiny vitreous reflections. The dust weighed by estimate a hundredth of a grain, and showed under the microscope the characteristics of volcanic glass. It was partly irregular, flat, and blobby fragments, and partly filaments more or less contorted, which were sometimes attached together in little wisps, and were mostly sprinkled with minute glass particles. Under a knife-edge the filaments broke easily and cleanly. The irregular fragments were of various sizes and shapes, mostly transparent, but, even when examined by strong transmitted light, showing no trace of crystalline structure. Their diameter was about that of single filaments of silk. No crystalline particle of pyroxine, or black crumb of augite, such as observers have found elsewhere in similar dust, was present; nor did a strong magnet stir any particles of magnetic oxide of iron, though they also have been found in other volcanic dust. It may fairly be assumed that those heavier minerals, if at first mingled with the volcanic glass, had been already deposited during the long voyage through more than ten thousand miles of space and more than four months of time, while the tenuity of the intrinsically lighter glass threads (the Pele's hair of Mauna Loa) enabled them to float farther from the point of eruption.

"THE International Conference for fixing upon a universal prime meridian and a universal system of time has," *Science* states, "at length been called by the State Department to meet in Washington, Oct. 1. Diplomatic proceedings are always expected to go on with a certain dignified leisure; but the arrangements for the meeting of this conference have been delayed far beyond anything customary even in diplomacy. The act authorising the conference became a law in August, 1882. As there was some doubt whether there would be a sufficiently general response to the invitation to insure the success of the conference, a preliminary circular requesting the views of the various governments interested, and an expression of their willingness to enter the conference, was issued from the State Department toward the end of 1882. The responses were in some cases favourable, and in others negative or undecided. A desire was felt by the Europeans to have a preliminary discussion of the subject at the International Geodetic Conference at Rome in October, 1883. The feeling at this conference having shown that there would be little difficulty in the universal adoption of the Greenwich meridian, the final step of calling the conference was taken. Why so late a date was chosen we are not informed."

THE Magdeburg Wetter Verein has been transformed into a branch of the general German Meteorological Society, which is under the direction of Dr. Neumayer of Hamburg.

THE valuable ethnological collection made by Herr Zembsch at Apia, for many years German Consul-General at that place, has been purchased by the Ethnological Museum at Berlin. It consists of over 500 specimens.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius* ♀) from South Africa, presented by Col. Gildea; a Macaque Monkey (*Macacus cynomolgus* ♂) a Black Kite (*Milvus migrans*) from India, presented by Mr. John M. Hagerman; a Common Hedgehog (*Erinaceus europaeus*), British, presented by Mr. Archibald Aitchinson; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. J. Wilson; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Capt. F. R. Slater; two Common Jackdaws (*Pica rustica*), British, presented by Master Harrott; a Chanting Hawk (*Melierax musicus*) from South Africa, a Partridge Bronze-winged Pigeon (*Geophaps scripta*) from New South Wales, purchased.

OUR ASTRONOMICAL COLUMN

PONS' COMET.—It appears that this comet was sufficiently conspicuous to attract the attention of unscientific passengers on board one of our mail steamships in approaching Rio de Janeiro from the south on January 20, while it was an object of popular interest in Southern Italy towards the end of that month, according to the Naples correspondent of the *Times*. Observers in the other hemisphere may be able to follow it for several months longer; in the last week in June the theoretical intensity of light will be equal to that at the date of its discovery by Mr. Brooks.

This comet approaches the orbit of Venus within 0·076; that of Jupiter within 1·98; and that of Uranus within 1·17. The ascending node falls at a distance of 15·46. During the revolution 1812–1884, the calculations of MM. Schulhof and Bossert show that the approximate effect of planetary attraction upon the periodic time, at the instant of perihelion passage in the former year, has been as follows:—

	Days
Comet accelerated by action of Jupiter	446·49
,, ,, ,, Saturn	13·96
Comet retarded by action of Uranus	13·48
,, ,, ,, Neptune	1·48

Hence the period of revolution in 1812 has been shortened by perturbation to the extent of 445·49 days. The orbital velocity of the comet at perihelion is 29·2 miles in a second, at aphelion it is 3550 feet in the same time.

THE GLASGOW CATALOGUE OF STARS.—Prof. Grant has just issued the important catalogue of stars which has been for some time in active preparation at the Observatory of Glasgow, and towards the publication of which the Royal Society has largely contributed from the Government Grant Fund. Its appearance is too recent to allow of a description of the contents in the present column.

THE VARIABLE STAR U GEMINORUM.—Mr. G. Knott, writing from Cuckfield on the 4th inst., sends observations of a recent maximum of this star; his estimates are:—

	h. m.			h. m.	
Jan. 24,	8 10	... 13·3 m.	Jan. 28,	8 15	... 9·95 m.
26,	9 50	... 9·6	30,	9 0	... 11·4
27,	8 53	... 9·7	Feb. 2,	7 20	... 13·9

Clouds prevented observation on January 25, but it is quite possible that the maximum may have been attained on that day, since in 1877 the star increased from 13·2 m. to 9·8 m. between February 20, 8h. 10m., and February 21, 10h. 30m. The last previous maximum observed by Mr. Knott fell on January 30, 1883, the date also assigned by the observations of M. Safarik (*Astron. Nach.* No. 2505).

The period which best represented the observations in the years immediately following the discovery of the star's variability by Mr. Hind (in December 1855) was 97 days, but there has been subsequently great irregularity, and according to Mr. Knott it has fluctuated between 71 and 126 days, though the values on the whole cluster about a mean of from 90 to 100 days; the limits of variation being about 14½ and 9¼ of Argelander's scale. These inferences are drawn from thirty-four maxima, observed partly by Mr. Knott and partly by Mr. Baxendell (see the *Observatory*, April, 1882).

THE LATE J. F. JULIUS SCHMIDT.—Practical astronomy has sustained a serious loss in the sudden death of the well-known Prof. Julius Schmidt, who has been for many years Director of the Observatory at Athens. According to a Reuter's telegram his funeral, which took place on the 8th inst., was of a public character, the King and Queen of Greece being present at the Observatory during the delivery of the funeral oration. A notice of Prof. Schmidt's long-continued astronomical labours must be deferred to another week.

THE ROYAL SOCIETY OF EDINBURGH

AT the meeting of this Society on the 4th inst., the President, Lord Moncreiff, delivered an address on "The Past Hundred Years' History of the Society." Regarding this long interval, Lord Moncreiff said: "From the watch-tower of the Royal Society I can trace within the century a revolution more wonderful and more extensive than monarchs, or empires, or republics can display. Since this Society held its first meeting, how great to the community has been the fruit gathered from those branches of knowledge which it was incorporated to prosecute! During that interval, what has science not done for human comfort and happiness? What interest so great, what dwelling so humble, as not to have felt its beneficent influence? Since the invention of the art of printing, no such advance in material comfort, prosperity, and intelligence has ever been made within a similar period as this century has witnessed. Its triumphs have not been confined to the more abstruse fields of thought and study, but have come straight to the world of every-day life. One homely illustration meets me on the threshold of the opening night, and homely things go deep into the foundations of human life. I picture to myself our founders wending their way to the College Library, through close and wynd, in mid-winter 1783, while flickering oil lamps made the darkness visible without, and a detestable tallow candle made the student miserable within doors. Those who cannot recollect the universal reign of tallow candles and their sufferers, cannot appreciate how much the sum of human enjoyment has been enhanced, and the tranquillity of human temper increased, by the transmutation—partial, we must admit—of darkness into light. There has been, I believe, no more potent agent in humanising the denizens of our large cities than the flood of light which chemical science has in our day poured into their recesses. Prophets tell us that, before the end of the century which we now begin, gaslight will probably have followed the tallow candle into the same unlamented obscurity; but, even should this be so, history will carry to its credit the vast amount of public utility, and the many hours of useful employment or comfort in the factory, the study, or the sick-room, which this simple application of chemical science gained in its day for the nineteenth century. But the dispersion of material darkness is but a slender illustration of the triumphs of scientific discovery. Time and space are no longer the tyrants they were in 1783. I rather think that when our founders first met they could hardly hope to hear by post from London under ten days, as Palmer's mail coaches had not begun to run until 1789. It would be an interesting inquiry, if my limits permitted, to trace the moral and social effects of the change from the days when a London letter took even three days to reach Edinburgh, and cost 13½d.—the pre-Macadamite days, when twenty miles a day was a fair posting rate on any roads but the main thoroughfares. Lord Cockburn lamented over the prospect of London being within fifteen hours of Edinburgh, as endangering the characteristics of our social community. His sagacity was not altogether at fault, but even that time has been reduced by a third, and I rather think we and the world are all the better for the change. But although larger victories were in store for the century, they came slowly. Both Boulton and James Watt were original members of the Royal Society, but it was more than thirty years before steam navigation became general, and more than fifty before the first passenger railway train ran in Scotland. No doubt, in 1791, Erasmus Darwin, in his 'Botanic Garden,' a poem too little read, had exclaimed in the well-known lines:—

'Soon shall thy arm, unconquered steam, afar,
Drag the slow barge, and urge the flying car.'

Godwin, too, looked forward with confidence to the ultimate victories of steam. Now, the locomotive carries mankind to all ends of the earth; their sanguine suggestions have been all but realised. There has been during this interval a still more powerful magician at work. To this audience I need not dwell on the triumphs of the future ruler of the world of science—electricity. But one illustration I may be permitted. Franklin was one of the first of the non-resident members elected by the Royal Society of Edinburgh. How little he thought when, many years before, he drew the electric spark from the cloud, that, before 100 years had sped, his experiment, but slightly modified, might convey a message from a meeting of the Society in Edinburgh to one of its fellows in New York, and bring back an answer before the meeting separated. In slightly alluding to this scientific revolution, my object has been partly to illustrate the surroundings of 1783, and also to remind my hearers that, of all the changes the century has seen, far the most important and the deepest have been the work of science. Increased facilities for inter-communication carry with them a complete change in the economical and social condition of the communities they affect. New wants, new customs, new ambitions, new possibilities, follow in their train by the operation of inevitable laws. By this talisman we have seen, perhaps sometimes without due appreciation, many a social problem solved which had before seemed hopeless; and although in the process of transition some period of adaptation may be necessary, and some temporary hardships endured, the result in all cases must be beneficent, and is, at all events, beyond the power of lawgivers to control or to resist.

"The Edinburgh Royal Society sprung partly out of the example of the Royal Society of London. But its immediate antecedent was the Philosophical Society, which had been founded nearly fifty years before by the celebrated McLaurin, and contained many distinguished names. Lord Kames became its president, and raised it to considerable distinction, both in science and literature, although that vigorous and versatile thinker and writer did not live to witness the commencement of the new institution. Dr. Robertson's plan was to absorb this Society and all its members in a new institute, on the model of the Berlin Academy of Sciences, for the prosecution both of physical science and of literature. The charter, however, was not obtained without some controversy, for, even as Romulus and Remus quarrelled over the boundaries of unbuilt Rome, so did the Philosophical and the Antiquaries squabble over the charter of the Royal Society. The Antiquaries wanted a charter of their own; Dr. Robertson thought Scotland not wide enough for two such institutions; the feud ran high, and great was the "dust," as Prof. Dalzel calls it, which was raised by Lord Buchan on the occasion. Some notice of this dispute will be found from the Antiquaries' side of the question in the recent life of Henry Erskine; and it is also alluded to in Mr. Cosmo Innes' work, where a letter is quoted from the energetic Professor of Greek couched in terms more forcible than philosophical. But it is certainly time to bury such feuds when they come to be a hundred years old. I find, from the minutes of the first meeting, that the Society was of opinion that the College Library was an inconvenient place for their usual meetings, and a committee was appointed to find one more suitable, apparently without success, for they continued to be held in the Library for twenty-three years, when the Society migrated to the Physicians' Hall in George Street in 1807. They afterwards purchased No. 40, George Street, in which the meetings were held until they obtained their present rooms in the Royal Institution. At a subsequent meeting, held on August 4, 1783, it was resolved that the Society should divide into two classes, which should meet and deliberate separately, to be called the Physical Class and the Literary Class, with separate office-bearers.

"The first president was Henry, Duke of Buccleuch, who had rendered great assistance in obtaining the charter. The vice-presidents were the Right Hon. Henry Dundas and Sir Thomas Miller, the Lord Justice-Clerk. I forbear to go over the names of what may be called the original members of the Society. I include in that term all who were elected within the first ten years. All the members of the Philosophical were assumed without ballot; the rest, to the number of more than 100, were elected by ballot, and a general invitation was made to the Lords of Session to join. There were the ordinary resident members. There was also a list of non-resident members, which comprised nearly as many. Of the ordinary resident members there is hardly a name which is not known—I might say conspicuous—in the annals of Scotland at that time. Twelve of the Lords of Session accepted the invitation, including the Lord President, the Lord Justice Clerk, and the Lord Chief Baron of the day; upwards of twenty professors, with Principal Robertson at their head; twenty-two members of the bar, including Sir Hay Campbell, the Lord Advocate, and of these at least fourteen rose afterwards to the bench. The medical contingent included Munro, Cullen, Gregory, and Home; and the non-resident list contained the names of the Duke of Buccleuch, the Earl of Morton, the Earl of Bute, the Earl of Selkirk, Lord Daer, James Steuart Mackenzie, the Lord Privy Seal, Sir George Clerk Maxwell of Penicuik, Sir James Hall of Dunglass, and many other familiar names. But I select from the list those of the members on whom fell the burden of the real work; and I venture to say that no city in Europe could have brought together a more distinguished circle. They were—Hay Cambell, Henry Dundas, Joseph Black, James Hutton, John Playfair, Adam Smith, William Robertson, Dugald Stewart, Adam Ferguson, Alexander Monro (*secundus*), James Gregory, Henry Mackenzie, Allan Maconochie, and William Miller of Glenlee. I ought to add to these Sir James Hall of Dunglass, and Sir George Clerk Maxwell of Penicuik, the last of whom died the first year. Some of these names are European; all are celebrated; and these were men who, for the most part, did not merely contribute the lustre of their names to the infant Association, but lent the practical vigour of their great intellectual power to aid in the first steps of its progress. And very soon the impress thus stamped on the Society began to establish its reputation in the world, and it took no undistinguished place among the learned societies of Europe. I find the names of Goethe and Buffon among the original foreign members; and although the events of the next twenty years interrupted our relations with the Continent, by the time the Society had completed the half-century there was scarcely a distinguished *savant* in Europe who had not joined, or been invited into, our ranks.

"In the Physical Class were four men who rose to great positions in the scientific world, and to whom the Society was greatly indebted for their general reputation, and for the vigour and efficiency with which their proceedings commenced. They were James Hutton, Joseph Black, John Playfair, and Dugald Stewart. Hutton and Black were then in the zenith of their fame, and have left a strong impress on the first years of our Society. I am desirous, in this review of the Society's early days, to revert with gratitude and respect to the memory of one whose labours on behalf of the Society were invaluable. Hutton was an observer and a thinker of remarkable originality and power. Black, again, was a Frenchman by birth, although his parents were British, and he was nearly related both to Adam Smith and to Adam Ferguson. He came to Scotland when he was about twelve years old, and, long before the institution of the Royal Society, had risen to the front rank of European chemists—his discoveries on pneumatic chemistry and latent heat having laid the foundation of much that is valuable in subsequent investigations, and opened a course of inquiry pursued with great ability in our own *Transactions* by Leslie, and Brewster, and Forbes." Lord Moncreiff having glanced at some peculiarities of the social meetings of those days between Black, Adam Smith, Hutton, and others, proceeded to speak of Playfair and Dugald Stewart, who by themselves could have raised to distinction any circle to which they belonged. "Both of them were men of great versatility, and, within the walls of the Royal Society, capable of filling a foremost place whether in the fields of abstract science or in those of literature or mental philosophy. Dugald Stewart's contributions to the *Transactions* are not so numerous as those of Playfair; but no man had more influence in moulding the tone and cast of thought prevalent among the cultivated class of his countrymen than that most popular and most eloquent instructor of youth. But no one can study these volumes of the *Transactions*, as I have done, without feeling that, for the first two decades of the existence of the Royal Society, Playfair was the soul and life of the institution. His versatility and power have impressed me exceedingly, high as was the estimate I had previously formed of him. Profound and transparently clear, whatever might be the topic, he bears about with him a far-reaching vigour which never flags. Whether it be the origin and investigation of porisms, or the astronomy of the Brahmins, or their trigonometrical calculations, or meteorological tables, or a double rainbow, nothing seems too great or too small for him.

"There are many curious and interesting by-paths, both of science and of literature, traversed in these earlier volumes. In 1787 Mr. George Wallace read a paper, which he did not incline to have printed in the *Transactions*, which I regret, for it related to a subject the interest of which has not ceased by the lapse of nearly a century. Its title was, 'On the Causes of the Disagreeableness and Coldness of the East Wind.' In the first volume of the *Transactions* a very singular problem was presented to the Society, through Mr. Adam Smith, along with other learned bodies in Europe, by a Hungarian nobleman, Count Windischgratz, and a prize was offered by him of 1000 ducats for the best solution of it, and 500 ducats for an approximation to a solution. It was a bold effort of philanthropy, for its object was the abolition of lawyers for the future. The problem was addressed to the learned of all nations. It was couched in Latin, but was in substance this:—'To find formulæ by which any person might bind himself, or transfer any property to another, from any motive, or under any conditions, the formulæ to be such as should fit every possible case, and be as free from doubt and as little liable to controversy as the terms used in mathematics.' I suppose that the prospect here held out of dispensing for the future with the least popular of the learned professions inclined the Society to entertain it favourably, for they proceeded to invite solutions of the problem, and three were received by them. In 1788 we find it recorded in the minutes that Mr. Commissioner Smith (for so the author of the 'Wealth of Nations' was designated) reported the opinion of the Committee that none of the three dissertations amounted to a solution, or an approximation to a solution, of that problem; but that one of these, with a certain motto, although neither a solution nor an approximation to a solution, was a work of great merit; and Mr. Fraser-Tytler was instructed to inform Count Windischgratz of their opinion. Whether this meritorious dissertation obtained the 500 ducats or not, we are not informed, but as lawyers continue to flourish, and legal terminology to produce disputes as prolifically as ever, it seems clear that the author had not earned them.

"Now that we have an Observatory on Ben Nevis, our successors at the end of the next century will know accurately the conditions of the climate under which the hundred years have been spent. There are, however, some details scattered over these volumes which are sufficiently interesting, although whether they show any material alteration in our seasons may be doubtful. The only cheering fact which they disclose is that the first set of returns is decidedly the most discouraging, and certainly does not support the idea that the mean temperature in the olden time was higher than it is now. There are two sets of returns printed in the first volume of the *Transactions*—one kept at Branxholm from 1773 to 1783, communicated by the Duke of Buccleuch, who was the first president of the Society; and the second by Mr. Macgowan, kept at Hawkhill, near Edinburgh, from 1770 to 1776. In the first, the mean temperature of the ten years is 44°; in the second, 45°—not a very genial retrospect. Things must have been somewhat discouraging for the farmers in 1782, for a paper is noticed in the second volume of the *Transactions*, by Dr. Roebuck, of Sheffield, who was the manager of the Carron Iron Works, recommending farmers not to cut their corn green in October, although there was ice three-quarters of an inch thick at Borrowstounness, because corn would fill at a temperature of 43°. Things looked brighter from 1794 to 1799, for which years we have results furnished by Playfair. For the first three years—1794, 1795, and 1796—the mean temperature was 48°; and that although 1795 was one of the most severe winters on record, the thermometer having stood frequently several degrees below zero, and a continuous frost having lasted for 53 days. The mean temperature in 1794, however, was 50°. The account of the great frost of 1795, which is given in the *Transactions*, is well worth referring to. In the next three years the mean temperature was 48°, that of 1798 being 49°·28. Of this year (1798) Playfair says that the climate of this part of the island hardly admits of a finer season. No tables were furnished to the Society, in continuation of those of Prof. Playfair, until 1830, when fortunately Dr. Barnes of Carlisle communicated to the Society a series of meteorological tables kept at Carlisle for the first twenty-four years of the century. The results seem mainly to concur with those of Prof. Playfair—the mean temperature for the twenty-four years being 47°·4547, being 3° higher than the average of the ten years from 1773 to 1783 at Branxholm, and 2° higher than the mean temperature of the seven years from 1770 to 1776 at Hawkhill. The highest temperature I have noted in these returns is that of May 1807, when the thermometer stood at 85° at Carlisle, and the next, that on the 5th of August, 1770, when the thermometer at Hawkhill was at 81°. The two years of the century in which the mean temperature was the highest were 1811 and 1822, in both of which years it was 49°.

"Of the purely scientific part of the Royal Society's work for the first fifteen years of its labours, while Hutton and Black and Playfair and Stewart were in full vigour, it is not too much to say it was brilliant—full of interest, full of power, and full of enthusiasm. The first great founders of course gradually waned, and all such associations are necessarily subjected to alterations of the tide, but as the tale goes on the mathematical papers begin to bear the names of John Leslie and William Wallace. We encounter Walter Scott in 1800, in 1808 the name of David Brewster, and in 1811 that of Sir Thomas Macdougall Brisbane, whose names adorned and whose labours were in the future the prop and stay of the Society. Of Scott I need not speak; but of the services rendered by Brewster it is impossible to express myself too strongly. He, too, like Playfair, had a mind of rare versatility. He could observe, as well as draw from his own resources. He could reason as well as describe. He could build a framework of sound deduction from the most unpromising hypothesis, and work out with unflagging spirit the thread of demonstration, however slender. He was the most prolific contributor of his day; nor do I think that any one but himself in these times could have kept the fire lighted by Hutton and Playfair burning so brilliantly. For it is not to be disguised that in the heat of the Continental struggle an air of languor creeps over the proceedings. The joyous enthusiasm of 1783 refuses to be invoked, and is elicited in vain. Nor is it wonderful. When the Gauls were so nearly at our gates, the safety of our own commonwealth was comparatively our only care. But when 1815 had arrived, and men's minds, set free from the long anxiety, had again tranquillity to cultivate the arts of peace, the energy of the rebound was great, and the history of British science has been one continued triumph ever since. By the exertions of Brewster and Brisbane, and many other associates, our Society again began to flourish, both leading and following the course of discovery as the stream flowed on. Both of these men continued to be the pride and ornament of the Society long after the expiration of the half-century which I have assigned to myself as my limit, for Thomas Brisbane succeeded Sir Walter Scott as president in 1832, and survived until 1860. Long before that a new generation had surrounded the veteran philosophers, and their destiny has been to recount and carry forward discoveries of which even Brewster and Brisbane hardly dreamt.

"Enough for the present of this retrospect, and the slender tribute I have attempted to pay to the memory and labours of a masculine and powerful generation. That we have built on their discoveries and learnt even by their errors is quite true; for the history of the second half of the century exhibits science far in advance of 1783, and even of 1833. In 1783 geology was in its infancy; palæontology was all but unknown. Cuvier was only then commencing his pursuits in comparative anatomy, which were to end in reproducing the forms of extinct life. The Glacial epoch had not then been elucidated by the research and genius of Forbes and Agassiz, and the dynamic theory of heat was still unproclaimed. The wonders of the photographic art were unknown even in 1833, for Talbot and Daguerre did not come on the scene for several years afterwards. In 1833 the apostle and disciples of evolution had not broken ground on that vast field of inquiry. Spectrum analysis and the marvellous results which it has already furnished and those which it promises have in our day only heralded the advent of a new science. Be however far in advance of the founders of the Royal Society the current philosopher may be, there was a robustness and characteristic individuality about the great men of that generation which we may not hope to see replaced. We may assume—indeed, we hope—that the close of the next century will find the progress of knowledge as far advanced beyond its present limits as we think that the science of to-day is beyond the point reached a century ago. We may be assured that before that time arrive many surmises, still in the region of hypothesis, will have become certainties, and that many supposed certainties will have turned out fallacies. Many errors will have been corrected, many dogmas discredited, many theories confirmed or refuted, at the bar of ascertained fact, as those of 1783 have been. Yet even then will our successors, I trust, as we do now, stand reverently before the memory of our founders. Happy is the institution which can show such a muster-roll, and happy the country which can boast such sons. I take leave of my theme with the fervent hope and firm conviction that in the century which we now inaugurate the Royal Society will continue with success the noble task to which by its charter it is devoted, of investigating the hidden treasures of nature and appropriating them to the benefit and happiness of mankind."

INSTINCT

1. *Is there a Science of Comparative Psychology?*

"IN the family of the sciences Comparative Psychology may claim nearest kinship with Comparative Anatomy; for just as the latter aims at a scientific comparison of the bodily structures of organisms, so the former aims at a similar comparison of their mental structures." These words form the opening sentence of Mr. G. J. Romanes' Introduction to his recently published volume on "Mental Evolution in Animals," and in a footnote he is careful to remind us that the phrase "mental structures" is used in a metaphorical sense. Let us consider how far a comparison of the mental structures of animals, even in a metaphorical sense, is possible.

Our knowledge of mind is either direct or inferential: direct on the part of each individual so far as his own individual mind is concerned; inferential so far as the minds of others are concerned. For it is a law of our being that mind cannot come into direct contact with mind. This fact—that the mental processes of our neighbours can never come within the sphere of our objective knowledge—has long been recognised (see *ex. gra.* Berkeley, "Princ. Hum. Know.," §§ 27 and 145; Kant as quoted in F. Pollock's "Spinoza," p. 177); and the late Prof. Clifford (see "Lectures and Essays," vol. ii. p. 72) coined the exceedingly convenient term *ejective* as descriptive of that class of phenomena which belong neither to the subjective nor to the objective category. My neighbour's mind is not and never can be an object; it is an eject, an image of my own mind thrown out from myself. Into every human being that I meet I breathe this subtle breath; and that man becomes for me a living soul.

Our knowledge of mind is therefore partly subjective, partly ejective. Now it is perfectly obvious that, were I an isolated unit, shut off from all communication with my fellows, no science of psychology would be possible for me. I might by the analysis of my own mental processes arrive at certain conclusions with regard to my own states of consciousness; I might reach some sort of knowledge of the working of my own mind. But this would not be a science of mind. A science of mind only becomes possible when I am able to compare my own conclusions with those which my neighbours have reached in a similar manner. By means of language human beings can communicate to each other the results which each has obtained; and each human being is able *to submit these results to the test of subjective verification*. For human beings therefore a *science* of psychology is possible just in so far as the results obtained indirectly are capable of direct *verification*.

One of the most remarkable results of modern scientific investigation is the establishment of a more or less definite parallelism between the phenomena of ejective psychology (thus capable of subjective verification) and certain objective phenomena of physiology—a parallelism of psychosis and neurosis. But these phenomena of physiology are not restricted to the human subject; and we therefore have grounds for believing that running parallel to the neuroses of animals there are certain psychoses. And it would seem at first sight possible that corresponding to a science of comparative neurosis we might have a science of comparative psychosis. We must remember, however, that it is only on the lower mental levels, so to speak, that we know anything approaching to definiteness with regard to the parallelism of neuro is and psychosis. All, therefore, that, as scientific investigators, we seem to have any grounds for inferring is that accompanying the neuroses of animals there are in all probability some kind of psychoses. We may speculate as to the character of these psychoses—and in the case of the higher mammalia our speculations are probably by no means worthless—but we cannot construct a comparative *science* of these psychoses because the results we obtain ejectively are incapable of direct verification. As a speculation modern constructive psychology has its value—like other speculations it may give direction to our scientific investigations—but let us not forget that the invaluable process of verification is, from the nature of the case, impossible.

To sum up. All our knowledge of minds other than our own is ejective; but in the case of human psychology the results reached ejectively may be verified subjectively. Animal minds are also ejective; they are more or less distorted images of our own minds. But such is the extraordinary complexity of the human mind—a complexity largely due to the use of language—that we may well suppose that any conception we can form of animal consciousness is exceedingly far from being a true conception. The results of comparative psychology—the science which has for its object the comparative study of these distorted images of our own mental processes—are incapable of verification. These are the facts which have to be taken into consideration when we seek an answer to the question "Is there a science of comparative psychology?" Notwithstanding that it has won for itself a more or less recognised place among the sciences, I venture to submit that our answer to this question should be an emphatic negative.

It must be noted, however, that I here mean by psychology the science which deals with subject and eject. If we include under psychology the science which deals with the "perpetual adjustments of special inner actions to special outer actions which accompanies increasing evolution of the nervous system," or that to which Mr. Herbert Spencer gives the name *objective* psychology ("Prin. Psychol.," vol. i. p. 142), our answer will of course be different. Objective psychology, or the comparative physiology of the nervous system *plus* a comparative study of the corresponding adjustive actions, has every right to be termed a science because the results obtained admit of verification. And it is a science in which Ferrier, Hitzig, Romanes, and others have done good work.

2. *The Place of Consciousness*

There would seem to be four hypotheses with regard to the place of consciousness in the animal world.

1. That according to which consciousness is a motive power (Free Will).
2. That according to which consciousness is altogether absent (Automatism).
3. That according to which consciousness is a product (Conscious Automatism).
4. That according to which consciousness is a guide (Determinism).

1. *Free Will.*—By free will I here mean the power of initiating actions by the mere volition of the self-conscious *Ego*. The exercise of free will involves an interference *ab extrâ* with the normal working of the nervous system.

This is not the place for a discussion of free will and determinism. That battle must be fought out within the domain of human psychology. From its bearing on the question of animal consciousness, however, I may be permitted to say a few words on the subject.

The answer which the ordinary believer in free will gives to the determinist is contained in three words—*I can choose*—and he thinks that there is an end of the matter. But the real point at issue lies deeper down, and is involved in the question—*What am I?* Let us hear the answer which the determinist gives to this question. I am, he replies, the sum of my states of consciousness at any moment. Apart from the stream of my mental states I, as a self-conscious individual, have no existence. This stream of conscious states or psychoses I believe to be the subjective aspect of a stream of nervous states or neuroses. And this stream is rigidly subject to law. But if these states of mind—under which head must be included states of definite consciousness, states of sub-consciousness, and states of submerged consciousness—if these states of mind, I say, constitute *me*, then, since these states of mind determine those which follow, these following states, and the actions which accompany them, are determined by me. But at the same time they are part of an orderly seqnence subject to law. The moment I identify myself with my states of mind I begin to see clearly that free will in the common-sense acceptation of the term—that is, a sense of individual choice—is perfectly compatible with the doctrine of determinism—that my mind is completely subject to law. The sense of choice I undoubtedly possess is due to the temporary equilibrium of motives, and the eventual prevalence of one set of motives over another set of motives. The freedom which every man is conscious of possessing is freedom to act in accordance with his own character.

"Freedom," says Kant, "is such a property of the will as enables living agents to originate events independently of foreign determining causes." This at first sight seems utterly opposed to determinism. And yet it contains a central core of truth which every determinist will accept. No determinist can deny that every human being carries about with him a special something, peculiar to himself, which is a most important factor—constituted as we are, the most important factor—in determining his choice in any act of volition. This special something we call, ejectively, his character, and, objectively, his organisation. Men are not like inorganic clouds at the mercy of external forces, but contain the springs of action in themselves. The brain is not merely a mass of inert matter; but a mass of matter cunningly organised, in which is locked up a vast store of potential energy. The organism is, moreover, a *variable* piece of mechanism. Hence at different times it reacts differently under the influence of the same stimulus. And this difference of reaction helps to fix the idea that the will is absolutely free. On a certain occasion we acted in a certain way. We see on reflection that our action was not the best. On a similar occasion afterwards we act differently. And we then imagine that we could have acted differently in the first instance. But it is clear that the two cases are not alike. Reflection has altered one of the determinants of action, the character. The character having changed, the action is different. Such a definition as Kant's—the essential truth of which I take to be that a man's actions are the outcome of his character—is as valuable to the determinist as to any one else. At the same time "it is inconceivable," as Chaldai Creskas said long ago (*circa* 1410), "that two men, being themselves of like temper and character, and having before them like objects of choice in like circumstances, should choose differently" (quoted from F. Pollock's "Spinoza," p. 96).

Determinism simply comes to this—that both on the objective side and on the subjective side our actions are determined by law. On the one hand a perfect knowledge of the organism *plus* a perfect knowledge of any stimulus and the surrounding conditions would enable us to say how the organism would act under that stimulus. On the other hand a perfect knowledge of the character *plus* a perfect knowledge of any motive and the circumstances of the case would enable us to say what feelings would result (the actions being the objective side of the feelings). If by free will it is meant that our actions are the outcome of the play of a motive-stimulus on our character-organisation, then free will and determinism are at one.

But this is not what is meant by those who maintain the doctrine of free will. What is meant by them is this—that presiding alike over our thoughts and actions, initiating, guiding, and inhibiting, there is a certain "masterful entity," the self-conscious *Ego*. This *Ego*, though in no wise connected with our bodily organisation, has nevertheless the power of interfering with the action of that organisation. And it is absolutely free, utterly unfettered by law. This doctrine I reject: not because I am in a position to disprove it, but because I see no reason for accepting it. And rejecting this doctrine in the sphere of the human mind, I feel bound to reject it in the sphere of animal intelligence. But I am not blind to the fact that many of my neighbours do not reject it in the sphere of the human mind. To them two courses are open: either to extend it into the sphere of animal intelligence, or not so to extend it. If they do so extend it, they thereby render the study of animal intelligence incapable of scientific treatment, even from the objective standpoint, by the introduction of a factor not subject to law. If they do not so extend it, they must accept one of the three views next to be considered.

2. *Automatism.*—Very little space need be devoted to a doctrine that very few believe. Those who accept the doctrine of the parallelism (or identity) of neurosis and psychosis and add to this a belief in evolution are logically bound to accept the corollary that the neuroses of animals are accompanied by some kind of psychoses which more or less dimly foreshadow our own psychoses. Those, however, who reject the hypothesis of evolution, or at least deny its application to the mind of man, and who believe in the doctrine of free will as restricted to the human being, will, not improbably, accept the doctrine of automatism in animals. In any case it is a theory upon which the study of organic processes, reflex, instinctive, and intelligent (or selective), admits of scientific treatment. It is indeed "objective psychology" *plus* the dogmatic assertion that consciousness is absent.

3. *Conscious Automatism.*—"Materialism," says Mr. Romanes, "is logically bound to argue in this way: We cannot conceive of a conscious idea, or mental change, as in any way affecting the course of a cerebral reflex, or material change; while, on the other hand, our knowledge of the conservation of energy teaches us as an axiom that the cerebral changes must determine each other in their sequence as in a continuous series. Nowhere can we suppose the physical process to be interrupted or diverted by the psychical process; and therefore we must conclude that thought and volition really play no part in determining action. Thoughts and feelings are but indices which show in the mirror of the mind certain changes that are proceeding in the matter of the brain, and are as inefficient in influencing those changes as the shadow of a cloud is powerless to direct the movements of that of which it is the shadow. . . . This is opposed to common sense, because we all feel it is practically impossible to believe that the world would now have been exactly what it is even if consciousness, thought, and volition had never appeared upon the scene—that railway trains would have been running filled with mindless passengers, or that telephones would have been invented by brains that could not think to speak to ears that could not hear" (*Nineteenth Century*, December, 1882, p. 879). How far the materialist—the logical results of whose doctrine are apt to be forced on him from all sides—is ready to accept this particular logical result I leave it for him to say. It is at any rate a possible view, and, like that of unconscious automatism, is one upon which a scientific treatment of organic processes is admissible.

4 *Determinism.*—This view has already been incidentally given under the heading of the directly opposed doctrine of free will. It is the doctrine of the parallelism (or identity) of neuroses and psychoses, which, both in their subjective and objective aspects, are rigidly law-bound. Determinism may be treated either from the philosophical or from the scientific standpoint. From the point of view of the man of science we may say that consciousness is a *guide* to action and has been a guide in evolution; that during the process of evolution there gradually emerged something distantly related to what we know in ourselves as consciousness, which at a very early stage of evolution became, so to speak, polarised into pleasurable and painful; that those actions which were associated with pleasurable feelings were more frequently performed than those associated with painful feelings; that those organisms in which there was an association between right action and pleasurable feelings would stand a better chance of survival than those in which the association was between wrong actions and pleasurable feelings; and that finally those organisms in which conscious adjustments of all orders were more perfectly developed would be the winners in life's race. Some such deductions as these would seem to be admissible on the hypothesis of evolution. With such questions as How have psychoses become associated with neuroses? or Why have psychoses been associated with neuroses? or How can psychosis exercise a guiding influence on neurosis?—with such questions as these the man of science, as such, has nothing to do. These are questions for the philosopher, and this is, therefore, not the place to discuss them. Suffice it to say that we must either accept some such view as that advocated by Clifford in his masterly essay "On the Nature of Things in Themselves" ("Lectures and Essays," vol. ii. p. 71) or be content to confess our ignorance.

Upon this view of the place of consciousness in the animal kingdom, the study of organic processes, reflex, instinctive, and intelligent (or selective), admits of scientific treatment. A science of "objective psychology" is possible for us; and a science of ejective psychology is also possible, but not for us.

3. *The Lapse of Consciousness*

One of the most surely established inductions of psychology is this: that the more frequently an action is performed the more perfectly automatic does it become—the more does it tend to pass into stereotyped reflex action. Actions which are at first performed with that definite consciousness implied in the term close attention can, after frequent repetition, be performed almost, if not altogether, without even indefinite consciousness. It would seem that after the definite establishment of the nerve connections necessary for the performance of certain actions or sets of actions the guiding influence of consciousness might be withdrawn.

This principle is too well known to require illustration here. I shall therefore content myself with drawing attention to one or two of its corollaries.

1. Since the same action or set of actions may be performed with full consciousness—a consciousness of the end in view, and of the means necessary to that end—with indefinite consciousness, or with a vanishing amount of consciousness, it is impossible for me to say what amount of consciousness, if any, an action performed by my neighbour involves. Again and again we see our neighbours perform most complicated actions—such as winding up their watches—with so little consciousness as to leave no trace upon the memory. Abernethy quotes a case of a lawyer writing out an important opinion in his sleep. Still more impossible is it for me to say what amount of consciousness, if any, an action performed by one of my dumb companions involves. Decapitated frogs—in which we have some grounds for believing that consciousness is absent—perform a number of seemingly purposive actions.

2. Since those actions which are frequently and persistently performed by the individual have a tendency to pass into the automatic and unconscious stage, it would seem highly probable that those actions which have been performed not only by the individual but by a long line of ancestors whose organisation he inherits are, or very soon become, completely, or in a very high degree, automatic and unconscious. Who can say what amount of consciousness, if any, is involved in the actions of newly-born piglings or newly-hatched chicks?

3. It would therefore seem difficult or impossible to disprove the hypothesis that all truly instinctive actions—in so far as they are not modified (as they so often are modified) by a little dose of reason—are automatic and unconscious. I do not mean to maintain that hypothesis. But I say that, having regard to the known phenomenon of the lapse of consciousness, I do not see how that hypothesis could be disproved.

4. *The Psychological Definition of Instinct*

"Instinct," says Mr. Romanes in his recently published "Mental Evolution in Animals" (p. 159), repeating the definition given in "Animal Intelligence" (p. 17), "Instinct is reflex action into which there is imported the element of consciousness. The term is therefore a generic one, comprising all those faculties of mind which are concerned in conscious and adaptive action, antecedent to individual experience, without necessary knowledge of the relation between means employed and ends attained, but similarly performed under similar and frequently recurring circumstances by all individuals of the same species."

To such a psychological definition of instinct there seem to me to be two grave objections. First, there is the general objection, indicated in the first section, arising out of the ejective nature of our knowledge of animal consciousness. Secondly, there is the special objection raised under the head of "The Lapse of Consciousness." These objections have not escaped Mr. Romanes' notice, but I think he underestimates them. "No doubt," he says ("Ment. Evol.," p. 160), "it is often difficult, or even impossible, to decide whether or not a given action implies the presence of the mind-element—*i.e.* conscious as distinguished from unconscious adaptation; but this is altogether a separate matter, and has nothing to do with the question of defining instinct in a manner which shall be formally exclusive, on the one hand of reflex action, and on the other of reason." But I venture to think that the difficulties of application are from the very nature of the case insuperable, and that the definition is therefore, whatever its logical value, practically of little service.

Again, on p. 17 of his recent volume, Mr. Romanes tells us that "the only test [of the conscious choice element] we have is to ask whether the adjustments displayed are invariably the same under the same circumstances of stimulation. The only distinction between adjustive movements due to reflex action, and adjustive movements accompanied by mental perception, consists in the former depending on inherited mechanisms within the nervous system being so constructed as to effect *particular* adjustive movements in response to *particular* stimulations, while the latter are independent of any such inherited adjustment of special mechanisms to the exigencies of special circumstances." And a little further on (p. 18) he says, "It is enough to point to the variable and incalculable character of mental adjustments as distinguished from the constant and foreseeable character of reflex adjustments." All which may be very true. But it seems to cut away the ground from under his definition of instinct. For surely what he says here of reflex actions is also true of instinctive actions. Surely instinctive actions "depend on inherited mechanisms within the nervous system being so constructed as to effect *particular* adjustive movements in response to *particular* stimulations." Surely we may also point to the "constant and foreseeable character of *instinctive* adjustments."

But though an instinctive action may involve no consciousness in the individual, it may have involved consciousness, during the process of its evolution, in the ancestors of the individual. In this way, perhaps, we may admit consciousness into our definition of instinct. But if we hark back to ancestors in one case, we may fairly do so in another. And since the secondary instincts of the individual involved intelligence in his ancestors, we must import not only consciousness but intelligence into our definition of instinct. If we admit lapsed consciousness, why not admit lapsed intelligence? Our definition will then become: Instinct is reflex action into which is imported (ancestrally) the elements of consciousness and intelligence. In which case instinct and reason run together.

It seems to me, therefore, that the psychological definition of instinct lacks that definiteness of application which is not merely desirable but essential. If I might be permitted to paraphrase Mr. Romanes I would say, "I am persuaded that if we are to have any approach to definiteness in the terms which we employ—not to say to clearness in our ideas concerning the things of which we speak—it is" *not* "desirable to restrict the word instinct to mental as distinguished from non-mental activity." And this just because it is so "difficult, or even impossible, to decide whether or not" instinctive actions "imply the presence of the mind-element—*i.e.* conscious as distinguished from unconscious adaptation."

5.—*A Physiological Definition of Instinct*

"Instinctive actions are actions which, owing to their frequent repetition, become so habitual in the course of generations that all the individuals of the same species automatically perform the same actions under the stimulus supplied by the same appropriate circumstances." This physiological definition of instinct, which is incidentally given by Mr. Romanes ("Animal Intelligence," pp. 16–17), is, if I mistake not, of more practical and scientific value than the psychological definition which immediately follows, and which introduces "the element of consciousness" and "faculties of mind."

Were it impossible to define instinct in such a manner as to be formally exclusive, on the one hand, of reflex action, and, on the other, of intelligent (or selective) action, without having recourse to the associated phenomena of consciousness, then it might be advisable to introduce consciousness into our definitions for the sake of giving them a logical status. And Mr. Herbert Spencer seems to see this difficulty when he defines *or describes* instinct as compound reflex action. But, though reflex action shades into instinctive action, and instinctive action (as seen in the phenomena described by Mr. Romanes, under the heading "The Plasticity of Instinct") into intelligent action, still some such definitions as the following would seem sufficiently to answer to the demand for formal exclusiveness:—

1. *Reflex Actions* are actions taking place in, or performed by, an individual in virtue of his possession of a general type of nervous organisation.

2. *Instinctive Actions* are actions performed by the Individual in virtue of his possession of a special type of nervous organisation, that is, a type of organisation common to his species.

3. *Intelligent (or Selective) Actions* are actions performed by an individual in virtue of his possession of an individual nervous organisation, that is, an organisation special to himself.

If we call the foundation type of nervous organisation (in the mammalia, for example) a, the special modification of that type (in all dogs, for example) b, and the individual modification developed in some individual (say Dr. Huggins's "Kepler") c; then reflex actions are the outcome of a, instinctive actions the outcome of $a+b$, and selective or intelligent actions the outcome of $a+b+c$.

That there are difficulties in the application of these definitions to special cases I readily admit, but I venture to submit that they are by no means of so grave a nature as those involved in the psychological definitions advocated by Mr. Romanes.

I need not say here that such definitions do not by any means imply the absence of consciousness, since I have devoted a special section to *The Place of Consciousness* with the special object of showing that the doctrine of determinism, which I accept, maintains the parallelism or identity of psychosis and neurosis.

6.—*The Origin and Development of Instincts*

This article has already exceeded the length to which it was intended to run. On this head, therefore, I must be brief. The problem of the origin and development of instincts comes to this—How has it come about that certain nervous structures, and the actions which are their external and obvious manifestations, are developed in all the members of a certain species? It is clear that such a development of certain structures and their corresponding actions in all the individuals of a particular species must answer to a widely felt need. The actions answer to circumstances of frequent occurrence in the life-history of the species, just as intelligent actions "answer to circumstances of comparatively rare occurrence in the life-history of the species" ("An. In.," p. 17). The question is—How far is the equilibration direct, *i.e.* by adaptation, and how far is it indirect, *i.e.* by natural selection? To discuss this question would require a separate article. I content myself with giving two quotations, the former from Mr. Darwin, the latter from Mr. Spencer. "I believe that most instincts are the accumulated result, through natural selection, of slight and profitable modifications of other instincts, which modifications I look at as due to the same causes which produce variations in corporeal structures. . . . But in the case of the many instincts which, as I believe, have not at all originated in hereditary habit, I do not doubt that they have been strengthened and perfected by habit; just in the same manner as we may select corporeal structures conducing to fleetness of pace, but likewise improve this quality by training in each generation" (quoted "Ment. Ev. in Ans.," p. 264). So far Mr. Darwin. Mr. Spencer says: "The equilibration of organisms that are comparatively passive is necessarily effected indirectly by the action of incident forces on the species as a whole. But along with the gradual evolution of organisms having some activity, there grows up a kind of equilibration that is relatively direct. In proportion as the activity increases, direct equilibration plays a more important part. Until, when the nervo-muscular apparatus becomes greatly developed, and the power of varying the actions to fit the varying requirements becomes considerable, the share taken by direct equilibration rises into co-ordinate importance" ("Princ. Biol.," vol. p. 468). It seems to me that we have here substantial agreement as to the part played by indirect equilibration in laying the foundation, and the part played by direct equilibration in perfecting the superstructure. (I venture to think that Mr. Romanes somewhat mistakes Mr. Spencer's position with regard to the "very subordinate importance of natural selection as an evolving source of instinct," and with regard to the question of "lapsed intelligence.")

7. *Conclusion*

One or two words in conclusion by way of summary.

1. While fully admitting the great interest that attaches to the study of the inferred mental faculties of the higher brutes, I believe that, from the ejective nature of the animal mind and the

necessary absence of verification, no science of comparative psychology, except such as is restricted to "objective psychology," is possible.

2. Of the four views of the place of consciousness in the animal world only one—that of *free will*—renders the study of the actions of animals incapable of scientific treatment. Of the other three I believe *determinism* to be the most satisfactory. According to this view both neuroses and psychoses are subject to law. But from our necessarily ejective knowledge of psychoses, we are forced to confine our attention (from the scientific point of view) to the objective phenomena of neurosis, especially as manifested in conduct. Of the psychoses we can know nothing with certainty; of the neuroses we may learn a little; of conduct we may learn much.

3. From the principle of the lapse of consciousness certain corollaries may be drawn—(*a*) that it is difficult or impossible to say what amount of consciousness, if any, an action performed by my neighbour involves; (*b*) that it would seem probable that the lapse of consciousness in the individual is paralleled by a lapse of consciousness in the species; and (*c*) that the hypothesis that instinctive actions are unconscious is incapable of disproof.

4. On the general grounds given in 1, and on the special grounds given in 3, I see grave difficulties in accepting the psychological theory of instinct—that instinct is reflex action into which is imported the element of consciousness.

5. In accordance with the principle thus advocated a physiological definition of instinct must be sought. Some such definition as this may be proposed: *Instinctive actions* are actions performed by the individual in virtue of his possession of a special type of nervous organisation, that is, a type of organisation common to his species.

6. The question of the origin and development of instincts thus becomes a question as to how this special type of structure has been evolved. It takes its place as part of the general question of the evolution of structures—the actions being the external manifestations of internal structures. To the question as to the relative importance of direct and indirect equilibration I could give no definite answer within the limits of this article, and therefore gave quotations from Darwin and Herbert Spencer.

C. LLOYD MORGAN

A NEW OBSERVATORY FOR PARIS

THE last number of the *Comptes Rendus* of the Paris Academy of Sciences contains a memoir by Admiral Mouchez, urging the necessity of removing to a separate establishment beyond the city the chief departments of the Paris Observatory. When the building was originally erected by Perrault about a mile to the south of the Luxembourg, the city scarcely reached beyond that point. But since then it has spread in every direction, completely surrounding the Observatory with lofty edifices, and charging the atmosphere with all sorts of gases, smoke, and other impurities. These altered conditions are all the more injurious that, thanks to the progress of astronomical studies, the power and accuracy of the instruments have to be continually increased, while a clear and still atmosphere is more than ever needed for taking observations. The vicinity of the Catacombs and of busy streets has also rendered the ground less firm than formerly.

In 1854, and again in 1868, these adverse conditions were brought before the Government, and discussed in the Academy. After a careful study of the situation, the Commission appointed by the Academy to inquire into the matter unanimously reported in 1869 in favour of a branch establishment outside of Paris; but this suggestion, although fully approved of by the Academy, was for various reasons allowed to fall into abeyance.

Since then the evils complained of have been aggravated, in spite of all the improvements introduced for the purpose of modifying them. Hence it becomes more than ever indispensable to carry out the project forthwith, if the Observatory wishes to maintain its efficiency and keep pace with similar establishments abroad. The most serious obstacles to its legitimate development are the disturbed and clouded state of the atmosphere in the centre of a large city, the constant vibrations of the ground, and the impossibility of accommodating the astronomers in the building, as is done in all foreign observatories. Hence arises an insurmountable obstacle to the proper organisation of the night service, while extreme difficulty is felt in improving the existing plant and obtaining other much needed instruments, for which no suitable position can be found.

Merely to erect the long-contemplated tower and cupola of the great telescope there would be required a Government grant of from 20,000*l.* to 24,000*l.*, besides at least an equal sum to prevent the erection of lofty houses in front of the new grounds and to purchase the instruments still needed. But even were such grants obtained, the Observatory would continue to labour under the serious inconveniences above described. Without, however, imposing such a burden on the State, the difficulty might be met, and the old historical edifice of Louis XIV. preserved, by erecting in one of the public domains a new and magnificent observatory furnished with all the improvements and appliances of modern science. In order to effect this, it would suffice to alienate about 22,000 square metres of gardens and open spaces surrounding the present Observatory, and serving only to isolate it from the neighbouring houses. Sold at the moderate estimate of from 4*l.* to 6*l.* per metre, a sum of nearly 120,000*l.* might be raised, which would be more than sufficient for the purpose.

After sacrificing enough land for the construction of two new streets in continuation of the Avenue du Luxembourg, and isolating the Observatory on all sides, it would still retain the northern court and a garden on the south 70 to 80 metres long by 50 broad. The building would thus also retain the exact appearance that it presented when originally constructed by Perrault. Here might be preserved the Archives, the Bureau des Calculs, the Museum, and three or four instruments still capable of rendering some service if placed at the disposition of the Faculty of Sciences for the instruction of students.

All the plans of some such project as is here proposed have already been prepared with the greatest care by the able architect, M. Deharme. They include accommodation for thirty astronomers and assistants with their families, all the instrumental and service rooms, the halls, and an underground gallery, a structure 300 metres high for the study of the atmosphere, gas-works, a covered gallery connecting all the instruments with the apartments of the astronomers; lastly, the great cupola for the 16m. telescope, at a total cost of 98,350*l.* Including the price of the new instruments, fittings, and inclosing wall, this sum would be raised to 108,000*l.*, which might be obtained by the proposed sale of lands.

The Council has unanimously adopted this project, demanding that it be referred to the Academy and to the Bureau of Longitudes, which bodies had already pronounced favourably on some such scheme in 1854 and 1868. Thus no serious objections seem to stand in the way of a project by which alone the present adverse conditions may be removed, and France endowed with the most complete and finest observatory of modern times.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The Sherardian Botanical Chair at Oxford has at length been filled up by the election of Mr. Bayley Balfour, Professor of Botany at Glasgow. Mr. Balfour has had a distinguished career. Passing his student life at Edinburgh, he finally graduated as a Doctor of Medicine, receiving the University Gold Medal for his thesis, having previously carried off first class honours as Doctor of Science in Botany. Two years were spent in acquiring a practical knowledge of the methods of morphological and physiological research in the botanical laboratories of France and Germany under Profs. De Bary and Sachs. We next find him assisting his father, the Regius Professor of Medicine and Botany in the University of Edinburgh, in conducting his classes alike in the lecture-room, in the laboratory, in the herbarium, and in practical field work. For four years he was assistant to the Regius Professor of Natural History in the University of Edinburgh, and for six years he lectured on botany to the students of the Royal Veterinary College, until finally he was appointed Crown Professor of Botany in the University of Glasgow. Of good scientific work done there is an ample record. A valuable paper published in the *Philosophical Transactions* gives the result of his labours at Rodriguez, where he was sent by the Royal Society in 1874 as botanist and zoologist to the Transit of Venus Expedition. In 1880 we find him making a scientific exploration of the Island of Socotra, the results of which have been published in various periodicals, the final report on the botany of the island being now in course of publication by the Royal Society of Edinburgh. Prof. Balfour's wide experience in field, laboratory, and herbarium, will make him a valuable addition to the Natural

Science Staff of Professors in Oxford. As Magdalen College has under its new statutes added a Fellowship to the endowments of the Chair, we may congratulate the College on gaining another addition to its already long list of distinguished Natural Science Professors who are members of the Society. Profs. Westwood, Burdon Sanderson, Odling, Lawson, Balfour, Daubeny, Phillips, Brodie (now dead), were all members of the College.

On May 6 an examination will be held at New College to elect an Exhibitioner in Natural Science. The Exhibition will be given for proficiency in Chemistry and Biology.

At Magdalen College an open Demyship will be offered for Natural Science in June next.

THE University College (London) School "Old Boys" annual dinner will be held this year at the Holborn Restaurant, on Tuesday, February 19, at 7 p.m.; George Buchanan, M.D., F.R.S., in the chair.

THE Central Institution of the City and Guilds of London Institute in Exhibition Road is now approaching completion, and the Executive Committee are proceeding to appoint, in the first instance, four professors to the chairs of Chemistry, of Engineering, of Physics, and of Mechanics and Mathematics respectively. The salary attached to each professorship will be 1000*l*. per annum, with a prospect of increase depending upon the number of students in attendance. It is expected that the appointments will be made during the next few weeks. The Council of the Institute, at the request of the Duke of Buckingham and Chandos, have consented to lend, during the summer months, and pending the preparation of the fittings, a portion of the Central Institution to the Commissioners of the International Health Exhibition for the display of appliances for scientific and technical instruction and of the work done in technical schools here and abroad.

SCIENTIFIC SERIALS

THE *Journal of Physiology*, vol. iv. Nos. 4 and 5, December, 1883, contains:—An account of the discussion which took place in the Physiological Section of the International Medical Congress held in London, 1881, on the localisation of function in the cortex cerebri. Prof. Goltz of Strasburg, it will be remembered, exhibited a dog, and Profs. Ferrier and Yeo a monkey. The brains of these animals were handed over to a Committee, consisting of Dr. Klein, Mr. Langley, and Prof. Schäfer. The report of this Committee is preceded by a memoir on the normal structure of the dog's brain, by J. N. Langley (plates 7 and 8), and the report consists of a report on the parts destroyed on the right side of the brain of the dog operated on by Prof. Goltz, by J. N. Langley (plates 9 and 10); of a report on the parts destroyed on the left side of the brain of the same dog, by E. Klein (plate 11); and of a report on the lesions primary and secondary in the brain and spinal cord of the Macaque monkey exhibited by Profs. Ferrier and Yeo, by E. A. Schäfer (plate 12).

THE *Journal of the Royal Microscopical Society* for December, 1883, contains:—On some new Cladocera of the English lakes, by Conrad Beck (plates 11 and 12).—On an improved method of preparing embryological and other delicate organisms for microscopical examination, by Edward Lovett.—On the relation of aperture and power in the microscope, by Prof. E. Abbe.—On a new camera lucida, by Dr. Hugo Schröder.—On optical tube length, an unconsidered element in the theory of the microscope, by Frank Crisp.—Also the usual summary of current researches relating to zoology, botany, and microscopy.

THE *American Naturalist* for December, 1883, contains:—On the development of a dandelion flower, by John M. Coulter.—Notes on *Chætonotus larus*, by C. A. Fernald.—Notes on the aborigines of Cooper's Creek, Australia, by E. B. Sanger.—Zoological gardens, a critical essay by Theodore Link.—The Copperhead, by Dr. R. E. Kunze.—Experiments with the antennæ of insects, by C. J. A. Porter.—On the position of the Compositæ and Orchideæ in the natural system, by J. F. James.—On the habits of certain sunfish, by C. O. Abbott.—Recent literature, and general notes.

Revue Internationale des Sciences Biologiques, October 15, 1883, contains:—Translations of Mr. W. S. Duncan's—Probable region of man's evolution, and of Prof. Huxley's—Living beings and the method of studying them; Dr. Hubrecht—on the ancestral form of the Chordata; and Dr. W. G. Parker—on the people and language of Madagascar.

The number for November 15, 1883, contains:—An essay by Dr. Lanessan, on Buffon: his ideas, his *rôle* in the history of science, his work, and on the development of the natural sciences since his epoch, which essay is to serve as an introduction to a complete edition of Buffon's works, including his correspondence, to be shortly published by Le Vasseur, Paris.

Rendiconti del Reale Istituto Lombardo, Milan, December 29, 1883.—Reports on the work of the various physical, literary, ethical, mathematical, and political sections of the Institute during the year 1883, by the Secretary.—Meteorological observations made at the Brera Observatory, Milan, during the month of December, 1883.

Nachrichten von der K. Gesellschaft der Wissenschaften und der Universität zu Göttingen, December 1, 1883.—On the formation of isomerous derivatives of toluol, by Paul Jannasch.—On the irreducibility of linear differential equations, by Leo Königsberger.—On the polar repulsion, the coefficient of induction, and temperature of a magnet, and on the determination of the moments of inertia through bifilar suspension, by F. Kohlrausch.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 10.—"Extracts from a Report on the Volcanic Eruption in Sunda Strait by Commander the Hon. F. C. P. Vereker, H.M.S. *Magpie*, dated Singapore, October 22, 1883." Communicated by Sir Frederick Evans, K.C.B., F.R.S.

. . . On the 18th inst. I entered Sunda Strait, passing east of Thwart-way Island. This island had been reported to be split by the eruption into several portions. This is incorrect.

The island is intersected by low valleys in several places; these being covered with tall trees did not show so prominently formerly as they do now. The whole of the vegetation having been swept away by the tidal wave, the island at a short distance off is apparently divided, the low necks joining the higher portions being only visible on close approach.

The surface of the Strait in this neighbourhood is covered with extensive fields of floating pumice-stone, often in one to two foot cubes, through which the ship easily forced her way. . . .

I inclose sketches which I trust will convey the general appearance better than a written description. The whole of the neighbourhood is covered with greenish yellow mud, and all traces of vegetation everywhere destroyed.

I communicated personally with the captain of the Netherlands frigate *Queen Emma* stationed on the spot, and was informed by him that the changes are considerably more extensive than was at first thought, and that Verlaten Island is still in a state of activity as well as Krakatoa itself.

From observation he thinks that another eruption is impending, but that Verlaten Island will be the centre of disturbance.

The Netherlands Government vessel *Hydrograaf* obtained a sounding of 100 fathoms without reaching bottom, in the centre of the group and off the cliff falling from Krakatoa Peak.

The two new islands are low mud and pumice banks, their configuration is continually altering, and I was informed that they are gradually subsiding. . . .

It is still impossible to examine Lampong Bay, but the pumice-stone is now beginning to float out.

The light on Fourth Point (Java) has been temporarily replaced by one of the 6th order, visible five miles, but beside this there are no signs of life on the Java shore. The whole coast is covered with the debris of trees, &c., demolished by the earthquake sea-wave, and over all lies a thick incrustation of volcanic mud.

During the height of the eruption a terrific whirlwind and a fierce south-westerly gale, apparently local, was experienced. . . .

Victoria Institute, February 4.—Mr. Ernest Budge, B.A., of the Oriental Department of the British Museum, read a paper upon a new and important inscription of Nebuchadnezzar the Great. Two copies of the same text had been brought to England by Mr. Rassam, one of which was much mutilated, but by a careful comparison of the texts Mr. Budge has succeeded in gaining a nearly perfect copy of the inscription. It related chiefly to the restoration of the fortifications of Babylon—the great walls, gates, and quays along the river bank, which had been thrown down by the conquering armies of Sowgon, Sennacherib, and Assurbanipal. It also stated the area of the citadel of Babylon was 4000 square cubits. The inscriptions described the restoration of the famous temple of Belus, which was made "bright as the beauty of heaven," with gold, silver, crystal, and precious stones; the roof of the "house of the oracle" was of cedar wood, plated with gold. The King recorded the restoration of many other public and sacred edifices, and among others the Tower of Borsippa, known as the Tower of Babel, according to Babylonian tradition. In concluding the inscription, the King, in a most beautiful prayer, commended his pious works to the keeping of "Merodach, King of Heaven and Earth," to whom he prayed "for long life, fullness of glory, and a widespread dominion."

EDINBURGH

Mathematical Society, February 8.—Mr. A. J. G. Barclay, vice-president, in the chair.—A presidential address was delivered by Mr. Thomas Muir, F.R.S.E., on the promotion of research. Attention was drawn to the backward state of mathematical research in Scotland, particularly when compared with the activity of Germany in the same department. Some of the causes of this were discussed, and methods were suggested for bringing about a reform.—Mr. H. H. Browning, Glasgow, contributed a paper on illustrations of harmonic section; and Mr. Muir communicated a theorem regarding the area of a polygon of $2n$ sides.

PARIS

Academy of Sciences, February 4.—M. Rolland in the chair.—Note on the necessity of establishing a branch of the Observatory outside of Paris, by Admiral Mouchez.—On a new application of the mercurial level suggested by M. Renouf for calculating the altitude of the stars at sea when the horizon is invisible, by Admiral Mouchez. This ingenious contrivance, which is available on land as well as on sea, almost completely removes the difficulties hitherto experienced in obtaining altitudes within 4′ or 5′ at night or in foggy weather. The apparatus, made by M. Hurlimann, mechanician, has been for some time in use on board the Transatlantic steamers plying between France and the United States. M. Mouchez describes it as much simpler and more exact than any other system hitherto invented.—On an optical phenomenon observed during a fire that broke out at Joly on January 31, by M. E. Chevreul. For three-quarters of an hour the light of the street gas presented the complementary colours of the light of the fire, that is, from yellow-green to green and bluish, the sensations being referable at once both to the simultaneous and successive contrast, according as the observer beheld both lights simultaneously, or one only at a time.—On Faraday's law regarding an electric current traversing a series of electrolisable salts during the same time, by M. Berthelot. The author argues that Faraday's law is in general more simply expressed by means of the equivalents than by the atomic weights, both for the electro-positive and for the electro-negative elements.—Reply to M. Richet's remarks on the method of anæsthesis by means of the titrate mixtures of chloroform and air, by M. Paul Bert.—Curves registered by the mareograph established at Colon (earthquakes at Santander, Guayaquil, Chios, &c.), by M. de Lesseps. The curves recorded on October 13 and 14, 1883, appear to have indicated the underground disturbances caused by the earthquakes that occurred on those dates at Santander on the Atlantic, Guayaquil on the Pacific, Chios in the Mediterranean, and elsewhere. Yet nothing abnormal was registered by the mareograph of the island of Naos, Gulf of Panama.—On the quantities forming a group of nonions analogous to the quaternions of Hamilton, by M. J. J. Sylvester.—*Résumé* of the meteorological observations made during the year 1883 at four points in the Upper Rhine and Vosges districts (Colmar, Munster, Schlucht, and Thann), by M. G. A. Hirn. Referring to the recent twilight effects observed at these stations, the author feels justified in concluding that the particles, whether gaseous or in the form of dust, lit up by the solar rays, were situated, at least to a large extent, beyond the terrestrial atmosphere, in any case at elevations where no traces have ever been observed either of cirrus or vapour of water.—On the late twilight phenomena, by M. de Gasparin. The author considers that the chief features of these phenomena were their rapid appearance from fifteen to sixteen minutes after sunset, and their constant recurrence in a given place for a period of sixty-six days.—On an instrument capable of producing in the same telescope the images of two stars at the moment when they are at the same altitude, and of further determining by a single observation the astronomic time of the place, its latitude, and exact position for the whole horizon, by M. Ch. Rouget.—On biquadratic involutions, by M. C. Le Paige.—On a class of abelian functions and on a hyperfuchsian group, by M. E. Picard.—Note on the exact number of variations obtained in the multiplication of the integral polynome $f(x)$ by the binome $x + a$, by M. D. André.—Transelementation of glyoxal into glycolic acid, by M. de Forcrand.—On the thermal properties of the numerous oxichlorides of mercury, by M. G. André.—Researches on the formation of the crystallised fluoride of antimony and its dissolution either in pure water or in solutions of fluorhydric acid, by M. Guntz.—On the heat of transformation of the prismatic oxide of antimony into octahedric oxide, by M. Guntz.—On the liquefaction of hydrogen, by M. S. Wroblewski. From the results already obtained, the author supposes that the temperature required for the complete liquefaction of hydrogen is about that which may be obtained by means of boiling oxygen.—On a case of isomerism of chloronitrous camphor, by M. P. Cazeneuve.—On the segmentary organs and the podocyst of the embryos of the slug family, by M. S. Jourdain.—On the Tongrian deposits at Longjumeau, Department of Seine-et-Oise, by M. Stan. Meunier.—On some freshwater formations of the Tertiary period in Algeria, by M. Ph. Thomas.—On the influence of oxygen under increased pressure on the cultivation of *Bacillus anthracis*, by M. J. Wosnessenski.—On the cause of the twilight effects of 1883, by M. G. Tissandier. Accepting M. Angot's assumption that hypotheses inapplicable to the year 1831 must be rejected for 1883, the author shows that the atmospheric conditions of both years resembled each other in every respect. The circumstances attending the eruptions in the Sicilian waters in 1831, when the volcanic island of Pantellaria made its appearance, were completely analogous to those of the Krakatoa eruption in 1883. On both occasions the optical phenomena were immediately preceded by igneous disturbances ejecting into the atmosphere vast quantities of gaseous products and fine dust. Hence the probability that to volcanic eruptions were due the optical manifestations in both years.—On the twilight effects of the last few months, by M. Perrotin. This author also argues that the twilights of 1831 prove nothing against, but rather confirm, the volcanic theory adduced to account for those of 1883.

CONTENTS

THURSDAY, FEBRUARY 21, 1884

THE MODERN LANGUAGES OF AFRICA

A Sketch of the Modern Languages of Africa, accompanied by a Language Map. By Robert Needham Cust. 2 vols. (London: Trübner, 1883.)

WHY this work has been restricted to the "modern" languages of Africa is not apparent, seeing that there are not half a dozen ancient or extinct African tongues altogether of which science has any knowledge. The limitation is the more remarkable that every one of these ancient tongues is duly recorded and dealt with in its place, partly lest it should "seem to have been overlooked," partly seemingly for no other reason than that the author has forgotten the restriction so needlessly imposed upon himself. Yet when we are told that Gíz, the most important of them next to Old Egyptian, "may be deemed the *Lingua Franca* of Abyssinia"! (p. 88), and when Rinn's remark on the possible reconstruction of an Archaic Berber "offering analogies to the languages of High Asia" (p. 105) is quoted without comment, one begins to feel that after all it might have been wise to have adhered to the restriction.

But Mr. Cust does not profess to be critical or even scientific, and although in one place science is declared to be his "sole object," it is elsewhere explained that his "chief motive" is to assist the missionaries, "the peculiar outcome, the most wondrous development, and the great glory of the nineteenth century" (p. 461). He hastens even to assure us that personally he knows "absolutely nothing" of the subject, and in one not very clear passage he seems to take the anticipated charge of "his entire absence of training in any school of comparative philology" as "a compliment" (p. 15). Most people, however, will probably feel that some knowledge of the principles of comparative philology would at all events have been an advantage, if not an absolute *sine quâ non*, in a writer undertaking to give us "a sketch of the modern languages of Africa." Anyhow, in the absence of such a qualification it is the less surprising to find the hand of the amateur betrayed in almost every page of the present work, which supplies abundant evidence that it is written by a person sure neither of himself nor of his subject. Great vagueness, inaccuracies, and incoherencies of all sorts, commonplace platitudes gravely put forward as important truths, the existence of well-known or historical people, such as the Funj (Fung) of Senaar, referred to as doubtful, such expressions as "parallels of longitude," "Hervas, the Father of Comparative Philology"! and the like, everywhere reveal an essentially unscientific habit of thought. This is strikingly manifested in the treatment of the Bantu prefixes, which are described as "an intolerable nuisance," as indeed they must needs have proved themselves to be to a writer ignorant of their very meaning. He refers (p. 12) to "languages of the Hamitic group, such as *Wa*-Galla," where the form should obviously be *Ki*-Galla, *Wa* indicating the people, *Ki* their speech. Hence the difficulty presented by these troublesome particles is perhaps not unnaturally met by the naïve plan of making a clean sweep of them. Thus we have everywhere Swahili, Suto, Chuana, Ng'anga (Nyanja), for Ki-Swahili, Se-Suto, Se-Chuana, Chi-Ng'anga, and so on; nor can it be denied that at least on the score of simplicity this plan may possibly recommend itself to the ordinary reader.

To a writer ignorant of comparative philology, the phonetics, structure, and general morphology of the languages must necessarily have proved equally "intolerable nuisances." Hence this difficulty is also met by the same simple expedient of elimination, and we are accordingly quietly warned (p. 15) that "it lies outside the purport of this sketch to dwell upon the grammatica peculiarities of languages, or families, and groups of languages," the object being "to give a sketch of the whole subject, not to write an account of each language." Certainly a zoologist might in the same way undertake to write a "sketch" of the animal kingdom without reference to the comparative anatomy, osteology, general morphology, or other structural "peculiarities" of his various orders and families. But by so doing he would perform a remarkable *tour de force*, if he thereby either added to his own reputation or conferred any substantial benefit on his readers.

Nevertheless, it cannot be denied that, heavily handicapped as he was, Mr. Cust has contrived to produce a work of value to linguistic students. This he has done by wisely restricting himself to what may be called the topography and bibliography of the subject. Abundance of time and means, industrious habits, and the opportunities of procuring information afforded by his connection with a number of learned bodies in England and abroad, have enabled him to deal with these useful branches almost exhaustively. Apparently following somewhat on the lines suggested by the linguistic and ethnological appendixes to Stanford's Compendium, he has collected from all quarters copious materials bearing on the history, habitat, literature, bibliography, and classification of almost every known language and dialect still current amongst the African aborigines. The bibliographical references, perhaps the most valuable feature of the work, are reserved for a very full appendix, containing "a bibliographical table of languages, dialects, localities, and authorities." The other materials, generally brought well up to date, are distributed over the various chapters devoted to the "prolegomena" of the subject, and to the several linguistic families of the African continent. Here the author unfortunately still follows Fr. Müller's classification, apparently unaware that on some material points this writer's views have lately been completely exploded. Thus the Tibbu of the Eastern Sahara, although clearly shown by Nachtigal (*Sahârâ und Sudan*) to be essentially distinct both in speech and physical type from the Negro, are still grouped with that division. The consequence is that in the accompanying coloured language-map by Mr. E. G. Ravenstein, the Negro domain is extended beyond the Sudan northwards to Fezzan and Tripoli, at least 7° of latitude beyond its proper limits. The nomenclature is here also both confused and, as frequently elsewhere, at variance with the text. Thus we have "Teda or Tibbu" instead of Teda or Northern Tibbu, and below it "Dâza or Gora'an" for "Dâza or Southern Tibbu." And in quoting Nachtigal's work why does Mr. Cust go out of his way to give us a false prosody (*Sahâra*), where the author was so careful to write correctly *Sahârâ*?

A more serious blunder is his retention of the unfortunate "Nuba-Fulah" family, which has no objective existence, and which he has rashly taken upon himself even to enlarge. On this subject he writes in the true style of the amateur:—"This arrangement [an arrangement absolutely unscientific] commends itself to my judgment from its convenience, as enabling me to pass on from the confines of the Hamitic language-field, and sweep into this new group all that is not strictly Bántu, or which cannot be conveniently treated as Negro" (p. 142). So in their reports on Egyptian Sudan our officials "sweep" into the Arab group all that is not strictly Negro, and *vice versâ*. And so nearer home our popular ethnographists "sweep" into the "Turanian" group all that is not strictly Aryan, and so on. The scope that this sort of thing gives to discursive writing is about as boundless as is the mischief it does to the cause of scientific progress. In future editions Mr. Cust ought relentlessly to exscind this "convenient" Nuba-Fulah group, and relegate to one of his numerous appendixes "all that cannot be conveniently treated" under any recognised divisions.

These remarks will apply with equal force to the "Hottentot-Bushman Group," of which Mr. Cust again writes: "Following F. Müller and T. Hahn, I constitute a separate group, and take the opportunity of enlarging its dimensions, so as to sweep in certain tribes speaking apparently languages which differ entirely from any above described" (p. 434). It will be seen that Mr. Cust has constituted himself a sort of African "Spazzacammino," sweeping up and down the continent with an airy recklessness which may astonish the groundlings but "cannot but make the judicious grieve." The result in this instance is to scatter over the southern half of Africa a number of tiny little enclaves, all coloured alike and reaching as far north as Abyssinia, which make Mr. Ravenstein's otherwise excellent map look like nothing so much as one of those coloured maps of Scotland with fragments of Cromarty, Elgin, and the other northern shires strewn promiscuously over the face of the land. Now in Scotland these fragments have literally a *tribal* connection, but the connection between the African enclaves—Tua, Sarwa, Nena, Sania, Akka, Twa, Doko, &c.—is of a purely negative character. None of them speak Negro, Fulah, or Bantu idioms; therefore let us sweep them together. It is the old joke about elephant and tea-cup, which are said to resemble one another because neither can climb up a tree.

Besides the general classification, the whole text will need careful revision before the book can be accepted as a standard work of reference on the points with which it professes to deal. Almost on every other page we read such statements as these:—There is "nothing savage" in the Somali nature. There is little doubt that Kandáke was Queen of Napata on the Middle Nile, and a Hamite. The very existence of the Niger was unknown before the present century. The Siwah language is of no importance whatever, &c. The account given (p. 110) of the word *Tamashek* is hopelessly muddled. It is stated to have been applied to the people "by the Arabs, and not by the tribes themselves, who scarcely recognise it, and call themselves Imoshagh, or Amazirg," the fact being that Imoshagh and Tamashek are the same word, the former masculine, indicating the people, the latter feminine, indicating their language. About the closely related Kabail dialect again, Mr. Cust writes: "I was unable to satisfy myself on the subject of this language until I had personally visited Algeria, Tunisia, and the Sahara, conferred with men on the spot, and seen with my eyes the conformation of the country" (p. 106). Here there seems to be some mystification. It is not obvious at first sight what the conformation of the country has to do with the language; and it is still less obvious how a visit to the Sahara, of which we now hear for the first time, could throw any light on a language scarcely current within the frontier of that region.

At the same time it is but fair to state that, with all its inevitable shortcomings, it often betrays evidence of extreme labour profitably bestowed on obscure languages. A good idea of the general treatment of the subject is afforded by the subjoined account of the little-known Komóro group:—"There is no doubt that these languages are African, and not Malayan, like the Malagási. Several names are recorded, and it is presumed that they are dialects:—(1) Hinzua, (2) Angazidya, (3) Antilote, (4) Mohilla. Elliot left in manuscript a vocabulary of Hinzua, the dialect of the Island of Johanna, compiled by himself. Hildebrandt supplies a considerable one of Ki-Nzuáni compiled on the spot. Casalis in his Suto [Se-Suto] grammar gives a dozen words picked up by chance. Bleek in the 'Languages of the Mozambík' gives words picked up by Peters during a week's residence in the island. Hildebrandt remarks that this dialect is only spoken in the Johanna Island, but that the dialects of the other islands only differ a little. It is never committed to writing. For purposes of business the people use the Swahíli language in the Arabic character. Steere printed in 1869 a short vocabulary of the language of Great Komóro, called Angazidya, supplied by the sons of one of the kings of the islands. Van der Decken remarks that it is only a dialect of Swahíli, greatly altered in pronunciation and affected by the contact of Malagási. Gevrez, a French *employé* in Mayotte, one of the islands, and a French colony, published an account of the group from personal knowledge in 1870. He divides the population into fractions: one-tenth are Arabs, one-tenth are Malagási, four-tenths are Antilote—a mixture of Arabs and Africans, and four-tenths are of the Bántu family, though not entirely pure. The Antilote speak a mixture of Malagási and Swahíli. Very few in the island speak or write pure Arabic, but Swahíli, which is the language of the schools, the towns, and good society. The character used for writing is a corrupted form of Arabic." A. H. KEANE

RECENT TEXT-BOOKS OF DETERMINANTS

Die Anfangsgründe der Determinanten. Von Dr. H. Kaiser. (Wiesbaden, 1882.)

Die ersten Elemente der Determinanten Theorie. Von Prof. Wilh. Bunkofer. (Tauberbischofsheim, 1883.)

Éléments de la Théorie des Déterminants. Par P. Mansion. (Paris, 1883.)

Teoría elemental de las Determinantes. Por D. Darío Bacas y D. Ramón Escandón. (Madrid, 1883.)

THE literary activity of Germany seems to make it necessary that a new Introduction to Determinants shall appear at least once a year. What amount of good results from this is not quite apparent to an outsider: it is even probable that there is none, unless the unintended reflex benefit, in the form of experience in book-making, which the authors thereby obtain.

Here we have two elementary booklets, one of 40 pp., the other of 28 pp.; and a very short examination of them suffices to show that the writers could have spent their time and energy to much better purpose, if it was the public that they intended to benefit. What they have written is probably not worse than what has been in use for years; but certainly it is not any better. Indeed Germany has always had more really good elementary expositions of the theory of determinants than any other country, and two or three of these have passed through several editions. Dr. Kaiser and "Professor" Bunkofer are quite capable men for the work they have undertaken: on this score little fault can be found. The latter sketches his "Notes of Lessons," as young English teachers would call them, with pedagogic ability and skill; the former is more wooden, and more unwisely ambitious, and we cannot, unsupplicated, pardon him for saying that Gauss in coining the word "determinant" thereby introduced a definite new idea into analysis, but he goes about his work in a sufficiently workmanlike manner, and is on the whole sure of the ground he treads. We only wish both authors "more power," and next time a happier selection of subject.

Prof. Mansion's "Elements" is a book of a higher type. The present edition, however, is the fourth; and therefore no detailed examination can be looked for. Suffice it to say that there is really no better introductory book published; the exposition and arrangement are admirable, and it has, what so many Continental text-books want, small collections of suitably graduated exercises for the learner. There is only one point which it seems desirable that Prof. Mansion should reconsider, viz. the nomenclature of the special forms of determinants. He employs, for example, both Sylvester's term "persymmetric" and Hankel's "orthosymmetric." Should not one of these immediately receive decent burial, and should not the latter be that one? It is not shorter, it is not more descriptive, it is not more accurate in its description than its rival, and its rival was by several years first in the field. As for "doppelt-orthosymmetrisch," its author is simply unconscionable; it is one of those words which, as Mark Twain puts it, are alphabetical processions and have a perspective: we should have been glad if Prof. Mansion had dealt more summarily with it. In another instance, that of "skew" determinants, we have confusion worse confounded. Cayley's first paper regarding them appeared in *Crelle* (1846), and was written in French, the title being "Sur quelques propriétés des déterminants *gauches*." The term *gauche* (Eng. *skew*, Germ. *schief*, Italian *gobbo*) was at once accepted and employed, as well it might, by all the standard writers. Of late years, however, there have been busy times with the mathematical coiners on the Continent, and in consequence we have as substitutes for "skew"—

"symmetrale,"
"congruente" (not in Mansion),
"pseudosymétrique."

Surely it is too tiresome and quite unnecessary to wait until by a process of artificial selection the fittest or unfittest of these shall survive. Prof. Mansion's "Elements" and the German translation of it have deservedly a large circulation on the Continent, and thus have much power to propagate good or evil. We would therefore earnestly ask him to consider whether it would not be better to recognise throughout his work only *one* name for each special form, and to relegate all synonyms to the index.

The last text-book on our list is Spanish. Although it is the largest (200 pp.) and most pretentious of the four, we regret that it is impossible to say a good word regarding it. The authors have most manifestly no grasp of the subject, and advance with a gay step and light heart through inaccuracy after inaccuracy. Their model unfortunately is Dostor, and equally unfortunately they are more than faithful to him. At the very outset they show their hands. The so-called "notation of Cauchy" is not Cauchy's; what is really Cauchy's is not attributed to him; and the "notation of Leibnitz" is more Cauchy's than Leibnitz's, but belongs to neither. Nor is this wild start of Book I. redeemed by a good end. On pp. 96-98 five examples of skew determinants are calculated at length with a complacent unconsciousness of the simple property which makes all the calculation unnecessary; and pp. 99-101 are taken up with the rather epoch-making definition—

$$\left\| \begin{matrix} a & b & c \\ a' & b' & c' \end{matrix} \right\| \equiv \left| \begin{matrix} 1 & 1 & 1 \\ a & b & c \\ a' & b' & c' \end{matrix} \right|,$$

and some perfectly legitimate deductions from it. Book II. deals with the so-called applications of determinants, and closely follows Dostor. The most amusing part of it, as is the case also with Dostor, is the chapter devoted to "Applications to Trigonometry." Dostor, however, is outdone on his own ground. For example, after it has been proved that $\cos A = (b^2 + c^2 - a^2)/2bc$, one whole octavo page is occupied in showing, *by means of determinants*, that $\sin \frac{1}{2} A = \sqrt{(s-b)(s-c)/bc}$. This *tour de force* is like that of Hudibras, *telling the clock by algebra*; and the moral in both cases is the same.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Mr. Lloyd Morgan on Instinct

I HAVE read with much interest Mr. Lloyd Morgan's very able paper on "Instinct" in the current issue of NATURE, and I feel it is desirable, without following him over all the ground which he has traversed, briefly to consider those parts of his communication which have special reference to my own work.

The broad question with which he begins—viz.: "Is there a science of comparative psychology?"—is not a question which I feel specially called upon to answer, inasmuch as almost every one who has hitherto written upon psychology has taken it for granted that there is such a science. Nevertheless I may state the justification which I am myself prepared to give of this universal assumption.

When we say that a dog is a more intelligent animal than a sheep, we do not doubt that we are making as real a proposition as when we say that the President of the Royal Society is a more intelligent man than Dick, Tom, or Harry. Now in all cases where there is a general consensus of feeling of this kind, there is an antecedent presumption that the common sense of which it is the expression is in the right, and that any ingeniously-constructed argument of scepticism is in the wrong. We may therefore approach Mr. Lloyd Morgan's argument with the antecedent presumption that there must be something wrong about it somewhere; and I do not think that it requires much reflection to see where the error lies.

According to the argument as stated by my critic, there is a true science of human psychology, because, although my knowledge of another human mind is no less ejective than is my knowledge of a dog's mind, yet "by means of language human beings can communicate to each other the results which each has obtained, and each human being is able *to submit these results to the test of subjective verification*." But how, let us ask, in its last analysis is this verification obtained? By language, no doubt; but what in its last analysis is language? As spoken by my neighbour, it is for me nothing more than my own interpretation of a meaning presented by the observable activities of an organism. Therefore, if on such a basis I am entitled to affirm that such interpretations as I make are of the nature of "subjective verifications" of conclusions drawn from the introspective observation of my own mind, why am I not entitled to a similar view when the eject of my contemplation is the mind of a dog? The dog cannot speak, but he can display other activities which, so far as they go, are quite as valid as a basis on which to construct my "subjective verification" as are the activities manifested in language. Of course language is able to convey immeasurably more information touching the ejective mind than can be conveyed by any other kind of activity; but this fact is merely due to the further fact that language is a system of activities expressly designed for this very purpose. The higher value of language in this respect is therefore nothing more than an expression of the higher development of intelligence, which enables the mind to perceive the desirability of devising a system of bodily activities expressly designed to serve as the vehicle of communication between subject and eject,—as is proved by the fact that any system of bodily activities which may be agreed upon (such as gesture, lip-reading, writing, &c.) are alike available for this purpose. Language, then, of any kind is merely a conventional system of bodily activities which, because *intended* to convey information from mind to mind, we call signs. But now, the element of *intention* on the part of my neighbour is in no wise essential to my ejective interpretation of his bodily activities, or to what Mr. Morgan calls my subjective verification of them. The involuntary groan of pain, the pallor of fear, and a thousand other unintended "expressions of the emotions," as well as a thousand other unintended expressions of thought (*e.g.* the act of pocket-picking under the eye of an unseen detective), are, as it is proverbially said, "more eloquent than words."

I submit, therefore, that, although a dog cannot give us any large measure of ejective information intentionally, or by purposive signs (he does, however, give us some even of this), we have still abundant material furnished by his other bodily activities for constructing our ejective inferences. For example, the dog gives very much the same indications of pain under the whip that a boy gives under the cane; therefore the gamekeeper has no more doubt that he is hurting the dog than the schoolmaster has that he is hurting the boy—nor would the schoolmaster be more satisfied on this point by asking the boy whether the cane did hurt.

If I have been followed thus far, I should be inclined to go still further, and to say that in my opinion the "unpremeditated art" of natural movements (whether in men or animals) is a surer basis on which to build ejective conclusions than is the more indirect information supplied by intentional gesture or language, *so far as the low or simple intelligence to which animals attain is concerned*. Poets and moralists are fond of insisting upon this point as regards young children, where the level of intelligence may be even considerably above that of the most intelligent animal. The immense service of language in ejective analysis is rendered in those higher and more complex regions of intellectual life to which man alone attains. Still, I doubt not that if animals could speak, so that we could interrogate them as to their mental operations, we should obtain a great deal of supplementary information; only of course this supposition is an impossible one, seeing that, if an animal could speak, its intelligence would no longer be "animal intelligence."

On the whole, then, as concerns the question whether there is a science of comparative psychology, I should say that there certainly is such a science, in the same sense as there is a science of human psychology. For it seems to me, in view of the above considerations, that the argument adduced by Mr. Lloyd Morgan against the former is quite as applicable against the latter. In both cases alike our ejective inferences can only be founded on the observable activities of organisms, and if it is true that of these observable activities language affords an exceptionally meaning class, it is also true that where language is absent the mental processes which stand to be ejectively analysed are of a comparatively simple nature. I therefore see no reason to recede from the position which I have taken up in the works to which Mr. Lloyd Morgan refers, where I observe with reference to the peculiar standing of psychology (both human and comparative) among the sciences in the matter which we have been considering—"although the evidence derived from ejects is practically regarded as good in the case of mental organisations inferred to be closely analogous to our own, this evidence clearly ceases to be trustworthy in the ratio in which the analogy fails; so that when we come to the case of very low animals—where the analogy is least—we feel uncertain whether or not to ascribe to them any ejective existence" ("Mental Evolution in Animals," p. 22). And again, with reference to such objections as that of Mr. Morgan—"Scepticism of this kind is logically bound to deny evidence of mind, not only in the case of the lower animals, but also in that of the higher, and even in that of men other than the sceptic himself. . . . This is evident because, as I have already observed, the only evidence we can have of ejective mind is that which is furnished by objective activities; and, as the subjective mind can never become assimilated with the ejective, so as to learn by direct feeling the mental processes which there accompany the objective activities, it is clearly impossible to satisfy any one who chooses to doubt the validity of inference, that in any case, other than his own, mental processes ever do accompany objective activities" ("Animal Intelligence," p. 16). And, by parity of reasoning, the same argument may be used against Mr. Morgan's sceptical objection to comparative psychology as a science. In whatever measure he is *on principle* a sceptic touching the inferences which this science is able to draw as to the existence and nature of animal psychology, in that measure I think he ought in consistency also to be a sceptic with reference to the same points in the science of human psychology.

Coming now to Mr. Morgan's strictures on my psychological definition of instinct, I understand that they are made, not with reference to any defect in my definition as a psychological definition, but with reference to the possibility of any such definition whatever. In his view there can, from the nature of the case, be no psychological definition of instinct; there can only be a physiological definition of the cerebral processes which are concerned in actions termed instinctive. Here, then, is a broad issue, although it only constitutes a part of the still broader one which we have just been considering.

I may say first of all that, if we want a physiological definition of instinct, I do not think that the one which is furnished by Mr. Lloyd Morgan is valid. This definition is that reflex actions are due to a general type of nervous organisation, instinctive actions to a specific type, and intelligent actions to an individual nervous organisation. Now, this threefold definition presents none of that "definiteness of application" which Mr. Morgan implies, nor does it tend, as he supposes, to add any "clearness to our ideas concerning the things of which we speak." For it is open to the fatal objection of arbitrarily classifying as instinctive many actions which are now universally regarded as reflex; while, conversely, a still greater number of actions now universally regarded as instinctive would, under this definition, become classified as reflex. That is to say, there are, on the one hand, many reflex actions which we should all feel it absurd to call instinctive, and which are nevertheless manifested by only one species (in our own organisations, for example, we may mention the "patellar reflex," and the convulsions produced by tickling the soles of the feet); and, on the other hand, there is a very much greater number of instinctive actions which we should all feel it absurd to call reflex, but which are nevertheless manifested by many species of a genus, others by many genera of an order, and so on, until in such cases as those of nidification, incubation, &c., we arrive at instincts general to a whole class. The truth, therefore, is that a zoological classification, being made with reference to the whole organisations of animals, has no such special application to the refined structure of their nervous systems (which, indeed, we can only appreciate by its effects on conduct) as would be required for the groundwork of

Mr. Morgan's physiological definitions of reflex action, instinct, and intelligence. If we want such a definition it must be made independently of any zoological classification, *and with exclusive reference to the point whether the adaptive action requires for its performance the operation of the higher nerve-centres*—a point which can only be determined by vivisectional experiment. In other words, on the side of objective psychology the only distinction that can be drawn between a reflex and an instinctive action, is as to whether the action can be performed by the lower nerve-centres alone, or requires likewise the cooperation of the higher nerve-centres. And this is just what we should expect to find to be the case on the objective side if, as I have endeavoured to show, the one peculiarity which distinguishes actions classed as reflex from actions classed as instinctive, consists in the latter exhibiting in their performance a mental or conscious element which is not exhibited in the former.

Now, if the *raison d'être* of the term "instinct" is thus to denominate a class of adaptive actions in which there is a subjective, or rather let us say an ejective element, I cannot see that anything but confusion is to be gained by forcing this term into objective implications. Were any term needed to designate the neurosis of instinctive action, it would be far better to coin a new one than thus to abuse an old one. I am fully sensible of the difficulty which often arises in deciding whether a particular action should be assigned to the instinctive or to the reflex class; but, as I observe in "Mental Evolution in Animals," "this difficulty does not affect the validity of the classification any more, for instance, than the difficulty of deciding whether Limulus should be classified with the crabs or with the scorpions affects the validity of the classification which marks off the group Crustacea from the group Arachnida."

For the rest, Mr. Morgan's criticism on my psychological definition of instinct hangs entirely upon his previous criticism as to the possibility of a science of comparative psychology, and as I have already endeavoured to answer the latter, I need not go over the same ground again by answering the former. There are only two points raised by his paper to which this general answer does not apply, and with these, therefore, I shall conclude.

The first of these two points is a charge of inconsistency. My critic observes that, after having said "it is enough to point to the variable or incalculable character of mental adjustments as distinguished from the constant and foreseeable character of reflex adjustments," I go on to define instinctive actions as mental adjustments which are nevertheless of a constant and foreseeable character. Now I think, if any one will read my chapter on "The Criterion of Mind," he will see that this apparent inconsistency is not a real one. It would be a real one if the passage above quoted referred only to this and that particular action of an animal, apart from all the other actions of the same animal, which, according to my criterion of mind, are competent to inform us whether or not the animal in question is a *choosing* and *perceiving* animal. But the passage quoted refers to the whole constitution of an animal so far as we can know it by observation of activities, and therefore the question whether this or that particular activity is to be regarded as mental or non-mental (instinctive or reflex) requires to be answered by all that we learn concerning the other activities of that animal. If none of its activities are other than those of a constant and foreseeable character, we have no reason to suppose that it is a choosing or perceiving animal; but if some of its other activities are indicative of choice and perception, our knowledge of this fact must be allowed due weight in any attempt that we may make at classifying this or that particular action as reflex or instinctive. The case, in short, is just the converse of that which I thus state in the chapter referred to:—"Many adjustive actions which we recognise as mental are, nevertheless, seen beforehand to be, under the given circumstances, inevitable; but analysis would show that this is only the case when we have in view agents whom we already, or from independent evidence, regard as mental."

The second point to which I have referred as the only one that now remains for me to consider, is to the effect that I have mistaken "Mr. Spencer's position with regard to the 'very subordinate importance of natural selection as an evolving source of instinct,' and with regard to the question of 'lapsed intelligence.'" Here I can afford to be brief, inasmuch as any one who cares to do so can compare my interpretation of Mr. Spencer's writings with the passages in those writings to which I refer. It seems to me perfectly clear that, although both the principles in question are alluded to by Mr. Spencer, neither of them holds the same prominence in his theory of the development of instincts from reflex action as they hold in the theory of Mr. Darwin.

In conclusion, I trust Mr. Morgan may feel that, in writing this somewhat elaborate reply to his criticism, I am marking as emphatically as I can my sense of its ability. And if the general effect of this discussion is to show that the phenomena of instinct present peculiar difficulties to any attempt at a fundamental analysis, I should like no less emphatically to express my conviction that such an analysis is not to be facilitated by closing our eyes upon the entire class of phenomena to which alone the word is applicable. We may, of course, abstain from any attempt at such analysis, and devote our attention exclusively to the physical as distinguished from the mental side of the subject. Only in this case we may not speak of *instinct*.

GEORGE J. ROMANES

"Mental Evolution in Animals"

MR. ROMANES' comment on my communication in NATURE of February 7 (p. 335) is not quite satisfactory. I do not suppose that he has any spite against my skate; but as he does not know me, and did not see the incident in the Manchester Aquarium, I think it is very possible that he may have been naturally predisposed to underrate the significance of the story. I do not admit that I can be reasonably blamed for saying that a repetition of the conditions would have been useful, if possible, while at the same time pointing out that the result would not necessarily have settled the question. Test experiments are always useful, even if they do not settle the main question. Mr. Romanes' terrier story was not necessary to make clear what he means by "accident," and there is no analogy between it and my skate story. In one case a trained, or at least tamed, dog did as he was told, and the conditions of success were prearranged; in the other, a fish spontaneously did something for his own advantage. As for the fish smelling the food, this does not harmonise with the circumstances as I described them, and had Mr. Romanes seen the incident I do not think this explanation would have occurred to him; the whole series of actions was too rapid, and had too much the appearance of co-ordination. The propulsion of the food into the ready mouth was the work of an instant. Had the mouth not been ready, as the cricketer's bat is the instant the ball leaves the bowler's hand, the morsel would have been missed. Finally, Mr. Romanes tells us ("Animal Intelligence," p. 351) that the bear observed by Mr. Hutchinson was a Polar bear. Now this species is "almost marine in its habits." It lives upon seal-flesh and also upon dead meat which it finds floating in the water. It is not infrequently cast adrift on an ice-floe or an iceberg. It is therefore not at all improbable that the method of fishing described may be an instinct developed hereditarily. The fact that two bears behaved in precisely the same manner strengthens this supposition. Mr. Darwin does not say whether the bear observed by Mr. Westropp in Vienna was a Polar bear or not, but he observes that the action in question "can hardly be attributed to instinct or inherited habit," as it would be "of little use to such an animal in a state of nature." It seems to me that such action would be very useful to Polar bears in a state of nature.

Manchester, February 11 F. J. FARADAY

The Remarkable Sunsets

AT the present stage of the discussion upon the "green sun" and rosy sunsets it seems to me it would be well to recall attention to a few facts, for there seems to be a tendency on the part of some correspondents to allow imagination to carry them beyond the region of fact into that of fancy. First, then, I would point out that my observations show conclusively that at the time of the green sun there was an altogether abnormal amount of moisture in the upper regions of the atmosphere, while the ordinary hygrometric observations showed the air near the ground to be comparatively dry. I have studied the rain-band spectrum almost daily for the last six or seven years, and I have never before known such a long continuance of the heavy rain-band in a comparatively clear sky—a sky in which there was only a light haze. At sunset and sunrise the intensity of the bands was such as I have before seen only from an altitude of some six or seven thousand feet, and even then rarely. In this connection it may be well to point out that the spectrum as observed by Mr. Donnelly (NATURE, vol. xxix. p. 132), though, as remarked by Mr. Lockyer, resembling that observed here in some respects, yet differed from it in some important points. The "low sun-bands" appeared weak rather than strong, partly perhaps by contrast with the great intensity of the rainband, and the rainband itself was easily divided into lines, of which eight are recorded in my note-book as being seen with a one-prism spectroscope. The band between *b* and F, observed by Mr. Lockyer, was also seen here, and was found to be one ascribed to aqueous vapour, W.L. 504. A spectrum almost in all respects similar to that observed here can be seen by any one who will examine the absorption produced by a *small* cloud passing over the sun as seen with the spectroscope, having a lens in front of the slit. The contrast with the bright spectrum of the sun shows the general absorption in the red very clearly, and if the sun be near the horizon the other bands will be, in most cases, fairly well seen.

It is worth noting that we have had an unusually early and heavy monsoon, ushered in by a remarkable thunderstorm and followed by a period when the spectrum showed an abnormal freedom from vapour, the rainband at times being quite invisible. During this latter period we have had beautiful rosy after-glows, the sunlight being apparently reflected from thin, almost invisible, cirrus clouds.

If the presence of dust can be proved, these phenomena, as I previously indicated, can be readily explained in accordance with the facts so beautifully illustrated by Mr. John Aitken (*Trans. R.S.E.*, vol. xxx. p. 337), for the dust particles would condense moisture in the upper parts of the air, and we would have a light haze, such as was observed here, not sufficiently dense to cause actual clouds, but deep enough to give the special absorption effects, while the dust itself would assist in producing the general absorption.

Against the idea of Java dust, however, have to be set a number of facts of which the following are a few:—The maximum phase of greenness was on the same day (September 10), all over Ceylon and South India, and as far west as long. 64° (at sea). The green sun was not seen at Rangoon nor at the Andaman Islands, though at the latter place the sounds of the eruption were heard. The first rain that fell here afterwards was subjected to careful microscopic analysis, and showed no trace of volcanic dust. The phenomenon reappeared on September 22.

For my own part I think there is strong evidence that the influence of the Javan eruption was an electrical one, and that that was not necessarily propagated by the actual transference of matter. Mr. Whymper's very interesting letter is of course by no means conclusive as regards the effects of dust, for it is, I believe, regarded as virtually proved that the mere existence of dust in large quantities in volcanic ejecta proves the presence of an abundance of water vapour. C. MICHIE SMITH

P.S.—There is a misprint in my letter to Sir William Thomson which, as I have seen it twice quoted, ought to be corrected. It is in vol. xxix. p. 55, line 8, which should read: "After the electricity had gone to *negative*." C. M. S.

The Christian College, Madras, January 23

SINCE the end of October, when I first observed an unusual red glow for a considerable time after sunset, I have been a close observer of the atmospheric phenomena so fully described by your correspondents. For some time past they have appeared with little of their former brilliancy, until the evening of the 7th inst., when there was a remarkably fine display, equalling in many respects those of December. Of this I shall particularly mention but one feature which I had seen three times previously, but never displayed with such intensity and clearness of definition. At 5.30, when the after glow was at its maximum, a lovely crimson arc appeared opposite it in the eastern horizon, in every respect as described by Mr. Divers in his letter dated from Japan, which appeared in NATURE of January 24 (p. 283). I may remark that I have observed here, from November 10 to this date, but latterly with much diminished intensity, every one of the phenomena he so graphically describes. A. C.

Roscommon, February 11

"The Indians of Guiana"

IN the notice of Mr. Im Thurn's work on the Indians of Guiana, in the current volume of NATURE (p. 305), Mr. Tylor writes: "What is still more curious is that the rude method of making thread by rolling palm or grass fibre into a twist with the palm of the hand on the thigh may be commonly seen in Guiana, although the use of the spindle for spinning cotton is also usual." As such a fact appears to be curious to so eminent an anthropologist as Mr. Tylor, it may be of interest to some of your readers to learn that this mode of twisting fibres is still by no means uncommon in India, though spinning must there have been familiar to the natives for unnumbered generations. I have frequently seen Hindus of various castes twist a mass of jute-fibre into a compact and firm rope of considerable length, between the palm of the hand and the inside of the thigh, and by the same means they will frequently produce long pieces of strongly coherent twine when the need for it arises. From my experience, which, though confined to a small geographical area, comprehended an acquaintance with both Hindus and Mohammedans imported into the tea-districts from almost every part of British India, I should suppose that this custom of twisting fibres into rope and twine is universal throughout the country, though doubtless it is resorted to rather as a makeshift than as a regular mode of manufacturing twisted cords. That such a means should be resorted to by the wild tribes of the north-eastern frontier is by no means strange, though these have acquired not a little skill in spinning and weaving cotton, but that so primitive a method should still prevail amongst peoples so highly cultured as the Hindus and Mohammedans of India often struck me as remarkable.

While noticing Mr. Tylor's interesting article, I cannot refrain from questioning the justice of the supposition that pile-dwellings on the land are due to the "survival of the once purposeful habit of building them in the water." That in New Guinea such is the case there can be little doubt, as Dumont d'Urville and Mr. Wallace, as well as Prof. Moseley, have remarked. And that Mr. Im Thurn's supposition with regard to the natives of Guiana is also correct there can hardly be a doubt. But these two cases scarcely seem to me sufficient upon which to generalise, even when added to Prof. Moseley's pretty and ingenious view as to the origin of the Swiss châlet. As has been pointed out to me by my friend Mr. W. E. Jones, F.R.I.B.A., Lecturer on Architecture in the Bristol University, a somewhat similar development of single-storied into two-storied dwellings is to be traced in the stone buildings as well as in the less substantial dwellings of Western Asia, between the twentieth and the twelfth centuries B.C., and though of course it is not impossible, it certainly seems improbable that a race of ancient lake-dwellers should have perpetuated on sandy plains a practice which must altogether have ceased to be useful long before it reached a region so far removed from its original home. And indeed it seems to me that pile-dwellings may be observed in localities in which it is scarcely possible that the practice could have originated in lake-dwellings, or in any dwellings of any sort erected in water, whether fresh or salt. I allude more particularly to the raised dwellings of the Nagas, Kukis, Cacharis, Khassias, and other hill-tribes of the north-eastern frontier of India, in the midst of which I lived for several years. That these people should ever have dwelt so near the sea that they acquired the habit of erecting pile-dwellings therein seems to me highly improbable when it is remembered that their racial and linguistic affinities place them undoubtedly in that great Mongolian group of which the Thibetans and Burmese are examples; and that therefore they may be regarded as immigrants from more Eastern Asia, rather than as tribes which have been gradually driven back from the Bay of Bengal by the encroaching civilisation of the Hindus. Nor does it seem probable that their pile-dwellings were originally erected in lakes amongst the hills, for in fact the lakes nowhere exist. There are indeed extensive *bheels* or marshes, which during the rainy season sometimes contain a good deal of water. But these *bheels* are, during at least a portion if not the whole of the year, so pregnant with fever and ague that I cannot believe that they were ever employed, as were the lakes of Switzerland and Italy, for the protection of the habitations of man. Yet these north-eastern frontier tribes for the most part build their houses upon piles. These are generally of bamboo, and so of course are very perishable, but occasionally small timber is employed. The floor or platform (of coarse bamboo matting) is seldom raised more than from twenty-four to thirty inches above the ground, though, if my memory serves me, I have occasionally seen it raised as much as between six and seven feet. Beneath this platform a good deal of lumber generally accumulates, and the poultry and pigs frequently congregate for shelter, but I think I never saw an instance of the lower portion of the erection being inclosed by matting to form a "ground floor." Were these pile-dwellings confined to the low, flat lands upon which the Bengali delights to place his paddy-fields, it would be obvious that they were adopted for the purpose of obtaining a dry, wholesome floor, and security against unanticipated floods. But so far is this from being the case that only very rarely is a Naga or Kuki village to be found on low-lying ground, and generally they are to be seen upon the sides and even the summits of considerable elevations, where any danger from floods is quite out of the question. Again, it might be supposed that these elevated dwellings were adopted as a protection against wild animals but for a curious practice occasionally observable amongst the hill-men. This is the habit of building upon the steep side of a hill in such a manner that the back of the dwelling rests directly upon the ground, while the front is supported upon piles which are of a height sufficient to render the floor, throughout its length, horizontal. Such a plan as this reduces the protection afforded from vermin and wild animals to a minimum, and seems to justify the belief that the fear of these creatures at least could have little or no influence upon the architectural habits of the hill-tribes of this part of India; and I long ago came to the conclusion that here at least the object of the pile-dwellings was simply to attain in the easiest way a floor which should be exempt from the damp exhalations of a tropical soil.

JAMES DALLAS

"Probable Nature of the Internal Symmetry of Crystals"

UNDER this head Mr. Barlow has published in NATURE of December 20 and 27, 1883 (pp. 186 and 205) an interesting and ingenious memoir. The subject being very important, but also very difficult and intricate, a discussion of the new theory may perhaps contribute to render our ideas a little more precise.

Whilst Haüy, Frankenheim, Delafosse, Bravais, and others think a crystal built up of mere congruent particles, which may be either the chemical molecules or rather certain aggregates of them, Mr. Barlow considers the arrangement of the different chemical atoms in the interior of a crystallised compound, and illustrates some facts by this manner of viewing them. I purpose in the following submitting some objections which arise against the deductions of the author. These objections are of a geometrical, chemical, and physical nature; let us begin with the geometrical ones.

The first problem of Mr. Barlow is "to inquire what very symmetrical arrangements of points or particles in space are possible." He comes to this result: "It would appear that there are but five." Then he describes these five arrangements. What conditions are to be fulfilled by an arrangement of points in space which is to be "very symmetrical," is nowhere said. According to this indefiniteness of the fundamental notion, the five kinds of very symmetrical arrangement seem to be found rather by divination than by systematic reasoning. Therefore the foundation of the theory appears somewhat arbitrary; and we may suspect that it is incomplete. We are in fact confirmed in this presumption if we consider the results of a geometric research published in my "Entwickelung einer Theorie der Krystallstruktur" (Leipzig: Teubner, 1879). In this book I have specified all possible arrangements of points that are regular and infinite, I have called a system of points *regular* if the points are disposed around every one point of the system in precisely the same manner as around every other. *There are sixty-six such regular systems of points possible.* According to the peculiarity of their symmetry they are subdivided into groups, which correspond strictly to the known crystallographic systems. Many of those arrangements of points have a hemihedric or tetartohedric character; others have the structure of a screw; and amongst the latter I could even suggest one particular system which represents the internal structure of quartz. The latter result was obtained (*loc. cit.* pp. 238–245) by comparing the crystallographical and optical properties of quartz with those of the known combination of thin laminæ of mica arranged in the manner of winding-stairs, described by Prof. Reusch fourteen years ago. All sixty-six systems are in agreement with the principal law of crystallography, the law of rational segments of the axes (Wiedemann, *Annalen der Physik*, 1882, vol. xvi. p. 489). For example, if we have reason to suppose that a certain one of these systems should represent the structure of a given substance crystallising in hexagonal pyramids, then we derive geometrically the same series of possible pyramids which nature actually exhibits.

Four of Mr. Barlow's five kinds of "very symmetrical arrangements" prove to be extremely particular cases of four general systems of mine. The first, second, and third kinds of Mr. Barlow's result from the systems which I have called the "rhombendodecahedric, cubic, and octahedric system with 24-points-aggregates" ("Entwickelung," pp. 165-168), if we suppose the twenty-four points of the so-called "24-punkter" coinciding in one point, and if we identify this point with the centre of a sphere of Mr. Barlow. Mr. Barlow's fourth kind of "very symmetrical arrangements" results as a particular case from my "3-gängiges 6-punkt-schraubensystem" (*loc. cit.*, Fig. 46), if the sides of all hexagons are supposed to touch one another, and the layers to have convenient distances. Mr. Barlow's fifth kind of symmetry, not being regular in the sense defined above, cannot be found amongst my sixty-six systems. Though every point is surrounded by six neighbouring points at equal distances, the latter have not throughout an identical arrangement. Every point of the first, third, fifth, &c., layers is situated at the centre of a perpendicular prism (with regular triangular base) whose angles bear the six neighbouring points of the system, but around every point of the second, fourth, sixth, &c., layers, the six neighbouring points are situated at the angles of two regular triangles, which do not lie parallel over one another as before, one of them being turned round in its plane 60°.

As my sixty-six systems comprise four of Mr. Barlow's kinds of symmetry, it may be expected that they include other arrangements besides, which may also pass as "very symmetrical." For example, in a cubic aggregate of points, the centres of the edges of all cubes determine a very symmetrical arrangement of points, where every point has equal distances from the next eight surrounding points (cf. "Entwickelung," &c., p. 16[illegible] From this I believe I have shown that the geometrical f[illegible] dation of Mr. Barlow's theory is somewhat arbitrary [illegible] incomplete.

I now come to the chemical objections, which I will explain by an example. A chemical compound of two kinds of atoms, present in equal number—for example NaCl—could, according to Mr. Barlow, crystallise into the first or second of his five kinds of symmetry, for either of these two kinds allows the regular arrangement of two kinds of particles in equal number. In the first kind of symmetry (for example) spheres are so arranged that they constitute a cubic system of points, in which the centre of each cube bears also a point of the system. By putting atoms of one kind (Na) on the angles, and atoms of the other kind (Cl) on the centres of the cubes, we have built up the structure of a crystal of NaCl. Thus eight atoms of Na stand in exactly identical manner around an atom of Cl (and also eight atoms of Cl around an atom of Na). The atom of Cl seems consequently to be in equally close connection with eight atoms of Na; it has exactly the same relation to these eight atoms. It appears therefore as *octovalent*, certainly not as univalent; for it would be entirely arbitrary to suppose any *two* neighbouring atoms of NaCl in an especially close connection and to take this couple for the chemical molecule of NaCl. By this example we see *that from Mr. Barlow's point of view both the notion of chemical valency and of chemical molecule completely lose their present import for the crystallised state.* This objection, of course, will not destroy the theory of Mr. Barlow, since chemical valency does not yet belong to perfectly clear and fixed notions, and since the idea of the chemical molecule in a crystal is also not evident and clear. The author, however, is at all events obliged to show why these two notions, of such great moment for substances in a gaseous state, should become completely insignificant, as soon as crystallised bodies are in question.

Finally for a physical objection. With respect to the fact that most substances change their volume in congealing, Mr. Barlow admits that the atoms themselves undergo an expansion (positive or negative) in the act of crystallisation. Thus he attributes to the atoms variability of volume, *i.e.* one of those qualities, for the explanation of which the atomic theory has been devised. Well, let it be so, but this hypothesis of atomic expansion is not even found sufficient everywhere, but must be assisted occasionally by auxiliary hypotheses. Thus for explaining the isomorphism of substances which contain atoms of the same kind (*e.g.* $CaCO_3$ and $FeCO_3$) Mr. Barlow supposes that the expansion in the act of crystallising is confined to the common atoms, whilst the different atoms in both substances remain unaltered.

All these objections do not overthrow the author's theory, but they shake it. Perhaps they will induce Mr. Barlow to establish his theory in a more solid and more general way, and in this case also I shall have attained my aim. L. SOHNCKE

University of Jena

Holothurians

THE observations which I made in 1883 among the coral-reefs of the Solomon Group on the habits of the Holothurians support the view that these animals do not subsist on living coral. I carefully examined the material voided by about twenty individuals, and found its composition to be of a mixed character. In addition to the calcareous sand and gravel which formed its bulk, there were numerous tests of the large foraminifer—Orbitolites—and several small univalve and bivalve shells, besides the joints of a stony alga and the operculum of a young nerite, &c. This observation is supplementary to those contained in my previous letter on this subject (NATURE, vol. xxvii. p. 7).

Traders in this group tell me that when collecting a species known in the trade as the "large tit-fish," they have frequently found a small eel inside the animal, which usually escaped before it could be secured. One man received a smart electric shock, whilst handling a trepang containing one of these eels.

H. B. GUPPY

H.M.S. *Lark*, Auckland, N.Z., January 1

Unconscious Bias in Walking

SURELY Mr. W. G. Simpson has written from imperfect memory when he tells us in NATURE (vol. xxix. p. 356), "if the majority of people, as Mr. Darwin argues, are left-legged, they would circle to the *left* in a mist, as Mr. Larden says they do." In Mr. Larden's letter (p. 262) the following passage occurs: "This theory (his own) involving as further consequences that those in whom the left leg is the strongest would circle to the *right*," &c.; again, "I myself am right-legged and in a mist I always circle to the left." Although Mr. Simpson has misquoted Mr. Larden, he has arrived at the same conclusion that I did (see NATURE for January 31, p. 311), but gives his views in different words, namely, that "there is a bias *towards* the stronger limb, irrespective of length." JOHN RAE

The Storm of January 26

THE lowest reading, reduced to the sea-level, of the barometer here, about six miles south-east of Omagh, during the gale on Saturday, the 26th ult., was 27·68, and occurred at 4.15 p.m. Dublin time. ROBERT DIXON

Clogherny, Beragh

PALESTINE EXPLORATION

THE following communication has been forwarded to us for publication:—

Mediterranean Hotel, Jerusalem, January 18, 1884

DEAR PROFESSOR OLIVER,—A chest in a waterproof cover leaves here to-morrow for London to Messrs. Cook and Son, Ludgate Circus. It should arrive on February 25 or sooner, and I have directed that it should be forwarded immediately to Kew. I hope to arrive soon after. It contains all my dried plants. They are made up in various packages, with localities written outside. Of course you will have them kept dry and looked after, but I think they had better not be overhauled until I come, as I should like to open them as they are, while the contents of each package and its associations are fresh in my memory. The earlier desert plants are in many cases only valuable for recognition, I fear, as they are withered remains, but I frequently obtained a lingering flower and many seeds. All my seeds and bulbs I have sent according to promise to Mr. Burbidge, of the College Botanic Garden, Dublin. In the mountains about Sinai and Jebel Catherine I obtained better specimens, and things gradually improved to Akaba. We got through a good deal of unexplored country and had a most efficient conductor. Along the Wady Arabah I made frequent detours into the mountains on either side, and was especially fortunate in having a good collection on Mount Hor and at Petra and its neighbourhood. The flora of Mount Hor (5000 feet) is extremely rich—a warm sandstone. I also collected mosses and lichens in the desert, and am still gathering all I can. My collections reach to here, including a run down to the Jordan. The pace is now (horses) often too rapid, but the camel was an admirable companion on a long march. We were delayed in the Ghor-en-Safiet, at the south-east end of the Dead Sea for ten days, an unparalleled sojourn in this most interesting place. It was early a little, but I made large collections there, and was very glad of the difficulties that opposed our departure. I found many unexpected plants—three ferns, for instance, on Mount Hor, and a *Stapelia*. I knew the names of very few of the things, and had no books, but Redhead and Lowne's papers were a help, though they gave a very poor idea of the real state of affairs. There is a fine *Acacia* in the Ghor-en-Safiet, distinct in many respects and far finer than *A. seyal*. It is the true "scent" about which there seems a lot of confusion. Hoping my collections will be satisfactory,

I remain yours very truly,

(Signed) HENRY CHICHESTER HART

P.S.—Here in Jerusalem there are about six plants in flower; down below in the Jordan I gathered about a hundred two days ago! (Signed) H.

FAIRY RINGS

THE dark green circles of grass known as "fairy rings" formed the subject of a paper in the *Philosophical Transactions* of the new-born Royal Society in 1675; but it was only last year that the Rothamsted chemists, Messrs. Lawes, Gilbert, and Warington, announced what is no doubt a correct explanation of these phenomena.

The original theory of the electrical origin of the rings was succeeded by that of "chemical causes" propounded by Dr. Wollaston at a meeting of the Royal Society in 1807, and by Prof. Way in a paper read to the British Association in 1846. Besides the "mineral theory" which was here pressed into the service of a discussion that commenced, as already stated, more than two hundred years ago, De Candolle applied his famous "excretory theory" to its elucidation. At Rothamsted, however, the causes of fairy rings were still regarded as having been unsatisfactorily explained.

Sir John B. Lawes and his colleague Dr. Gilbert commenced their inquiries on this subject many years ago. Almost from the commencement of their experiments at Rothamsted they had regarded the alternate growth of fungi and grass as a striking example of what may be called the "natural rotation" of crops. As long ago as 1851 they described fairy rings in the *Journal of the Royal Agricultural Society* as "a beautiful illustration of the dependence for luxuriant growth of one plant upon another of different habits." It will be remembered that the experiments at Rothamsted led to the substitution of what is called the "nitrogen theory" for the "mineral theory" of former days, and practical agriculturists who know the value and the cost of nitrogen as an all-important agent of fertility will learn, perhaps without surprise, that the rich verdure of a fairy ring is due to the effect of nitrogen. Nitrogen is the *sine quâ non* of plant growth, and fungi require a large amount of it. From what source do they obtain it? At the present time few, if any, chemists would maintain that they obtained it by the absorption of free nitrogen from the atmosphere, but in 1851 the eminent investigators at Rothamsted attributed the nitrogen of the fungi to their extraordinary power of accumulating that substance from the atmosphere; and this they thought enabled them to take up the minerals which the grasses, owing to their more limited power of obtaining nitrogen, could not appropriate from the soil. They assumed that it was the nitrogen rather than the mineral constituents of the fungi to which the manuring action was mainly to be attributed, and in this they were right; but the theory has required some correction nevertheless, inasmuch as they have since proved the source of nitrogen in the fungi to be the soil, not the atmosphere.

As doubts were entertained at first on this point, direct experiments were tried at Rothamsted, and in 1874 samples of soil were taken within a fairy ring, immediately upon it, and outside, and these yielded on analysis the lowest percentage of nitrogen in the soil within the ring, a higher percentage under the ring, and a higher still outside it. The soil therefore had lost nitrogen by the growth of the fungi, and the obvious conclusion was that the fungi possess a greater power than the grasses of abstracting nitrogen from the soil.

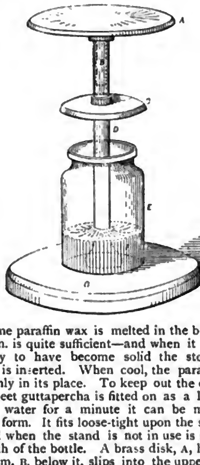
The analyses of the various species of fairy-ring fungi do not greatly differ. Two species occurring at Rothamsted—*Agaricus prunulus* and *Marasmius orcadum*—contain nitrogenous compounds to the amount of one-third of their dry substance, the ash being rich in potash and phosphoric acid. Their occurrence on pastures, like that of the common mushroom, is probably due to the manuring of the ground by animals and their continuance and growth depend on certain conditions of soil and season. They are rarely developed on rich soils, or on those which are highly manured, or in seasons favourable to the general herbage of the turf; and when they do appear under these conditions they will probably not be reproduced, or only in patches. The recent wet seasons have dispersed fairy rings in situations where they have usually proved persistent. They prevail wherever the growth of the grasses is inferior, especially on the poor downs of the chalk districts, and on poor sandy soils where the natural herbage is wanting in vigour.

The history of fairy rings, as it has now been written at Rothamsted, will attract close attention from all who are interested in the nutrition of plants, including the student of agriculture, and all, in fact, who are specially concerned in the question of the food supply. It was not previously known that any kind of plant could feed directly on the organic nitrogen of the soil itself. It was recognised that the root-development of plants differed, and that the greater extension of their roots enabled some plants to secure a larger proportion of the constituents of the soil than others. But here is a race of plants possessing quite unsuspected powers of assimilation! Instead of rising from the ashes of the phœnix they feed upon its undecayed body, that is, upon the organic nitrogen of the soil. The Leguminosæ, for example, such as beans and clover, are known to assimilate more nitrogen from a given soil than the Gramineæ, such as wheat and barley, and this has been attributed to absorption by their leaves, or to the superior development of their roots. Another alternative is now suggested, and possibly a new departure may be taken in the science of agriculture, as the result of the recent discoveries in connection with fairy rings. HENRY EVERSHED

A CHEAP INSULATING SUPPORT

INSULATING-SUPPORTS are so indispensable in the work of an electric laboratory that several forms have come into extensive use. The plan devised by Sir W. Thomson for securing high insulation by surrounding a glass stem with concentrated sulphuric acid to absorb the moisture which otherwise would condense from the air and form a conducting film over the surface of the glass is remarkably efficient, and has many advantages. Modifications of this form of insulator have been largely used by Prof. Clifton, F.R.S., in the Clarendon Laboratory, and by Profs. Ayrton and Perry in the laboratories of the Technical College at Finsbury. Another modification due to M. Mascart, was described in NATURE, vol. xviii. p. 44; and this pattern has come into extensive use under the name of the *support isolant Mascart*. Though excellent in every way it is very expensive, as its manufacture necessitates a special piece of glass-blowing. The central support of glass is solidly fused into the bottom of a glass vessel with a very narrow neck into which acid is poured through a tubulure at the side.

The insulating support which I have recently described before the Physical Society of London is a much simpler affair, and can be made very quickly and cheaply from the materials at hand in every laboratory. The figure shows the form of the support. A wide-mouthed glass bottle, E, about 10 cm. high, and from 5 to 6 cm. diameter, is selected. A piece of stout glass tubing about 20 cm. long is then taken. One end is closed in the blowpipe flame, and blown into a thick bulb; and while yet hot the bulb is flattened, so as to form a foot for the stem. The flattened bulb should be as large as is compatible with its insertion into the mouth of the bottle. To hold it in its



place some paraffin wax is melted in the bottle—from 50 to 70 grm. is quite sufficient—and when it has cooled so as nearly to have become solid the stem, previously warmed, is inserted. When cool, the paraffin holds the stem firmly in its place. To keep out the dust a disk cut out of sheet guttapercha is fitted on as a lid. If dipped into hot water for a minute it can be moulded to the required form. It fits loose-tight upon the stem, as shown at C, and when the stand is not in use is slid down over the mouth of the bottle. A brass disk, A, having a short brass stem, B, below it, slips into the upper open end of the tube, and forms the top of the stand. It is also found convenient to make from rods of glass other supports, shaped at the top in the form of hooks, which can be slipped down into the central tube. These are very useful for holding up wires that pass over the experimenting table and require to be well insulated. The bottle is let into a wooden foot, G. In cases where very perfect insulation is required I have poured a little strong sulphuric acid into the bottle above the paraffin. In practice, however, the insulation of the paraffin is amply sufficient for most purposes, provided dust is properly excluded.

SILVANUS P. THOMPSON

JOHN HUTTON BALFOUR

IN Prof. Balfour, whose death we announced in our last issue (p. 365), has passed away another of that group of eminent teachers, including Goodsir, Syme, Simpson, Christison, &c., which maintained the reputation and added lustre to the fame and prestige of the Medical School in our great northern University during the middle decades of this century; one, too, of that band of working British botanists of the first half of the century which counted amongst its members the Hookers, Munby, Carmichael, Greville, Walker Arnott, Babington, Parnell, Prior, the Macnabs, &c., the majority of whom have now left us; and where are their successors? By his death a figure—in later years picturesque with grey locks and patriarchal beard—familiar all over Scotland, and where scientific men do congregate, has been removed. Few men were more universally esteemed and popular, and few quit their sphere of active and busy life leaving behind them more pleasant reminiscences than he whose decease we have recorded. Compelled by failing health to retire about five years ago from public life, his powers since then gradually weakened, until on the 11th inst. he quietly breathed his last.

John Hutton Balfour was born in Edinburgh on September 15, 1808. Related, as his name indicates, to James Hutton, the famous author of "The Theory of the Earth," he possessed much of the enthusiasm and fire which characterised his ancestor. His early education was completed at the High School of Edinburgh, then at the zenith of its reputation, under Pillans and Carson, and he subsequently studied in the Universities of Edinburgh and St. Andrews, in the former of which he graduated in Arts and Medicine. His first intention appears to have been to enter the Church, and to this aim his studies were directed; but he afterwards abandoned this purpose and commenced to practise medicine in Edinburgh, having spent some preparatory time in Continental schools, and having become a Fellow of the Royal College of Surgeons of Edinburgh. During his early years he was devoted to botany, and his taste received a great stimulus by the teaching and example of Graham, then Professor of Botany in the University of Edinburgh. Whilst engaged in the active work of his profession, he found time to foster his bent and love for nature, and gathered around him many of those who, like himself, were keen students of natural science, and thus was formed the nucleus of the Botanical Society of Edinburgh, of which he was, in 1836, the founder—a society which has done much to promote the study of botany in Scotland, and in which, throughout his whole life, he was a guiding spirit. In 1840 Balfour found time amidst his medical duties to commence lecturing on botany in Edinburgh, and his ability as a lecturer was at once proved by the large numbers attracted to his classes. But it was not until 1842, when he was appointed to the Chair of Botany in the University of Glasgow, vacated by the translation of Sir William Hooker to Kew, that he was able to give up medicine, and devote himself solely to botany. After four years in Glasgow, the death of Prof. Graham made an opening in the East of Scotland, and Balfour was elected Professor of Botany in the University of Edinburgh, shortly thereafter obtaining the appointments of Regius Keeper of the Royal Botanic Garden and Queen's Botanist for Scotland. Subsequently he undertook the duties of Dean of the Medical Faculty in the University, and his energy on behalf of the Royal Society of Edinburgh led to his appointment as Secretary. From all these positions he retired in 1879, when a fitting tribute to the value of his services was paid by the presentation of his portrait, and he was then elected Assessor in the University Court for the General Council, and each of the three Universities with which he had been connected conferred on him the degree of LL.D. For many years he was an F.R.S., and also a member of a vast number of British and foreign scientific societies.

As a botanical investigator Balfour was a systematist, belonging to that school which is now, by a species of reaction, often held in contempt by those within whose reach the modern developments of physics and chemistry have placed methods of morphological and physiological research denied their predecessors. He had an acute perception of resemblances and a keen eye for a species. But it is not upon his original investigations that Balfour's reputation rests; his work of that character was not extensive, for the time which might have been devoted to it was fully occupied by his official duties as Dean of the Medical Faculty and Secretary of the Royal Society, and he was one of those who sacrificed scientific laurels for the good of the institutions he served. But as a teacher his fame was world-wide, and as a great teacher he will be remembered. He had in a remarkable degree the power of lucid exposition, and the inestimable qualification of infusing in his pupils the enthusiasm which possessed himself. Painstaking and conscientious in his work, no trouble was too great for him if it could contribute to the better comprehension by his students of the subject taught, and the wealth of illustration and the earnestness of manner which clothed his lectures impressed all who heard him. Though the natural cast of his own mind made taxonomy his favourite branch of botany, yet in his teaching, especially in his earlier years, this was given no undue prominence; his success, indeed, was in great part due to the way in which all branches of the science were handled, and he had the credit of being the first to introduce in Edinburgh classes for practical instruction in the use of the microscope. His text-books reflect the character of his teaching, and "if," as a critic remarked on their first appearance, "we recall the dry and dictionary-like manuals to which students were forced to have recourse in our young days—as inviting as so many pages of Johnson's Dictionary—we can but envy their successors." In later years his books and he himself fell behind—and who does not?—in the rapid march of science; but any one examining his books cannot fail to recognise how thoroughly they represent the state of science at their date of publication, and to appreciate the industry and the skill with which the author seems to have exhausted every source of information.

Another feature of Balfour's teaching was the "excursion." Amongst the 8000 students whom it was his pride to have passed through his classes will be many to whom the announcement of his death will recall pleasant recollections of these outings on hill and in glen; how, as they neared the habitat of some rare Alpine herb, the wiry and energetic Professor—"Woody Fibre" as they called him—would outstrip all in his eagerness to secure it; or how, toiling up some long barren slope, his constant flow of jokes and puns would enliven and rouse their flagging spirits. In these rambles, to which many will look back as not only healthful and recreative, but as giving them their first lessons in accurate observation of nature, Balfour visited almost every part of Scotland, ascended every important peak, and gathered every rarity in the flora. No one knew Scotland and its plants better. In this way Balfour became associated with his students in a way no other Professor did, and his position as Dean of the Medical Faculty brought him still more in contact with them. The Rhadamanthus of the examination-hall he enjoyed a unique popularity, and the esteem with which old pupils regarded him may be traced to the intimate relationships thus established, to the way he identified himself with and interested himself in them and showed himself always anxious to merge the professor in the friend. In all he did Balfour was methodical, and his powers of organisation and administration found exercise in the management of the Royal Botanic Gardens, which, under his direction and with the Macnabs—father and son—as curators, was greatly increased in extent, provided with a magnificent palm-house and other plant-houses, as well as with a botanical museum and improved teaching accommodation, and made one of the finest in the country. The latest addition to the garden—the arboretum—accomplished just before he retired from public life, was part of a scheme (perhaps chimerical) he encouraged with the view of establishing a School of Forestry in Edinburgh—a scheme now receiving some attention in Scotland.

Ready and rapid with his pen, Balfour's contributions to botanical and other literature are very numerous. Besides contributing to several Encyclopædias, he was for many years one of the editors of the *Annals of Natural History* and of the *Edinburgh New Philosophical Journal*. Of independent works, his text-books, to which we have already alluded, were very popular in their day, and are now valuable for reference, and he published works on Botany and Religion, Plants of the Bible, &c.

We should fail to give an adequate idea of the veteran Professor were we not to allude to that which gave a character to all he did—his religion. To him all nature was a symbol. He was one of that band of which Faraday, Clerk Maxwell, Greville, Wm. Allen Miller, and others were in the van, who "recognised the harmony between the word and the works of God," and who saw "in the objects of nature around indubitable evidences of a great designing mind."

By those who knew him—and his was a wide circle of friends—he will be remembered as a genial companion with the best attributes of humanity, and his name will always remain inseparably linked with the progress of botany in Scotland during this century, and as that of one of the eminent teachers in the University and city to which he belonged.

CAPTAIN HOFFMEYER

IN the early death of Niels Hoffmeyer, which occurred at Copenhagen on the 16th inst., modern meteorology has lost one of its most diligent and successful students, and one whose place it will be hard to fill.

Like more than one of our own physicists, Hoffmeyer was an artillery officer, and had attained the rank of captain in the service. At the close of the Prussian war he had fallen into bad health, and accordingly, on the reduction of the Danish army which then ensued, his name was placed on the retired list, and he was for a time unoccupied.

The Danish Meteorological Institute was organised in 1872, and Hoffmeyer was nominated its first director. There could scarcely have been a more fortunate appointment, for Hoffmeyer was gifted not only with unusual energy, but also with a very pleasant manner, so that he made friends for the new office and for its work wherever he went. He will best be known by his Atlas. He undertook to prepare daily weather-maps of the Atlantic—in great measure at his own expense—and he actually published them for a period of three and a quarter years, from September, 1873, to November, 1876. It is only a few months ago that he announced his intention to resume the work in combination with Dr. Neumayer, of the Deutsche Seewarte at Hamburg.

The most important results which Hoffmeyer had deduced from his own maps were contained in his pamphlet, "Étude sur les Tempêtes de l'Atlantique Septentrional, et Projet d'un Service Télégraphique International Relatif à cet Océan," Copenhagen, 1880; and up to the very last he never ceased to use his utmost efforts for the establishment of a meteorological telegraphic service with America, *viâ* the Faroes and Iceland.

While Hoffmeyer's chief work was in the domain of synoptic meteorology, he by no means disregarded climatology, and the service which the Danish Office has rendered to that science by the maintenance of stations in Iceland and Greenland has been very material.

When Capt. Hoffmeyer was in London last summer as Danish Commissioner to the Fisheries Exhibition, he was complaining of great weakness of the heart. During December he was laid by for some time, but he had somewhat recovered, when he was seized last week with rheumatic fever, to which he soon fell a victim. He leaves a widow, but no children. He was an Honorary Member of the Royal Meteorological Society (London). He had been one of the secretaries of the Meteorological Congress at Rome, 1879, and of the Conference on Maritime Meteorology in London, 1874, but his chief official service of this nature was as Secretary to the International Polar Commission, where his loss, coming after that of Weyprecht, will be severely felt.

NOTES

THE Council of the Royal Society of Edinburgh has awarded the Keith Prize for the biennial period 1881–83 to Mr. Thomas Muir for his researches into the theory of determinants and continued fractions, the most recent instalment of results obtained by him being in a paper on permanent symmetric functions. Also the Macdougall-Brisbane Prize for the period 1880–82 to Prof. James Geikie for his contributions to the geology of the north-west of Europe, including his paper on the geology of the Faröes, published in the *Transactions* of the Society, 1880–81. And the Neill Prize for the triennial period 1880–83 to Prof. Herdman for his papers in the *Proceedings* and *Transactions* on the Tunicata.

WE learn from the *Standard* that the Royal Astronomical Society has awarded Mr. Ainslie Common its gold medal for his photographs of celestial bodies. This high award has, it is believed, been mainly bestowed on account of the magnificent photograph he has succeeded in taking of the great nebula in Orion, of which we gave an illustration in a recent number.

WE regret to learn of the death of M. T. du Moncel, editor of *La Lumière Électrique*, and author of numerous works in theoretical and practical electricity.

THE needs of the higher education of women in London are gradually being met in the manner that has been found so satisfactory at Oxford and Cambridge, where women students have long enjoyed the advantages of collegiate life. On Monday, February 11, there was a gathering of many of the most influential friends of the movement to inspect an important extension of the College Hall of Residence established at Byng Place, Gordon Square, in October 1882. The success which attended the first development of the scheme, and the growing demand on the part of students for admission, has encouraged the committee to provide additional accommodation by adapting the adjoining house, No. 2, Byng Place. With the new extension they look forward to a yearly surplus instead of a deficit. With the power of accommodating thirteen extra students the receipts would be increased by 876*l*. for the short session, and there would not be a proportionate increase in the expenditure. The advantage of holding the two houses is therefore evident. The second house was opened at the commencement of the current term, and there are now seventeen students in residence. Of this number two are pursuing the course of instruction provided at University College for the B.A. degree, two that for the matriculation examination of the London University, and another, a foreign lady, is a student of English literature at the same college; another student is preparing for the examination of the Pharmaceutical Society. Four ladies are students of the London School of Medicine for Women, and preparing for the M.B. degree (Lond.), and the remainder are studying art at the Slade School and elsewhere. The first student of the Hall who went up for the examination for the B.A. degree passed successfully last October, and has now an appointment as teacher at a school in York. The expenses for board and residence vary, according to the size and position of the room occupied, from 51 to 75 guineas for the

University College session of about thirty-three weeks. Even these fees, moderate as they are, are beyond the means of a large nnmber of students, so that the eommittee, withont such assistance as would be afforded by exhibitions, are unable to extend to them the advantages of the Hall. Besides help in this direction a need is felt for a referenee library, as the books necessary for many of the courses at University College and the School of Medieine are numerous and eostly. A special fund has been started for this purpose, and it is hoped that further snbscriptions may be obtained. It is worth mention that the eommittee have reeognised a principle which, so far as we know, has never been adopted in institutions of this kind. We refer to the representation of students on the governing body. This liberal measure, which invites the co-operation of students and gives them a means for the legitimate expression of opinion, will enable the students in residence to have a member elected annually as their representative on the committee. It is hoped that the benefit of this may be felt in strengthening the bond of a common interest. We have not tonched on many of the advantages of the Hall which are felt by those who know the difficulties incident on a student's life in lodgings, as they were dwelt upon when we recorded in this journal the commencement of the scheme in the winter of 1882. It is therefore only necessary to state that the Hall in its enlarged scale offers the same eomfortable and well adapted academie residence as that originally provided, and that under Miss Grove, the able principal, the high tone which has marked the institntion from the beginning is still maintained. When we point out that the scheme has received the support of the late and present Presidents of the Royal Society, the late Sir William Siemens, Sir John Lubbock, M.P., Mr. Samuelson, M.P., Dr. Gladstone, Prof. Carey Foster, and many others, we have said enough to commend it to all our readers. In the nature of things Science and Art, as well as Literature, will gain by this and similar attempts to put the higher education on a more satisfactory basis.

Dr. Reusch has communicated to *Naturen* the result of his analysis of a portion of volcanie ash from the Krakatoa eruption, given him by Prof. Kjerulf, who had received it direet from Batavia. He finds the principal constituents of the ash to be ordinary pumiee-stone, some fragments of which are more than 1 mm. in length, while others are redneed to a condition of colourless or slightly brownish vitreous pumiee-powder. Intermixed in the general mass are fragments of larger crystals of felspar (Plagioklas) and of some rhomboidal mineral of the natnre of augite.

At a meeting of the Norfolk and Norwieh Naturalists' Society on the 29th ult., an account was read from the *Perth Enquirer* of a volcanie eruption in Western Australia, contributed by a highly respected settler who had lived in that districe some years. The phenomenon he describes was witnessed by him on the same day as that on which the calamity occurred in the Sunda Straits, although he was in total ignorance of that disturbance at the time. He writes:—"I was travelling inland with a flock of sheep, when late in the afternoon of Saturday, August 25, to my profound astonishment, a shower of fine ashes began to rain upon me and my party. The fall of the ashes commenced just about sunset, and the shower, which was at first but very slight, soon became thicker, until it resulted in a steady and heavy rain of light calcined fragments. After the sun set I noticed a bright ruddy glare on the horizon towards the north-east; this was at first only just perceptible, but as the time wore on it increased in both brilliancy and extent. The glare was not at all diffused, and it was of such a nature that it was impossible to mistake it for a display of the *Aurora Australis*. On the contrary, I could easily see that the sonrce of the glare was strictly circnmscribed, or, in other words, it was confined to one spot; but as it increased in intensity the fervid glow mounted higher and higher in the heavens. So far as I could roughly calculate, the source of this extraordinary illumination must have been situated about 400 miles inland to the north-east of Roeburne. The showers of ashes eeased just after sunset, and I observed that the steady glare was still to be seen until before sunrise, but as the sun rose the lurid appearance of that portion of the horizon gradually decreased, and at last quite died away when the orb of day made its appearance. Fortunately, I afterwards had an opportunity of questioning some natives who had recently come from that part of the country, and they described the cause of the glare plainly enough. 'Big mountain burn up big,' they said; and then they added, 'He big one sick. Throw him up red stuff, it run down side and burn grass and trees. We frightened and run away, and fire-stieks (*i.e.* I presume the ashes) fall on us. Two, three days after we go look again; mountain only smoke then, and red siek turned black and hard, just like stone.' A plainer description of a voleano in a state of eruption could hardly be given by uncivilised beings; and I am therefore compelled to eonclude that I was the far-distant witness of the first eruption of a volcano that has occurred in Anstralia within the memory of living men."

Nine lectures on the prineipal types of the human species will be delivered in the theatre of the Royal College of Surgeons, on Mondays, Wednesdays, and Fridays, at 4 o'clock, commencing on Monday, February 25, by Prof. W. H. Flower, LL.D., F.R.S., as follows:—Introduction, anthropology and ethnology; Physical or zoological anthropology; Nature and extent of the differenees between the permanent types or races of men, illustrated by comparison between the European and the Tasmanian native; Methods of estimating the differential characters of the various modifieations of the hnman species, elements of craniometry; Characteristics of the black, or frizzly-haired races, in their typical and modified forms; Characteristics of the yellow, or so-called Mongolian raees; Characteristics of the white, or so-called Caucasian races; Races not readily grouped under either of the above principal types; Classification of the races of the human species. The conrse will conclude on Friday, March 14.

We regret to learn that the Counci of the Geographical Society have decided to discontinue the examinations which they have held for a number of years for pnpils attending our public schools. The nnmber of candidates has been diminishing every year. The Council are, we understand, considering a scheme for establishing a Professorship of Geography; but, while we recognise their anxiety to promote in this way their branch of science, we confess that we are doubtful if this is the best means of attaining the object. The sphere of geography is at present quite undefined; in Germany it embraces something of nearly every science, while in this country it is often regarded as almost synonymous with topography.

Preparations for the holding of the International Health Exhibition are proceeding rapidly. The General Committee now numbers nearly 400 members, and from these 17 Snb-Committees have been formed. These have all been doing valuable work in advising the Executive Council as to the nature of objects which it is desirable should be fully illustrated, in obtaining the cooperation of many persons of eminence in the various branches on which the Exhibition will treat, and in supervising the applications for space. The allotment of space, which has been largely applied for, is being rapidly proceeded with, and applicants will soon be informed of the decision of the Executive Council with regard to their applications. In response to a reqnest made by His Royal Highness the Prince of Wales, President of the Exhibition, the eight Water Companies of London have resolved to exhibit, in a pavilion which is being erected for them, their appliances for the supply, filtration, &c., of water, together with diagrams showing the various processes and localities; and a powerful Sub-Committee, under the active chairmanship of Col. Sir Francis Bolton, has been formed to carry out this branch of the Exhibition. The Water Companies have also determined to put up in the grounds a large fountain, which will be illuminated at night by electricity. It is impossible, as yet, to give any definite information with regard to foreign countries; but, so far as one can judge at present, Belgium, China, and India will be the best represented.

ACCORDING to information received in St. Petersburg everything is well with the Russian Meteorological Expedition wintering at Cape Sagasta at the mouth of the Lena. Every preparation was made last autumn for the wintering—the second one—the Governor of Yakutsk having provisioned the station most plentifully. During the previous winter—1882-83—the cold was rarely before January 40° C. below zero, but in January and February the thermometer frequently fell lower. The greatest cold occurred on February 9, when it fell to 52·3° C. below zero. In March even the cold was 40° in the night and 19° in the day. One of the members of the expedition, Dr. Bunge, has forwarded to St. Petersburg some valuable reports on the fauna in and about the mouth of the Lena.

THE Academy of Sciences has received a requisition from M. Ferry to appoint three delegates to the International Commission which is to meet at Washington on October 1 next in order to determine the choice of a first meridian. It is the first time that places have been offered to the Academy on a diplomatic commission.

PROF. HULL, who has returned with his party, brings with him, it is stated, materials for the construction of a geological map of the Holy Land very much in advance of anything which could hitherto be attempted. He is reported to have traced the ancient margin of the Gulfs of Suez and Akaba to a height of 200 feet above their present level, so that, according to Prof. Hull, the whole country has been submerged to that extent, and has been gradually rising. As one result of this rise, the Professor is of opinion that at the time of the Exodus there was a continuous connection of the Mediterranean and the Red Sea. As regards the Dead Sea, Prof. Hull believes he has discovered that it formerly stood at an elevation of 1400 feet above its present level—that is to say, 150 feet above the level of the Mediterranean. The history of this gradual lowering of the waters will form a special feature in Prof. Hull's forthcoming report. He believes he has also found evidences of a chain of ancient lakes in the Sinaitic district, and of another chain in the centre of the Wady Arabah, not far from the watershed. The great line of the depression of the Wady Arabah and the Jordan Valley has been traced to a distance of more than a hundred miles. The materials for working out a complete theory of the origin of this remarkable depression are stated to be now available. They are bound to differ in many details from the one furnished by Lortet, whose patient observations have hitherto been received with respect. The terraces of the Jordan have been examined, the most important one being 600 feet above the present surface of the Dead Sea. The relation of the terraces to the surrounding hills and valleys shows, according to Prof. Hull, that these features had already been formed before the waters had reached their former level. Sections have been carried east and west across the Arabah and Jordan Valley. Two traverses of Palestine have also been made from the Mediterranean to the Jordan. Prof. Hull has in hand, besides his scientific report, a popular account of his journey, which will first appear in the *Transactions* of the society. Captain Kitchener's map-work is in the hands of Mr. Armstrong, who was for many years on the survey of Western Palestine. He has himself been ordered on service up the Nile; but it is hoped that his absence will not retard the publication of a new and very interesting piece of geographical work.

WE have received the following communication from the Royal Victoria Coffee Hall:—"By the kindness of the Gilchrist Trustees the Committee of the Royal Victoria Coffee Hall, Waterloo Road, have been enabled to arrange another series of Penny Science Lectures on Tuesday evenings, as follows:—March 4, Prof. H. G. Seeley, F.R.S., on Ancient English Dragons; 11, Wm. Lant Carpenter, B.Sc., F.C.S., on Air, and why we Breathe (with experiments); 18, P. H. Carpenter, M.A., D.Sc., on Fossils, and what they teach us; 25, Edward Clodd, on the Working-Man 100,000 Years Ago. April 1, E. B. Knobel, F.R.A.S., F.G.S., Hon.Sec.R.A.S., on the Planets; 8, J. W. Groves, on the Dangers and Safeguards of Beauty in Animals. All the lectures will be illustrated by means of the oxyhydrogen lantern. If any of your readers can distribute handbills among working people, or cause window bills to be displayed in suitable situations, we shall be grateful for their help, and beg they will communicate with the Honorary Secretary. The difficulty of making anything known in this crowded, busy London is acknowledged on all hands, but it is believed that if these lectures could be made known in the right quarters, people would come long distances to hear them."

IT appears from the report of Drs. Brouardel, Segond, Descout, and Magnin, who conducted the autopsy of Tourguenief, that the brain of this eminent Russian author weighed 2012 grms. This extraordinary weight, which is only known to have been exceeded in the case of Rudolphi, is inexplicable, for Tourguenief, although tall, was not of exceptionally high stature. The brain is said to have been remarkably symmetrical, and distinguished by the extreme amplitude of the convolutions. According to generally accepted views, however, symmetry of the circonvolutions is not a favourable cerebral characteristic.

AN Anthropological Society has been founded at Bordeaux with Dr. Azam as president, and Dr. Testut as vice-president; both being members of the Faculty of Medicine of Bordeaux.

A SPECIAL commission has been established by the French Government to investigate the several processes proposed as a cure for phylloxera. It was stated officially at the last meeting of this body that every suggestion had proved abortive.

KING OSCAR of Sweden has personally conferred upon Mr. Carl Bock the Order of St. Olaf.

"IN our issue of December 14," *Science* states, "we published an article on 'The Signal-Service and Standard Time,' criticising the action of the chief signal-officer in not adopting the new standards of time at signal-service stations. We have since learned that our criticism was not well founded, as the information upon which it was based gave an incomplete idea of the position of the service in this matter. It is true that the observers of the service are still governed by the local times of their respective stations; but this is only a temporary arrangement, and will be changed as soon as possible. The reason of the delay is this: the international observation, which is taken at many stations of observation throughout the whole world, is made at 7 a.m., Washington time. It is proposed to make this observation eight minutes earlier, or at 7 a.m. of the time of the 75th meridian, which is exactly Greenwich noon; but, before this change can be made, the cooperating weather-services and numerous independent observers must first be notified, and their consent obtained. Correspondence has already been begun, and a circular letter sent to all who cooperate in the international work asking consent to the proposed change. Favourable replies are being received; and there is little doubt that the change will be made, probably Jan. 1, 1885. It should be remembered that the international observation is made largely by observers who kindly cooperate with the chief signal-officer, but who are not under his orders: a change of this kind cannot, therefore, be summarily ordered, but must be made by mutual consent."

The Commissioners on Technical Education have now practically concluded their labours, and are likely to have only one more meeting to formally sign their Report, the greater part of which is in type. It will consist of at least five octavo volumes, it being found impracticable, even after careful consideration, to bring the mass of evidence and information within smaller compass. It is stated that any *résumé* of the series of conclusions and recommendations at which the Commission have arrived would not be useful or fully intelligible to the public without the explanatory details with which they will be accompanied. It is, however, hoped that the complete Report may be presented soon enough to permit of the House of Commons proceeding during the present session with such legislation, based upon the recommendations, as may be thought necessary. Meantime it is understood that technical training will form an important part of the measures of which the Government and Mr. A. O'Connor have given notice with regard to education in Ireland.

Messrs. W. Eagle Clarke and W. Denison Roebuck, Leeds, are preparing a supplement to their "Handbook of the Vertebrate Fauna of Yorkshire," and would be glad to have notes of additions or corrections to that work, or notices of the occurrence of any species of quadrupeds, birds, reptiles, or fishes in Yorkshire which their friends may be pleased to communicate. As they wish to publish in the April magazines, it is hoped that the desired information may be sent in immediately. Communications may be addressed to No. 9, Commercial Buildings, Park Row, Leeds.

At the Royal Institution Prof. Tyndall will begin a course of six lectures on "The Older Electricity—its Phenomena and Investigators," on Tursday next (February 28), illustrated by experiments; and Capt. Abney, R.E., will begin a course of six lectures on "Photographic Action, considered as the Work of Radiation," on Saturday (March 1). Prof. Hughes will give a discourse on Friday evening next, on "The Theory of Magnetism," illustrated by experiments.

We have already referred to the International Ornithological Congress which is proposed to be held in Vienna on April 16–23, under the protectorate of the Crown Prince Rudolf. It is now announced that arrangements are in progress for an International Ornithological Exhibition, which is to precede the Congress, and which will occupy from April 4–14. Single specimens and collections of living birds of all kinds, including domestic birds; all apparatus serving for the protection, cultivation, breeding, and conveyance of birds; implements used in bird catching and bird shooting, falconry, carrier-pigeon-post; aviaries, and bird cages; scientific objects and products which originate in or refer to the feathered world, will all be included in the programme of the Exhibition. All details will be furnished to intending exhibitors or partakers in the Congress by the Secretary of the Vienna Ornithological Society, Dr. Gustav von Hayek, III. Marokkanergasse 3 Vienna. The main subjects to be discussed at the Congress are—(1) An international law relating to the better protection of birds; (2) the establishment of a system of ornithological observing stations all over the inhabited globe; and (3) investigations concerning the origin of the domestic fowl, and measures for the amelioration of the cultivation and breeding of domestic birds generally.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Miss Furniss; two Common Roe (*Capreolus capræa* ♀ ♀) from Dorsetshire, presented by Messrs. Charles Hambro and J. C. Manuel Pleydell; a Passerine Owl (*Glaucidium passerinum*), European, presented by Mr. G. R. Lake; a Naked-necked Iguana (*Iguana delicatissimus*), a Banded Basilisk (*Basilicus vittatus*) from Nicaragua, presented by Mr. Albert Vidler; two Prairie Marmots (*Cynomys ludovicianus*) from North America, a Shaw's Gerbille (*Gerbillus shawii*) from North Africa, a Military Macaw (*Ara militaris*) from South America, two Iceland Falcons (*Hierofalco islandus*) from Sweden, deposited; a Red-eared Monkey (*Cercopithecus erythrotis* ♀) from Fernando Po, two Slow Loris (*Nycticebus tardigradus*) from the Malay Countries, a Red-eyed Ground Finch (*Pipilo erythrophthalmus*) from South America, an Eyebrowed Weaver Bird (*Hyphantornis superciliosus*) from West Africa, four Asiatic Quails (*Perdicula asiatica* ♂ ♂ ♀ ♀) from India, purchased.

OUR ASTRONOMICAL COLUMN

Australian Observatories.—The eighteenth Annual Report of the Director of the Observatory at Melbourne to the Board of Visitors (who in their turn report to the Governor of Victoria) has been issued. The new transit-circle was expected in a short time, and would find the new circle-room ready to receive it, but the instrument which had been in use for twenty years continued to give excellent and trustworthy results; nevertheless each year had forced upon Mr. Ellery the necessity of greater optical scope for the meridian work. The inevitable loss of reflective power in the great telescope increases a little year by year, but does not yet sensibly affect the work upon which it is employed. Indeed, Mr. Ellery says, "Some photographs of faint objects obtained lately are clear evidence of the immense light-gathering power it still possesses, and of the trivial loss occasioned so far by the slight tarnish apparent." The instrument had not been kept quite so closely to its special work—the revision of the southern nebulæ—as before, owing to the number of nights occupied with the great comet and in experimenting in celestial photography. Among the subjects of observation Mr. Ellery refers to the transit of Venus, the Port Darwin Expedition for determination of longitude of Australian observatories, and measures of differences of declination of the minor planets *Sappho* and *Victoria* for determination of the solar parallax, according to the scheme arranged by Mr. Gill. The great comet of 1882 was kept in view for 250 days, or until April 26. A large portion of the work connected with the telegraphic determination of the longitude of Australian observatories from Greenwich fell upon the Melbourne establishment, which is now assumed to be in longitude 9h. 39m. 53·37s. E., subject perhaps to some very small correction. As soon as the new transit-circle was properly adjusted, it was Mr. Ellery's intention to devote it to the revision of a rather large catalogue of stars at the request of the "Astronomische Gesellschaft," besides its more special work. The great telescope would be applied more exclusively to the continuation of the revision of Sir John Herschel's nebulæ, several of which, by the way, the Melbourne observers have not been able to find.

Mr. H. C. Russell sends us an historical account of the Observatory at Sydney and of the observations which preceded the erection of the present one in that colony. With the details of the actual observatory the reader will be probably acquainted through the volumes of results which have been issued therefrom; that for 1877–78 contains a general view of the building; but Mr. Russell mentions circumstances attending the erection of the first observatory on Australian soil which are perhaps little known. He extracts from the "History of New South Wales," by Col. Collins, the following note:—"Among the buildings that were undertaken shortly after our arrival [that of the first colonists in 1788] must be mentioned an observatory which was marked out on the western point of the cove, to which the astronomical instruments were sent, which had been sent out by the Board of Longitude for the purpose of observing the comet which was expected to be seen about the end of this year. The construction of this building was placed under the direction of Lieut. Dawes, of the Marines, who, having made this branch of science his peculiar study, was appointed by the Board of Longitude to make astronomical observations in this country." The observatory was erected as soon as the colonists landed, but, being found small and inconvenient, a new one for the better reception of the instruments and the residence of Lieut. Dawes was built of stone, for which ample materials were found upon the spot.

The comet to which reference is here made was that of 1661, supposed to have been identical with the comet of 1532, and again expected about the end of 1788 or beginning of 1789. It is not difficult to explain how this body came to be associated with the arrival of the first Australian colonists. Halley, who had calculated the orbits of the comet observed by Apian in 1532, and that observed by Hevelius in 1661, gave very similar elements in his "Synopsis of Cometary Astronomy." Pingré considered the comets identical, and thought he had recognised several previous appearances, as detailed in his "Cometographie," which was published in 1783. Maskelyne appears to have adopted Pingré's opinion, and was at the trouble of preparing sweeping ephemerides, which he communicated to the Royal Society, and we may conclude that it was through his interest with the Board of Longitude that Lieut. Dawes was supplied with instruments and charged with a search for the comet. Mr. Russell says there is no record of what was done at the Dawes' Point Observatory, but since the comet was not observed as expected, we may infer there were only negative results to be reported, though Lieut. Dawes did occupy himself in other ways to assist in the progress of the colony.

CHEMICAL NOTES

THE water supply of Boston (U.S.A.) became contaminated about a year ago with some substance or substances which imparted to it a peculiarly nauseous odour and taste. Chemical examination resulted in showing a large percentage of "albuminoid ammonia," and also that the "free ammonia" increased somewhat rapidly when the water was kept. The production of ammonia, and also the odour and taste, was finally traced to the decomposition of a freshwater sponge (*Spongilla fluviatilis*, Anct.) present in large quantities on the sides and bottom of one of the storage basins; removal of this sponge was followed by improvement in the water (see *Analyst*, viii. p. 184).

PROF. CLEVE describes, in the August number of the *Journal of the Chemical Society*, methods for extracting and purifying the earth *samaria*. From determinations of the amount of sulphate obtained from quantities of this oxide, Cleve deduces the number 150 as the atomic weight of the metal *samarium*. Various salts of samarium are described; the metal is closely allied to didymium.

HARTLEY showed some time ago (*C.S.J. Trans.* for 1882, p. 84 *et seq.*) that the ultra-violet spectra of elements belonging to the *same series* (in the nomenclature of the periodic law) exhibit fairly marked analogies as regards general character; recent observations of the spectrum of beryllium and comparison of this spectrum with that of allied metals have led Hartley to the conclusion that this metal probably belongs to the group which contains magnesium, calcium, &c., and not to that containing aluminium, scandium, &c. But if this is so, oxide of beryllium must be represented as BeO, and the atomic weight of the metal—about which there has lately been so much dispute—must be taken as 9 (*C.S.J. Trans.* for 1883, p. 316).

V. MEYER has recently separated, from benzene oils, a compound to which he gives the name of *Thiophen*. The composition of this body is represented by the formula C_4H_4S; it presents the closest analogy in general reactions with benzene, yielding a sulphonic acid, a methyl derivative, &c.; it reacts with diketones to form highly coloured compounds. The further study of this interesting compound, now being carried on in Prof. Meyer's laboratory, is likely to lead to important results (*Berichte*, xvi. 2968).

OSTWALD has recently made a further advance in his study of chemical affinity. He has examined the action of acids on methylic acetate, determining the velocity-coefficients of various acids, and from these calculating the relative affinities of the acids in terms of hydrochloric acid taken as 100. His results are entirely in keeping with the theory of Guldberg and Waage, and confirm the supposition that each acid possesses a specific affinity constant. The determination of affinity constants for groups of compounds must evidently be a work of preeminent importance to chemical science. Ostwald's results, *e.g.* for acetic and trichloracetic acids, enable us to see that in these constants we shall find materials for constructing a theory which will represent the connection between molecular structure and reactions as resting on a real basis, and not, as is done at present, on a purely formal conception (*J. für pract. Chem.* (2) xxviii. 449).

A NUMBER of redeterminations of atomic weights have recently been published. The most important are these:—

Thorpe,	Ti = 48·0,	*Berichte*, xvi. 3014.
Baubigny,	Ni = 58·75,	*Compt. Rend.* xcvii. 951.
,,	Cu = 63·46,	,, ,, 906.
Brauner,	Te = 125·0,	abstract in *Berichte*, xvi. 3055 (original in Russian).
Marignac,	Bi = 208·16,	*Archiv. des Sci. Phys. et Nat.* (3) x. 5.
,,	Mn = 55·07,	,, ,, ,,
,,	Zn = 65·29,	,, ,, ,,
,,	Mg = 24·37,	,, ,, ,,
Löwe,	Bi = 207·33,	*Zeitschr. Anal. Chem.* xxii. 489.

IT is known that Dr. Landolt, after laborious researches into the refracting power of chemical compounds, arrived at the conclusion that it may be expressed, for organic bodies, by a very simple equation: the refracting power of the compound is equal to the sum of the same powers of carbon, hydrogen, and oxygen, multiplied each by the number of atoms of each of these bodies which enter into the compound. This law proved, however, not to be quite exact with regard to several organic bodies, and the researches of Herr Bruhl established that in the lower compounds the refracting power received from the equation must be increased by two units for each double pair of atoms of carbon. These results had been arrived at with liquid compounds. As to the solid ones, which were the subject of the researches of Dr. Gladstone, it was desirable to pursue these researches to the same degree of accuracy as the researches of Landolt and Bruhl. M. Kanonnikoff has prosecuted this work on a great many solid bodies belonging to both groups of the fatty series, the aromatic series and the group of terebenes and camphors. He publishes now in the *Memoirs* of the Kazan University and (abridged) in the *Journal of the Russian Chemical Society* (vol. xv. fasc. 7) the results of his researches. It appears from them that the method of determining the refracting power of a solid from its solution, applied by Dr. Gladstone, is quite satisfactory, the dissolved body not changing its refrangibility when dissolved, and that the laws discovered by Landolt and Bruhl for liquid bodies are quite true also with regard to solids. This inquiry at the same time enables M. Kanonnikoff to arrive at most interesting conclusions as to the structure of the investigated bodies.

THE atomic weight of tellurium not corresponding to what it ought to be according to Prof. Mendeléeff's theory of periodicity, M. Brauner has tried to determine it again with greater accuracy. The chief difficulty is to have the tellurium free from selenium, but this difficulty has been overcome, and the body has been obtained in beautiful crystals. As to Berzelius's method for the transformation of tellurium into anhydride, M. Brauner discovered that it is liable to considerable losses, and to avoid them he has had to take the most minute precautions. The process was controlled also by transforming tellurium into a new salt, $Te_2O_4SO_3$, and by the synthesis of the telluric copper, Cu_2Te. The results are four series of figures varying from 124·94 to 125·40, which would give, on the average, an atomic weight of 125, that is, corresponding to the theory.

WE find, in the last number of the *Journal of the Russian Chemical Society*, an interesting theory of solutions, by M. Alexeyeff; the forces of gravitation, cohesion, and chemical affinity being considered as three different degrees of one single force, which differ from one another only by the distances at which the action of the force is exercised. M. Alexeyeff asks, Which of these two last forces, of cohesion or of chemical affinity, is manifested in solutions? and pronounces himself for the former. The simplest cases of solutions are, in fact, those where there is no chemical affinity between the bodies dissolving and dissolved. Such cases were well known long since for gases and solid bodies. The solution of gases in solid bodies is quite analogous to imbibition of solids with liquids, and the much greater solubility of gases in liquids may be easily explained by the easier penetration of gases between the molecules of a liquid; the law of solubility of gases given by Dalton is perfectly agreeable with the supposition that the dissolved gases maintain their own aggregation when dissolved. The same is true with regard to solutions of liquids. The simplest of these is the solution of phenol and aniline in water. The stability of the compound formed by phenol with aniline shows that both have no affinity to water. Further, M. Alexeyeff discusses the applicability of his theory to bodies which easily pass from one state to another, and the relations of water to colloids. The solutions of liquids in liquids being, on his hypothesis, quite like emulsions. He is engaged now in experiments intended to show that the common emulsions have the properties of solutions.

M. FLAVITSKY proposes, in the *Journal of the Russian Chemical Society*, the following interesting theory of chemical affinity. According to this theory, the atoms of each simple chemical body, when its molecule is dissociated, move in circles parallel to one another, and to a certain plane, the position of which is constant in space. Each chemical element has its own plane of motion, and the circles described by the atoms of different elements cross one another under different angles. Besides, the atoms of opposite elements (such as metals and haloids) move in opposite directions. The chemical relations between different elements would thus depend upon the masses of the atoms, their velocities, their positions on their orbits, the direction of the motion, and the angles between the orbits; while the chemical combinations would be nothing more than the mutual destruction (or rather equilibration) of the velocities of the atoms of the respective chemical elements which enter into a combination. This supposition would explain all the variety of chemical relations even without a great difference in the masses of the atoms and their velocities; a complete stop might be brought only when the orbits are parallel, or the orbits being inclined with regard to one another—when a certain number of velocities acting under different angles make together the necessary resultant. This mutual action of the atoms on one another could be imagined—the author says—at a distance, by means of the ethereal medium which would be thus the medium of transformation of the physical energy into the chemical one.

TECHNICAL EDUCATION[1]

General Objects

THE object of the Central Institution is to give to London a College for the higher technical education, in which advanced instruction shall be provided in those kinds of knowledge which bear upon the different branches of industry, whether manufactures or arts.

Just as the Royal School of Mines gives a technical training to mining engineers, so the Central Institution is intended to afford practical scientific and artistic instruction which shall qualify persons to become—

1. Technical teachers.
2. Mechanical, civil, and electrical engineers, architects, builders, and decorative artists.
3. Principals, superintendents, and managers of chemical and other manufacturing works.

The main purpose of the instruction to be given in this Institution will be to point out the application of different branches of science to various manufacturing industries; and in this respect the teaching will differ from that given in the Universities and in other institutions in which science is taught rather for its own sake than with the view to its industrial application. In order that this instruction may be efficiently carried out, the Institution, in addition to the lecture theatres and class rooms, will be fitted with laboratories, drawing offices, and workshops; and opportunities will be afforded for the prosecution of original research, with the object of the more thorough training of the students, and for the elucidation of the theory of industrial processes.

Students

It is probable that the students seeking admission into the Central Institution will belong to one or other of the following classes:—

1. Persons who are training to become technical teachers.

These will be students entering the College by means of exhibitions under category 2 (*b*); or students selected at the May examinations in technology who pass with special distinction in the Honours Grade; or teachers of the Institute, registered under the scheme of technological examinations, who, during certain months of the year, when they are disengaged, will receive gratuitous instruction, and will have the opportunity of using the laboratories, collections of machinery, instruments, and apparatus with which the College will be provided.

2. Persons not under sixteen years of age who, having passed a matriculation or entrance examination, are prepared to take a complete course of instruction with a view to some professional or industrial occupation. These students will probably belong to two classes—

(*a*) Persons who pay full fees, and will receive in this Institution an education similar, in many respects, to that which they may acquire in one of the technical high schools of the Continent.

(*b*) Persons who are received into the Institution from the Finsbury Technical College, or other similar colleges in the provinces, by means of exhibitions, which will cover the whole or part of their educational and other expenses.

It is probable that many of the persons in sub class (*b*) will be select pupils from the public elementary and national schools, who, having received a preliminary science training, and distinguished themselves at the Finsbury Technical College or elsewhere, will proceed to the Central Institution in the hope of qualifying themselves for some of the higher posts in engineering or manufacturing industry.

3. Persons who, having been already engaged in industrial pursuits, desire to attend special courses, with the view of acquainting themselves more fully with the scientific principles underlying their work.

Conditions of Entrance

The matriculation or entrance examination for students intending to take the ordinary science curriculum, with the view of subsequently obtaining a diploma, will include mathematics, pure and applied; chemistry; physics; drawing, and modern languages. Whilst considerable freedom will be allowed to students entering the College as regards the courses of instruction which they desire to follow, a definite scheme of instruction will be drawn up for each of the different branches of industry, and students intending to spend two or three years in the College and to devote their whole day to study will be recommended to follow the scheme laid down. The fee for the courses to be pursued by a matriculated student will be about 30*l*. per annum, and a fee of about 20*l*. per annum will be charged to students wishing to take special courses and to occupy themselves for the greater part of the day with laboratory practice and research work. With the view of encouraging research work, the Institution will be provided with separate laboratories in which the students will have the opportunity of working without distraction or disturbance. The permission to use these laboratories will be reserved for the advanced students who have previously passed through the ordinary courses of the College, and for non-matriculated students under very special circumstances.

Subjects of Instruction

As the object of this Institution is to train technical teachers, proprietors and managers of chemical manufactories and of other industrial works, as well as mechanical, civil and electrical engineers, architects, builders, and persons engaged in art industries, the Institution will comprise five chief divisions, viz.:—(1) Chemical Technology; (2) Engineering, mechanical, civil, and electrical; (3) General Manufactures; (4) Architecture and Building Construction; (5) Applied Art; and the subjects of instruction may accordingly be grouped under the general headings of Chemistry, Engineering, Mechanics and Mathematics, Physics, Manufacturing Technology and Art. Inasmuch as the Royal School of Mines is already established as a training school for mining engineers, no provision will be made for the instruction of students in this branch of industry; and consequently the sciences of geology, mineralogy, and metallurgy will not necessarily be included in the subjects of instruction at the Central Institution.

Professorial Staff

Chemistry.—The main object of the instruction in this department will be to afford to students facilities for acquiring a knowledge of the highest branches of Chemistry, and of its application to such industries as alkali manufacture, the manufacture of artificial colouring matters, brewing, soap boiling, the manufacture of oils and varnishes, dyeing, &c. To provide the requisite instruction in this department, it will be necessary to

[1] The scheme for the organisation of the Central Institution of the City and Guilds of London Institute, recommended to the Council for adoption at a meeting of the Executive Committee held January 21, 1884, is now being circulated. We regard the matter as so important, and the scheme so perfect in its way, that we give it in full.

have one chief professor, who shall devote the whole of his time to the work of the Institution, and who will be expected to direct and superintend the students in his department and to train them in the methods of original research. In addition to this appointment, it will be advisable to have two assistant professors, who shall respectively take charge of the research and of the technical departments. A separate laboratory will be placed under the direction of each professor; and the arrangements of the building, which provide three large laboratories, besides several smaller rooms which may be used as such, render possible this division of the work. Besides these professors, demonstrators, laboratory and lecture assistants and attendants will be required to complete the staff in this department.

Engineering.—The instruction to be given in this subject will have for its object the practical scientific training of persons who intend to enter any branch of the engineering profession. The instruction will be adapted to those who have already spent some time in the office of a civil engineer or in engineering works, as well as to those who desire to obtain in the College a sound theoretical knowledge of the principles of science applicable to their future career, and an insight into the practice and manipulative work in which they will be subsequently engaged. The professor appointed to take charge of this department will be expected to devote the whole of his time to the work of the College, and to lecture on such subjects as the strength of constructive materials; the construction of docks, roads, bridges, and roofs; machine designing; hydraulic and other machinery; steam-engines, gas-engines, &c. He will also be required to give instruction in levelling and surveying, to superintend the laboratory practice of the students in the testing and engine rooms, and to direct their work in the machine shops and drawing offices. He will need the assistance of a teacher of machine drawing, and of a workshop instructor, besides one or two laboratory demonstrators, and the necessary attendants to look after the engines and machines. Later on, an additional professor will be required to take charge of some of the work of this department.

Mechanics and Mathematics.—Immediately connected with the teaching of engineering and physics is the instruction required by the students of a technical college in mechanics and mathematics. There is little doubt that the student's progress in the several branches of engineering depends very much upon his possessing such a knowledge of pure and applied mathematics as enables him to use it as an instrument of his ordinary work, and for this purpose it is necessary that his knowledge should be in advance of such applications of it as he may at any time be required to make. The professor appointed to this post will be expected to give practical instruction in the application of mathematics and mechanics to the solution of engineering and physical problems. He will be required to devote the whole of his time to the work of the College, and to give courses of instruction, illustrated by laboratory practice, on the principles of dynamics and of mechanicism, on graphical statics, on descriptive geometry, and on some of the higher parts of pure and applied mathematics. He will need the services of two demonstrators to assist in the mechanical laboratory and in the drawing office.

Physics.—In view of the present and future applications of electricity to engineering problems, considerable importance attaches to the character of the instruction to be given under this heading. The teaching of practical physics has only recently been introduced into schools of applied science, and the number of students receiving laboratory instruction in this subject in our own colleges, and in foreign polytechnic schools, is still very limited. The large number of students in attendance at the courses of electricity in the Finsbury Technical College shows that there is already a strong demand for instruction in the practical applications of this important branch of physical science. In order to supply the requisite teaching staff in this subject, it will be necessary, in the first instance, to appoint a professor, who shall devote the whole of his time to the work of the College, and who shall be responsible for the work of his department. This appointment will be supplemented by that of an additional professor, whose duties will depend very much upon the particular branch of physics to which the chief professor may devote his attention. Whilst it is highly desirable that every facility should be afforded in the Central Institution to students desiring to become electrical engineers, of receiving practical instruction in the theory and application of electricity to such technical subjects as telegraphy, electric lighting and the transmission of power, for experiments in which subjects special laboratories will be set apart, it will be the duty of the chief professor or of the additional professor to give courses of lectures on heat, light, and sound; to superintend and encourage laboratory practice in these branches of physics; and to take up from time to time the consideration of other technical subjects, such as the principles of thermo-dynamics in their application to the theory and working of steam-engines, gas-engines, ventilation, &c. To complete the teaching staff of this department, the professors will require the assistance of one or more demonstrators, according to the number of students in attendance at their laboratories.

Technology.—Under this heading is included instruction in the processes and practical details of various manufactures, some of which will be treated of by the professors of the several departments already referred to, whilst others will need the assistance of specialists who will be engaged to give lectures on these subjects. The gentlemen appointed to give these lectures will be either the Institute's examiners in technology, or other persons equally well acquainted with the technical details of particular manufacturing processes. They will be appointed from time to time as required, and will not necessarily form part of the permanent staff of the College.

The lectures will probably be of two kinds, according as they are delivered during the session or during the long vacation. The one course will form part of the curriculum of the ordinary students of the College, whilst the other course will be especially arranged for the instruction of teachers of the Institute, registered under the scheme of Technological Examinations. The lectures given during the session will be attended by the matriculated students towards the close of their regular course of study, those delivered during the recess by teachers of technical classes in London and the provinces, who will be invited to hear them without payment of fee. Arrangements will also be made by which other persons seeking information on technical matters may be admitted to these lectures.

The lectures will embrace several of the subjects included in the programme of Technological Examinations, such as Alkali Manufacture, Spirit Distilling, Glass Manufacture, Pottery and Porcelain, Printing, Weaving, the Manufacture of Cotton, Wool, Linen, &c., and will treat of the technical details involved in these and other industrial processes. For the illustration of the lectures, specimens of materials in various stages of manufacture, models and diagrams of machinery, will be required; and these should be found ready for use in the Museum of Technology, a room for which has been provided in the Institution. Facilities will be afforded to the lecturers and students for carrying on experimental work in explanation of the lectures; and considering the varied character of the work which may have to be performed in connection with this department, for which it is impossible to make provision at the outset, it is very important that here and there rooms should be left available to be fitted with such arrangements and apparatus as experience may show to be desirable. These lectures will form a special and characteristic feature of the instruction to be given in the Central Institution.

Architecture and Building Construction.—To give completeness to the instruction which this Institution should afford, a department of Architecture and of Building Construction should be added to these already enumerated. The establishment of a special school for Architects and Builders would not involve any great addition to the professorial staff which it is suggested should be provided for the other departments of the College. But as the funds at the disposal of the Institute are not sufficient to enable the Council to give effect at starting to a complete scheme of higher technical instruction adapted to all the different industries of the country, it would seem advisable at first to restrict within certain limits the work to be carried on in the Institution, and to defer for some little time the organisation of this special school.

Applied Art.—Under this heading instruction might be given in decorative art, and in several special branches of applied art, particularly in those in which artistic effects are produced by a combination of art with processes involving applications of science, such as Chromo-lithography, Enamelling, Photo-engraving on Metals, Photo-lithography and Photography. Lectures might be delivered on these subjects, and on the scientific principles connected with them; and the processes themselves might be practically illustrated under the direction of experienced teachers in the workshops of the building. Lessons might also be given in designing for, and in the execution of, glass painting, mosaic work, wood and ivory inlaying, the inlaying of metals into various substances, wood-engraving and wood-carving.

Instruction of this kind would be very serviceable in creating and developing art industries in this country, and it would be especially valuable in the training of teachers; and it is hoped that means will be found, at a very early date, for giving such instruction.

Modern Languages.—In view of the increasing importance to students of applied science of being able to read foreign scientific and trade journals so as to understand what is being done abroad in the particular branch of industry in which they are engaged, the students will have the opportunity in the Central Institution of pursuing their studies in the French and German languages. It is true that they might obtain these lessons elsewhere, but it is found, as a fact, that students very rightly object to the loss of time involved in going from place to place in pursuit of the instruction they require, and commonly neglect the lectures which they have not the opportunity of attending in the Institution in which they pass the greater part of their day. Moreover, students are attracted to a place of learning in which they can obtain all the instruction they need. For these reasons, it is thought desirable that teachers of French and German should, as soon as possible, be appointed. At the same time it is hoped that, as the teaching of modern languages becomes so far improved that students, seeking admission to the College, will be able to translate with ease passages from French and German into English, the necessity of supplementing the technical instruction, which the Institution is intended to afford, by providing for this branch of education will cease to exist.

Courses of Instruction

Systematic courses of instruction will be drawn up for matriculated students, which will be obligatory upon those who seek the Diploma of the Institute. These courses will cover a period of three years, and will be varied according to the branch of engineering or of manufacturing or art industry for which students are preparing. The details of these courses will be best settled in consultation with the several professors; but it is understood that, besides the general and special lectures and class work already referred to, the instruction will consist largely of laboratory practice in chemistry, mechanics, and physics; and that for students who may not previously have acquired any manipulative skill, the workshops of the Institution will be available; whilst machine drawing will form an important part of the ordinary curriculum. It is hoped, too, that the professors will have opportunities of conducting their students to some of the different factories and works in and near London.

Diplomas

It is desirable that the Institute should grant diplomas, in accordance with the power conferred upon the Council by the Articles of Association, Sec. 51. The diplomas should be of two kinds, the Associateship of the Institute, and the Fellowship of the Institute.

The Associateship should be awarded to students of the Central Institution, who shall have gone through the complete course of instruction as laid down for them, and have satisfactorily passed their several examinations. Of these examinations, the first would be the Matriculation or Entrance Examination, and candidates unable to pass it would be recommended to spend one year, at least, in some suitable College, in preparation for it. A subsequent examination would be held at the end of each year on the College work, and the final examination, at which external examiners would be selected to assist the Professors of the Institution, would be essentially practical in character. The diploma might be granted to students educated at any other College affiliated to, or associated with, the Institute, who should pass the Matriculation and other examinations.

The Fellowship would be conferred upon persons who, having obtained the Associateship, and spent at least five years in actual practice, should produce evidence of having done some original and valuable research work, or of having otherwise contributed to the advancement of the industry in which they are engaged.

Evening Instruction

Although, at the outset, the education of day students is all that can with advantage be attempted, it is desirable that, later on, the experiment shall be made of giving evening instruction in the Central Institution.

The instruction so given should consist of courses of lectures dealing with some of the applications of science or art to special branches of industry, and serving the double purpose of imparting information and of showing the importance of more systematic technical teaching. These lectures should be somewhat of the character of the Cantor lectures periodically delivered at the Society of Arts, and somewhat similar to the well-attended and varied courses held at the Conservatoire des Arts et Métiers at Paris. Whilst differing from class lessons, they would have a distinctly educational value; and, as distinguishing them from the Cantor lectures as well as from those given at the Paris Conservatoire, opportunities would be afforded to some of the students attending them of themselves doing laboratory work on one or more evenings of the week. It would be necessary that the evening instruction should be so arranged as not to interfere with the ordinary day courses.

Appointment of Chief Professors

Should the scheme now proposed for the organisation of the Central Institution be adopted, there are numerous details connected with it which will need to be carefully worked out. But before entering further into the consideration of these details, it is desirable that the chief professors should be appointed, not with the view of their entering immediately upon their duties, but in order that the Sub-Committee may confer with them as to the courses of instruction to be given, and as to the fittings of the several laboratories and class rooms, the preparation of which will occupy some considerable time.

It is recommended, therefore, that the Committee should at once appoint—

A Professor of Chemistry.
A Professor of Engineering.
A Professor of Mechanics and Mathematics.
A Professor of Physics.

These gentlemen having been elected, the appointment of the other professors, the demonstrators, and lecturers on technology may be deferred, it being understood that some of these additional posts must be filled before the opening of the first session. Meanwhile, however, the work of preparing the fittings and of arranging the courses can be advanced.

Management

The following Rules have been drawn up for the regulation of the educational and administrative work of the Central Institution:—

1. There shall be a Board of Studies, composed of the Professors of the Institution, for the consideration of all matters connected with the education of the students.

2. Any lecturer holding an annual appointment and giving a separate course of instruction may be appointed by Sub-Committee A as a member of the Board.

3. Subject to a general scheme of instruction to be laid down by the Institute, the Board shall arrange courses of instruction for students, and shall recommend to the Institute with respect to the appointment and removal of instructors, teachers, demonstrators, and attendants.

4. The Organising Director and Secretary of the Institute shall have a branch office in the Central Institution, and shall have a right to visit its classes, laboratories, and workshops, and to call for any information he may think necessary for the use of the Sub-Committee A. He shall also have a right to be present at any time he may think it desirable at the meetings of the Board, and to take part in the discussions, but without a vote.

5. All communications from the Board to the Institute shall be made in writing, and shall be addressed to the Organising Director and Secretary.

6. The Institute, at the outset, shall appoint, for the period of a year or longer, from among the professors, a Dean, who shall preside at the meetings of the Board, and who shall attend any meeting of Sub-Committee A at the request of the Sub-Committee or of the Board for consultation on any special business.

7. The minutes of the meetings of the Board shall be recorded, and shall be laid on the table at the meetings of Sub-Committee A.

8. The chief clerk of the Central Institution shall act as secretary to the Board, receiving in that capacity his instructions from the Dean, and shall take minutes of the proceedings.

9. The Dean shall consult with the Organising Director and Secretary, who shall confer with the Chairman of the Executive

Committee, or, in his absence, with one of the honorary secretaries, with respect to any *ad interim* arrangement that may have to be made requiring the subsequent sanction of Sub-Committee A.

10. All the administrative work of the Central Institution, general questions of discipline, and the superintendence of the library and museum, shall be in charge of the Organising Director and Secretary of the Institute, who shall act under instructions from Sub-Committee A.

GEOLOGICAL SURVEY OF THE UNITED KINGDOM [1]

THE completion of the one-inch Geological Survey Map of England and Wales affords a fitting opportunity for directing public attention to the history and progress of this great national undertaking.

As far back as the year 1832 that enthusiastic geologist, Henry T. De la Beche, began at his own expense to prepare geological maps of the mining districts of Cornwall and Devon. Being impressed with the great public utility of such maps in a country deriving so large a portion of its wealth from its mineral resources, he applied to the Government of the day for recognition and assistance. Eventually he and his two or three assistants were incorporated as a portion of the staff of the Ordnance Survey. From this modest beginning De la Beche's genius conceived the idea of founding a great central establishment in London, in which specimens of all the ores and other mineral products of the country should be selected and arranged for public inspection and reference, and where should also be preserved copies of the plans of mines and collieries, from which it would be possible to learn at any moment what areas had been exhausted and the condition of the abandoned underground workings. But besides the practical applications of science, he contemplated the foundation of a school in which all the sciences concerned in mining operations should be taught by the ablest professors in the country, and of a museum in which the rocks, minerals, and fossils of the British Islands should be thoroughly illustrated and made completely available to the public for instruction as well as for economic purposes. Being gifted with indomitable perseverance and no common measure of personal tact, he succeeded in impressing his views upon the Government. By degrees the Geological Survey was fully organised and equipped, and the Mining Record Office and the Royal School of Mines were established, De la Beche himself becoming the Director-General of the whole scheme. The accommodation afforded him at first in the buildings in Craig's Court soon proving inadequate, Parliamentary sanction was in the end obtained for the erection of the present establishment in Jermyn Street, which was opened in 1851, and which, as was then said by the late Sir Roderick I. Murchison, "stands forth, to the imperishable credit of its author, as the first palace ever raised from the ground in Britain which is entirely devoted to the advancement of science."

In the meantime, while its offshoots were showing such vigorous growth, the original and parent Geological Survey was extending its operations over the country. The objects for which it was created were twofold. In the first place it was meant to advance geological science by the production of an accurate and detailed geological map of the United Kingdom, with the necessary sections and descriptive memoirs, and by the collection of a full series of specimens to illustrate the mineralogy, petrography, and palæontology of the various geological formations. In the second place it was designed to be "a work of great practical utility bearing on agriculture, mining, road-making, the formation of canals and railroads, and other branches of national industry." This original conception of the object of the Survey has been steadily kept in view. From the districts first surveyed in Devon and Cornwall the mapping was pushed forward into the south-west of England, and then into South Wales. In 1845, the importance of the work having now been fully realised by the Government, some changes were made in the organisation. In particular, the charge of the whole scheme was transferred from the Board of Ordnance to the Office of Woods and Works. A branch of the Survey was likewise equipped for the investigation of the geology of Ireland, where some progress had already been made by Capt. Portlock, R.E. Nine years later—viz. in 1854—the operations of the Survey were extended to Scotland, and the whole establishment was finally placed under the Science and Art Department, which had now been created. The basis of the Geological Survey map is the one-inch map of the Ordnance Survey. In Ireland and Scotland, where Ordnance county maps on the scale of six inches to a mile have long been in existence, the geologists of the Survey made use of this larger scale for their field work, which was subsequently reduced and published on the one-inch scale. In England corresponding six-inch Ordnance maps having meanwhile appeared, the Geological Survey of the northern counties was carried on upon them. The surveys of the northern coalfields and other mineral tracts have been engraved and published on this larger scale. These maps embody a mass of accurate information regarding the structure and resources of our mineral districts, and have been much appreciated by those who are practically interested in the development of this branch of the national industry.

The Ordnance Map of England and Wales is divided into 258 squares, known as sheets or quarter-sheets. These can now be procured as sheets of the Geological Survey, except those last completed, which are now in preparation. As the whole ground has been surveyed, the remaining maps may be expected to appear with no great delay. To make the maps fully available for the information of the public, sections and memoirs are issued. The sections are of two kinds. One of these, called Horizontal Sections, of which 130 have been published, are drawn on a true scale of six inches to a mile, the profile of the ground being accurately shown by levelling, with the geological structure underneath. Many of these sections are accompanied by explanatory pamphlets. For various economic purposes, such as railway-cutting, tunnelling, water-supply, mining, road-making, building, and so on, these Horizontal Sections are of the utmost value. The second kind, called Vertical Sections, are drawn on the scale of forty feet to an inch, in explanation of the detailed structure of our coalfields. One of the most valuable parts of the work of the Survey is embodied in its "Memoirs." At first these were issued in goodly octavo volumes, either embracing a number of disconnected essays, some of which, like Edward Forbes's famous paper on the history of the British flora, have become classics in geological literature, or devoted entirely to the description of a particular area, such as John Phillips's well-known treatise on the Malvern Hills. After 1855, when, on the death of Sir Henry De la Beche, Sir R. I. Murchison became Director-General, this form of memoir was postponed in favour of shorter explanatory pamphlets with which each sheet or quarter-sheet was to be accompanied. These were designed to supplement the map and sections, and to make their information at once intelligible to the public by giving detailed information regarding the natural sections, characteristic fossils, economic minerals, &c., in each district. It was fully determined, however, that, as the Survey advanced, ample monographs should be prepared for each geological formation or important district. Among the other publications of the Survey are the "Decades" and "Monographs" of organic remains, of which seventeen have been issued; the "Mineral Statistics" of the Mining Record Office, which have appeared as an annual volume for the last thirty years; and various catalogues and other works, which swell up the total separate printed publications of the Survey of the United Kingdom to upwards of 270. It ought to be stated here that, first under De la Beche, and subsequently under Murchison, the work of the Survey depended largely for its efficiency and breadth of view on the Local Director, Prof. (now Sir A. C.) Ramsay, who on Murchison's death was appointed Director-General in 1872, and continued in that post until his retirement from the service at the end of 1881. He was then succeeded by Prof. Geikie, who had for more than fourteen years held the office of Director of the Survey in Scotland, and who since his appointment has pushed on the completion of the one-inch map of England and Wales, which is now announced by him as accomplished. The completion of the map of what is termed the "Solid Geology" of England and Wales—that is, the rocks underlying the superficial deposits—terminates indeed an important part of the work of the Survey.

But much remains to be accomplished. The one-inch map of Ireland will be completed in a few years; but that of Scotland, not having been begun till much later, and having always had a much smaller staff, will require longer time. From the last published report of the present Director-General we learn that such of the staff as are qualified for the difficult mountainous area of Scotland will be transferred to that region as soon as

[1] From the *Times*.

they have prepared their recent work for the engraver. The staff retained in England will have to complete the survey of the superficial deposits, which is so valuable as a basis for the agricultural valuation of land, as well as for other purposes. For some years past the mapping of these deposits has advanced simultaneously with that of the rocks underneath them. Two kinds of maps are supplied to the public, one indicating the superficial accumulations, and therefore invaluable as an agricultural map, and the other showing the "solid geology" or older rocks that lie below. The importance of mapping the superficial deposits, however, both from an industrial and scientific point of view, was not recognised until comparatively recently. Over the larger part of the country, therefore, these deposits are not expressed upon the Survey maps, and it is to the completion of this work that one part of the energy of the staff must now be directed. It will be desirable also to resume the survey of the coalfields on the scale of six inches to a mile, which has been temporarily interrupted in order to hasten the completion of the one-inch map. The South Wales coalfield, for example, was mapped some forty years ago, and so much has been done in the interval towards the development of that vast mineral basin that the maps are so antiquated as to be of comparatively little practical value. We learn from the same report that the most important work lying before the Survey in England and Wales is the geological description of the country. As the issue of explanatory pamphlets to accompany the one-inch maps was not begun until 1857, there is a large area of ground of which no published account has been given, except on the maps and sections. Printed explanations of each sheet are now to be supplied, and from these and all the data in possession of the Survey a series of Memoirs or Monographs is to be compiled which will embrace a generalised view of the geological structure and of the minerals and industrial resources of the whole country. It is the fate of geological maps, as well as of other human productions, to get out of date. As the nation has expended so ungrudgingly to carry on a Geological Survey which is acknowledged to stand at the head of the geological surveys of the world, it would be worse than folly to lose the benefit of all this expenditure by allowing the maps to become obsolete. New openings are continually being made which throw fresh light on what lies beneath us. It will be the duty of Parliament to see that a permanent staff, which need not be a large or costly one, is always retained for the purpose of keeping the maps up to date. Meanwhile it is pleasant to see that the work of this worthy national enterprise is being carried on with vigour, and that its staff are fully alive to the importance of the duties that still lie before them.

THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[1]

THE Scottish Highlands must be looked upon as the relics of an ancient tableland cut out of highly crumpled and plicated schists. Among the eastern Grampians large fragments of the plateau exist at heights of more than 3000 feet, forming wide undulating plains terminating here and there at the edge of precipices. In the Western Highlands, the erosion having been more profound, the ridges are narrower, the valleys deeper, and isolated peaks are more numerous. It is the fate of a tableland to be eventually cut down by running water into a system of valleys which are widened and deepened, until the blocks of ground between are sharpened into ridges and trenched into separate prominences. The Highlands present us with far advanced stages of this process. In the youngest of British tablelands—that of the volcanic region of Antrim and the Inner Hebrides—we meet with some of the earlier parts of the change. That interesting tract of our islands reveals a succession of basaltic sheets which appear to have spread over the wide valley between the Outer Hebrides and the mainland, and to have reached southwards beyond Lough Neagh. Its original condition must have been like that of the lava-fields of Idaho and Oregon—a sea-like expanse of black basalt stretching up to the base of the mountains. What may have been the total thickness of basalt cannot be told; but the fragment remaining in Ben More, Mull, is more than 3000 feet thick. So vast has been the erosion since older Tertiary time that the volcanic plateau has been trenched in every direction by deep glens and arms of the sea, and has been reduced to detached islands. It is strange to reflect that all this revolution in the topography has been effected since the soft clays and sands of the London Basin were deposited.

The intimate relation of a system of valleys to a system of drainage lines, first clearly enunciated by Hutton and Playfair, has received ample illustrations from all parts of the world. Yet the notion is not yet extinct that in some way or other valleys have been as much, if not more, determined by subterranean lines of dislocation as by superficial erosion. Some favourite dogmas die hard, and though this dogma of fracture has been demolished over and over again, it every now and then reappears, dressed up anew as a fresh contribution to scientific progress. We have only to compare the surface of a much dislocated region with its underground structure, where that has been revealed by mining operations, as in our coal-fields, to see that valleys comparatively seldom, and then only as it were by accident, run along lines of dislocation, but that they everywhere cut across them, and that faults rarely make a feature at the surface, except indirectly by bringing hard and soft rocks against each other.

In Britain, as in other countries, there is a remarkable absence of coincidence between the main drainage system and the geological structure of the region. We may infer from this fact that the general surface, before the establishment of the present drainage system, had been reduced to a base-level of denudation under the sea, the original inequalities of configuration having been planed off irrespective of structure; or at least, that the present visible rocks were buried under a mass of later unconformable and approximately level strata, on the unequally upraised surface of which the present drainage system began to be traced. Where the existing watershed coincides generally with the crest of an anticline, its position has obviously been fixed by the form of the ground produced by the plication, though occasionally an anticline may have been deeply buried below later rocks, the subsequent folding of which along the same line would renew the watershed along its previous trend. Where drainage lines coincide with structure, they are probably, with few exceptions, of secondary origin; that is, they have been developed during the gradual denudation of the country. Since the existing watershed and main drainage lines of Britain are so independent of structure, and have been determined chiefly by the configuration of the surface when once more brought up within the influence of erosion, it may be possible to restore in some degree the general distribution of topography when they were begun.

One of the most curious aspects of the denudation of Britain is its extraordinary inequality. In one region the framework of the land has been cut down into the very Archæan core, while in the immediate vicinity there may be many thousands of feet of younger strata which have not been removed. This inequality must result from difference in total amount of upheaval above the base-line of denudation, combined with difference in the length of exposure to denudation. As a rule the highest and oldest tracts will be most deeply eroded. Much of the denudation of Britain appears to have been effected in the interval between the close of the Carboniferous and end of the Triassic period. This was a remarkable terrestrial interval, during part of which the climate was so arid that salt lakes were formed over the centre of England. Yet the denudation ultimately accomplished was enormous, thousands of feet of Carboniferous rock being entirely removed from certain areas, such as the site of the present Bristol Channel. An interesting analogy to this condition of things is presented by the Great Basin and adjoining tracts of Western America, where at the present time great aridity and extensive salt-lakes are accompanied by great erosion.

This deeply-eroded post-Carboniferous land was eventually screened from further degradation, either by being reduced through denudation to a base-level or by being protected by submergence. It was to a large extent covered with Secondary rocks, though the covering of these may have been but thin over what are now the higher grounds. The present terrestrial areas emerged at some period later than the Chalk. In England there were three tracts of land—Wales, the Pennine Chain, and the Lake District. The eastern half of the country, covered with Secondary rocks, was probably the last portion to be uplifted above the sea; hence the watersheds and drainage lines in that tract may be regarded as the youngest of all.

The history of some of the valleys of the country tells the story of the denudation. The Thames is one of the youngest

[1] Abstract of the third of a course of lectures given at the Royal Institution, February 19, by Archibald Geikie, F.R.S., Director-General of the Geological Survey. Continued from p. 348.

rivers, dating from the time when the Tertiary sea-bed was raised into land. Originally its source probably lay to the west of the existing Jurassic escarpment of the Cotswold Hills, and it flowed eastward before the Chalk escarpment had emerged. By degrees the Chalk downs have appeared, and the escarpment has retreated many miles eastward. The river, however, having fixed its course in the Chalk, has cut its way down into it, and now seems as if it had broken a path for itself across the escarpment. As all the escarpments are creeping eastward, the length and drainage area of the Thames are necessarily slowly diminishing. The Severn presents a much more complex course; but its windings across the most varied geological structure are to be explained by its having found a channel on the rising floor of Secondary rocks between the base of the Welsh hills and the nascent Jurassic escarpments. The Wye and Usk afford remarkable examples of the trenching of a tableland. The Tay and Nith are more intricate in their history. The Shannon began to flow over the central Irish plain when it was covered with several thousand feet of strata now removed. In deepening its channel it has cut down into the range of hills north of Limerick, and has actually sawn it into two.

SCIENTIFIC SERIALS

THE *American Journal of Science*, January, 1884.—The effect of a warmer climate on glaciers, by Capt. C. E. Dutton. The author fully discusses the theory of those who argue that the more copious snowfall required for a more extended system of glaciation implied more atmospheric moisture, greater evaporation, and a generally higher temperature; in fact, a warmer climate than at present, due probably to a greater rate of solar radiation. He concludes that the possibility of obtaining a greater snowfall by a warmer climate would be necessarily limited to the Arctic regions, or to altitudes far above the present snow line. Elsewhere a higher temperature would add to the rainfall, and actually diminish the snowfall. The advocates of the theory have failed to perceive that the additional moisture postulated could fall only as rain. Not until the air has discharged as rain all the moisture in excess of the quantity which saturates it at zero, can it begin to yield snow.—On the application of Wright's apparatus for distilling, to the filling of barometer tubes (one illustration), by Frank Waldo.—Account of a new method of measuring the energy expended on or rendered by a dynamo or a magneto machine in connection with the production of electricity in a large way, by C. F. Brackett. —On some points in climatology: a rejoinder to Mr. Croll, by Simon Newcomb. The assumed lower mean temperature of the northern hemisphere at some former geological epoch is attributed by Mr. Croll to a greater eccentricity of the earth's orbit, combined with a position of the perihelion near the northern solstice, causing a short perihelion summer and a correspondingly long aphelion winter. To this the author replies that too little is known of the laws of terrestrial radiation of heat through the atmosphere to justify the establishment of any theory of the glacial epoch, and that, in any case Mr. Croll fails to show why the mean temperature should be different at the supposed periods. Hence the conclusion, not that Mr. Croll's theory is false, but that it is not proven.—An account of some recent methods of photographing the solar corona without an eclipse, and of the results obtained (one illustration), by Dr. W. Huggins.—Elliptical elements of comet 1882 I., by F. J. Parsons.—The Minnesota Valley in the Ice Age, by Warren Upham.—On the so-called dimorphism in the genus Cambarus, by Walter Faxon. —Evolution of the American trotting horse, by Francis E. Nipher. In reply to the criticism of Mr. W. H. Pickering, the author argues that the known facts are not opposed to the conclusion that the trotting horse may finally trot his mile in about the same time that the running horse will cover the same distance.—On the origin of jointed structure, by G. N. Gilbert.—A theory of the earthquakes of the Great Basin, by the same author.

Revue d'Anthropologie, tome vi. fasc. 4, Paris, 1883.—The larger portion of this number is devoted to M. Mathias Duval's lecture on Transformism, of which two parts have already appeared in the earlier fascicules of the *Revue* for 1883. For English readers generally the address lacks the interest of novelty, as it is little more than an exposition of the works and opinions of Darwin and of the principal authorities, chiefly English, whose observations corroborate his views. It is satisfactory, however, to find that, while maintaining with patriotic zeal Lamarck's claim to be regarded as the originator of the theory of evolution, M. Duval recognises in Darwin the one man who, through varied yet profound scientific acquirements, intellectual qualifications, and special personal and social conditions, was alone capable of giving to novel conclusions of such extraordinary significance the authoritative force and stability of a true science.—On so-called Wormian or supernumerary bones in domestic animals, by M. Cornevin, Professor in the Lyons Veterinary College. The author finds that while in man such bones are generally cranial, in animals they are facial, and he believes himself justified in drawing from his observations two important conclusions (which, however, need support) that in animals the Wormians appear some time after birth, developing more and more with age, and that they are of frequent occurrence in the less carefully bred races, while they are very rarely found in the high breeds of horses, oxen, sheep, pigs, &c.—On the Kalmuks, by M. Deniker. The author, who is a native of the regions which he describes, has made the presence of an encampment of Kalmuks in the "Jardin d'Acclimatation," at Paris, the occasion for bringing together all the most reliable historical, geographic, ethnic, and socio-physical data in connection with this people, whose various migrations, including their great exodus from the region of the Volga in the eighteenth century, he treats at great length. He considers the oblique opening of the eye, which most writers accept as an ethnic characteristic, as of little scientific value, since it is not of specially frequent occurrence among pure Mongols such as are the Kalmuks; but he recognises, on the other hand, that such an ethnological peculiarity is to be found in a peculiar introversion of the upper eyelid which in young Kalmuk children has often the effect of obliterating the eyelashes; while the general narrowness of the opening imparts a triangular form to the eye. Black, scantily developed hair, dark brown eyes, slightly yellow skin, and a stature somewhat below the mean (the adult Kalmuk presenting the proportions of Europeans of thirteen to fourteen years of age), constitute the chief physical characteristics of the Mongol race. The paper, which is illustrated by an admirable map of the Kourghees and Kirghees territories of South Russia and West Thibet, will be continued in a subsequent number.

Journal of the Russian Chemical and Physical Society, vol. xv. fasc. 7.—On the relations between the refracting power and the chemical constitution, by S. Kanonnikoff.—On the velocities of chemical reactions, by A. Potylitzin. The thermo-chemical equivalents obtained separately for several pairs of elements allow to foresee only the direction which will be taken by the reaction when they are brought together; the heat disengaged by one pair of elements brought into reaction in the presence of other bodies, which are also liable to chemical modifications, is not equal to the whole of the thermo-chemical work of the pair, a part of it being employed for chemical work in the accessory bodies; the thermo-chemical equivalents are proportionate to the velocities during the first moments of the reaction.—Sketch of the present state of the theory of explosive substances, by S. Tcheltsoff. The actual tendency of the technics to substitute determined chemical combinations, instead of the mixtures which were used at first as explosives, is quite rational. Not only the decomposition goes on with more regularity in a chemical compound, but also the potential energy is greater.—On the chloride of pyrosulphuryl, by D. Konovaloff.—On the cause of the changes in the galvanic resistance of selenium under the influence of light, by N. Hesehus. The author concludes in favour of the dissociation transmitted into the interior of the body as the cause of this change, and, following the hints of Messrs. Bidwell and Siemens, tries to prove it by mathematical arguments.—Notes on radiophony, by M. Geritch; and on resounding tubes, by M. Bachmetieff.

Zeitschrift für wissenschaftliche Zoologie, vol. xxxix. Part 2, November 6, 1883, contains:—Researches on the brain structures in Petromyzons, by Dr. F. Ahlborn (plates 13-17). A very excellent and detailed memoir, based chiefly on the brain in *Petromyzon planeri* and *P. fluviatilis*.—On the biology and anatomy of Clione, by N. Nassonow, assistant in the Zoological Museum of Moscow (plates 18 and 19). These investigations were carried on at the biological station at Sebastopol, and on an apparently new form called *C. stationis*, found in the shells of *Ostrea adriatica*, in it the oscula are prominent orange-coloured. Branching plasmodia were traced through the shell-structure, reminding one of the mycelial threads of a fungus.—Contributions to the histology of the Echinoderms, by Dr. Otto Hamann (part 2).—The nervous system of the Holothuria pedata: Cuvier's organ. The nervous system and sense organs of the Holothuria apedata (plates 20-22).—On some new species of Thalassema, by Kurt Lampert, Erlangen.

Vol. xxxix. Part 3, December 21, 1883, contains:—On the Rotifers of the environs of Giessen, by Karl Eckstein, natural history student, Giessen (plates 23-28), enumerates and describes in detail fifty species (one new genus Distyla, with two new species, *D. giessensis* and *D. ludwigii*). A list of all known genera is given, with a general description of the anatomy, development, and habits of the group. A very complete bibliography is appended.—On the digestive apparatus of the Decapods, by Dr. F. Albert (plates 29-31, and woodcuts).

Vol. xxxix. Part 3, December 31, 1883, contains:—On Bucephalus and Gasterostomum, by Dr. H. Ernst Ziegler (plates 32 and 33) (*Bucephalus polymorphus* was found in considerable quantities in *Anodonta mutabilis*).—On the central nervous system in *Periplaneta orientalis*, by Dr. Max Koestler (plate 34).—On the varieties of the cerebral fissures in Lepus, Ovis, and Sus, by Dr. Victor Rogner (plate 35).—On the structure and fissiparity of *Ctenodrilus monostylus*, sp. nov., by Max Graf Zeppelin (plates 36 and 37).—On the nervous system of the snout and upper lip in oxen, by Ivan B. Cybulsky (plates 38 and 39).—On the anatomy and physiology of the proboscis in Musca, by Dr. Karl Kraepelen (plates 40 and 41).—On the connective tissue of the epiphyses in Plagiostomes, Ganoids, and Teleostea, by Dr. J. Th. Cattel.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 10.—"On the Amount of Light Reflected by Metallic Surfaces." By Sir John Conroy, Bart., M.A. Communicated by Prof. Stokes, Sec. R.S.

In a paper which Prof. Stokes did me the honour of communicating to the Royal Society, and which appeared in the *Proceedings*, vol. xxxv. p. 26, I gave an account of some experiments I had made on the amount of light reflected by polished metallic surfaces when ordinary unpolarised light was incident upon them.

The light of a paraffin lamp fell either directly, or after reflection from the metallic surface, on a photometer, and the readings were made by altering the distance at which another similar lamp had to be placed from the photometer in order to produce an equal illumination.

I have repeated the experiments with the steel and speculum metal mirrors with polarised light. The polish of the tin and silver mirrors being defective, it was not thought worth while to re-examine them.

The general arrangement of the apparatus remained the same; but in order to obtain a more intense light, a magic lantern (the one known as the "Sciopticon" being used) was substituted for the paraffin lamp carried by the goniometer.

The metal plates were clamped to the vertical stage, and their adjustment examined by placing a second, or analysing, Nicol in the path of the reflected light and crossing the Nicols, the former being placed with its principal section either in or perpendicular to the plane of incidence, and adjusting the stage screws till the light reflected from the plate was completely extinguished.

The experiments were made in the manner described in the former paper, the light being polarised in, or perpendicularly to, the plane of incidence by the Nicol. It was found that the illumination of the paper varied with the position of the Nicol, being always greatest when the light which fell on the paper was polarised in the plane of incidence.

Four sets of observations and their means, made with the steel and speculum metal mirrors, are given in the tables.

TABLE I.—*Steel, with Light Polarised in the Plane of Incidence*

Angle of incidence °	A	B	C	D	Mean
30	57·01	61·67	63·06	61·05	60·70
40	61·73	64·04	68·18	62·90	64·21
50	65·31	67·41	71·97	69·41	68·52
55	68·76	70·41			
60	70·88	74·55	77·96	74·31	74·42
65	77·22	76·02	81·40	74·83	77·37
70	81·48	80·77	85·22	81·57	82·26
75	84·09	84·92	90·32	84·71	86·01
80	84·58	86·34	91·55	89·01	87·87

TABLE II.—*Steel, with Light Polarised Perpendicularly to the Plane of Incidence*

Angle of incidence °	A	B	C	D	Mean
30	49·27	50·53	53·67	47·28	50·19
40	45·53	45·39	49·79	44·40	46·28
50	40·45	41·24	43·47	38·78	40·98
55	37·47	37·34			
60	35·54	33·79	36·90	32·89	34·78
65	29·57	28·88	31·97	29·70	30·03
70	25·69	26·61	27·72	26·14	26·54
75	23·71	25·55	25·38	24·30	24·73
80	26·29	26·46	27·60	26·04	26·60

TABLE III.—*Speculum Metal, with Light Polarised in the Plane of Incidence*

Angle of incidence °	A	B	C	D	Mean
30	64·58	64·09	63·37	66·18	64·55
40	67·76	68·22	65·14	69·86	67·74
50	72·65	72·23	69·04	71·90	71·45
60	76·63	78·65	77·57	77·95	77·70
65	79·65	79·68	79·44	81·26	80·01
70	83·09	81·25	84·94	83·90	83·29
75	82·94	84·20	86·93	88·01	85·52
80	87·52	86·78	90·96	89·72	88·74

TABLE IV.—*Speculum Metal, with Light Polarised Perpendicularly to the Plane of Incidence*

Angle of incidence °	A	B	C	D	Mean
30	59·31	57·86	59·83	59·63	59·16
40	53·30	54·01	56·41	54·29	54·50
50	49·47	51·44	49·61	49·69	50·05
60	41·50	43·36	44·02	43·83	43·18
65	39·95	39·12	40·50	40·85	40·10
70	38·27	35·84	37·42	38·29	37·45
75	36·20	34·45	36·84	35·88	35·84
80	40·51	38·67	41·22	41·15	40·39

The amount of light which, according to Cauchy's theory, ought to have been reflected by the mirrors was calculated out by the formulæ, the principal incidences and azimuths for the two mirrors having been determined—

$$J^2 = \frac{\theta^2 + \cos^2 i - 2\theta \cos \epsilon \cos i}{\theta^2 + \cos^2 i + 2\theta \cos \epsilon \cos i}$$

and

$$I^2 = \frac{\theta^2 \cos^2 i + 1 - 2\theta \cos \epsilon \cos i}{\theta^2 \cos^2 i + 1 - 2\theta \cos \epsilon \cos i},$$

and the observed and calculated results are set forth in Tables V. and VI.

TABLE V.—*Amount of Light Reflected by Steel Mirror*

	Observed		Calculated	
°	J^2	I^2	J^2	I^2
30	60·70	50·19	63·17	54·95
40	64·21	46·28	66·44	51·31
50	68·52	40·98	70·80	42·09
60	74·42	34·78	76·72	39·24
65	77·37	30·03	79·52	35·32
70	82·26	26·54	83·04	31·62
75	86·01	24·73	86·85	29·46
80	87·87	26·60	90·97	32·39

TABLE VI.—*Amount of Light Reflected by Speculum Metal Mirror*

	Observed		Calculated	
°	J^2	I^2	J^2	I^2
30	64·55	59·16	69·78	62·82
40	67·74	54·50	72·53	59·74
50	71·45	50·05	76·18	55·37
60	77·70	43·18	80·77	49·59
65	80·01	40·10	83·42	46·38
70	83·29	37·45	86·32	43·53
75	85·52	35·84	89·44	42·29
80	88·74	40·39	92·77	45·88

As far as regards the general character of the phenomena the agreement is complete and in accordance with the observations of

M. Jamin, but the actual values of the observed intensities always fall short of the calculated intensities, the difference being least with the steel mirror.

The polish of the mirrors was examined at the end of the experiments by the method suggested by Prof. Stokes, and described in the paper already referred to; both the mirrors stood the test satisfactorily, the polish of the steel being very slightly the best.

These experiments appear to show that the generally received formulæ for metallic reflection are approximately correct, but that the actual intensity of the reflected light is always less than the theoretical intensity, and that therefore, unless this be due to defects in the metallic surfaces, the formulæ do not completely express the laws of metallic reflection. If, as appears to be the case, a change in the reflective power of a plate can occur without any change in the values of the principal incidence and azimuth, it is necessary to regard the formulæ as only approximately true, and there is additional reason for thinking that, as Prof. Stokes has suggested, three constants are required to define a metal optically.

Linnean Society, February 7.—Sir J. Lubbock, Bart., president, in the chair.—Mr. Henry Groves of Florence and Mr. F. L. Keays of Cobham were elected Fellows.—Mr. F. O. Bower showed specimens of the leaf of *Tomeia menziesii*, with adventitious buds situated at the base of the lamina. These buds appear at the same point in all the leaves, and under normal circumstances, so that their development seems to be a constant character of the species. Their origin is exogenous, and the buds are found already present at the period when lignification of the xylem of the young vascular bundles begins. Mr. Bower compared this development with that already known in *Cardamine pratensis* and *Athyrurus ternatus*.—There was exhibited, on behalf of Mr. Arthur C. Cole, a box containing mounted preparations illustrative of his "Studies in Microscopic Science," a work devoted to animal and vegetable histology, now being issued in parts.—A note on the gemmæ of *Aulacomnion palustre* was read by Mr. F. O. Bower. Specimens kept in a warm and damp atmosphere flourished well, but showed no sign of sexual organs. It was found, however, that the ordinary vegetative axes often bore towards their apices structures which were undoubtedly of a foliar nature, with a special adaptation for effecting asexual or vegetative reproduction of the plant. Indeed, these gemmæ were found to be capable of immediate germination when laid on damp soil or even floating on water.—The second part of the Rev. A. E. Eaton's monograph on the recent Ephemeridæ or mayflies was read in abstract, its contents being a descriptive account of the genera and species from *Potamanthus* to *Callibætes* inclusive.—Another paper taken in abstract was by the Rev. A. M. Norman, on European and North Atlantic Crustacea. In this an attempt has been made to gather together all the present known and recorded forms of the group. Notices of many of the species are only to be found in obscure periodicals, &c., difficult of access almost in every language; consequently, since the production of Milne-Edward's "Histoire Naturelle des Crustaces" in 1834, the numbers have increased nearly threefold—revision therefore being highly necessary.—Mr. B. T. Lowne gave an interesting communication embodying his researches on the compound vision of insects. He compares the structures of the simple ocellus with those of the compound ocellus (common in larval insects), and with those of the compound eye. The compound eye, according to him, is but composed of aggregated compound ocelli, or one of the latter in the larval insect is merely equivalent to a single segment of a compound eye. He refers to the development of the compound eye, and points out that in many larvæ during the moulting stages the "segregate" retina is finally replaced by another. He describes a deep, spindle-like layer in intimate connection with the nervous structures, and which layer he regards as playing an important part in the phenomena of compound vision rather than that this kind of vision is solely dependent on the number of corneal facets.

Mathematical Society, February 14.—Prof. Henrici, F.R.S., president, and subsequently Sir J. Cockle, F.R.S., vice-president, in the chair.—Messrs. A. B. Basset and D. Brocklebank were admitted into the Society.—The following communications were made:—On the intersections of a triangle with a circle, by H. M. Taylor.—On the difference between the number of $(4n + 1)$ divisors and the number of $(4n + 3)$ divisors of a number, by J. W. L. Glaisher, F.R.S.—On a general theory, including the theories of systems of complexes and spheres, by A. Buchheim.—Prof. Sylvester, F.R.S., made some remarks on matrices with reference to nonions, &c. (see forthcoming paper in the *American Journal of Mathematics*).

Chemical Society, February 7.—Dr. W. H. Perkin, president, in the chair.—It was announced that a ballot for the election of Fellows would be held at the next meeting of the Society (February 21). The following papers were read:—On the expansion of liquids, by D. Mendeléeff; translated from the Russian by B. Brauner. In this paper the author, principally from data furnished by Thorpe (*Chem. Soc. Journ. Trans.*, 1880, p. 141), gives the equation $V = \frac{1}{1 - \kappa t}$ as expressing approximately the expansion of liquids. κ is named the "determinator of expansion." It is a coefficient characterising each liquid, just as each liquid has a specific gravity, boiling point, &c. The author states that the above expression, although many liquids deviate slightly from it, is sufficient in the majority of physico-chemical investigations.—Researches on secondary and tertiary azo-compounds, by R. Meldola, No. 2. The author describes, in continuation of his former researches, the action of diazotised paranitraniline upon tertiary monamines. In the case of dimethylaniline the resulting product is paranitrobenzenazo-dimethylaniline. This, on reduction with ammonium sulphide, furnishes an amido-compound, which is a most delicate test for nitrous acid. The nitro-azo compounds of the meta-series could not be reduced by ammonium sulphide without complete decomposition. The author concludes that the β-naphthylamine compounds of para- and meta-nitrodiazo-benzene do not contain an amido-group, as they yield with nitrous acid nitroso derivatives.—Note on the nitrogenous matters in grass and ensilage from grass, by E. Kinch. The author has determined the albuminoid and non-albuminoid nitrogen in a sample of grass and in the ensilage made from the grass. In the grass 9 per cent. of the nitrogen was non-albuminoid; in the ensilage 55 per cent. of the nitrogen was non-albuminoid. The albuminoids were determined by the phenol, the copper hydrate, the mercuric hydrate, and the lead hydrate methods. The author points out the importance of this serious diminution in the albuminoids, with reference to the food-value of ensilage.—On the influence of the temperature of distillation on the composition of coal-gas, by L. T. Wright. The author finds that more gas is obtained at high temperatures, but that it contains more hydrogen and less hydrocarbons.

Physical Society, February 9.—Prof. R. B. Clifton, president, in the chair.—Annual General Meeting.—The motion to make past presidents permanent vice-presidents was carried, and the articles of the Society altered accordingly.—Prof. Clifton read a report on the business of the past year, which showed that steady work had been done by the Society. Dr. Atkinson read the balance-sheet, showing a flourishing condition of the Society. A proposal to adopt certain letters to indicate membership of the Society when placed behind the name was, on the motion of Prof. G. Forbes, supported by Prof. Adams, Prof. McLeod, and others, held in abeyance for the present. The officers and Council for the ensuing year were then elected, and were as follows:—President: Prof. F. Guthrie, F.R.S.; Vice-Presidents: Profs. R. B. Clifton, F.R.S., W. E. Ayrton, F.R.S., W. Chandler Roberts, F.R.S., Dr. J. Hopkinson, F.R.S., Lord Rayleigh, F.R.S.; Secretaries: Prof. A. W. Reinold, M.A., Mr. W. Baily, M.A.; Treasurer: Dr. E. Atkinson; Demonstrator: Prof. F. Guthrie; other Members of Council: Mr. Shelford Bidwell, M.A., LL.B., Mr. C. W. Cooke, Prof. F. Fuller, Mr. R. T. Glazebrooke, F.R.S., Mr. R. J. Lecky, F.R.A.S., Prof. H. McLeod, F.R.S., Dr. Hugo Müller, F.R.S., Prof. J. Perry, Prof. S. P. Thompson. Honorary Member, Prof. H. A. Rowland. Prof. Clifton then resigned the chair to Prof. Guthrie, whose zeal for the Society he warmly praised. Prof. Guthrie expressed his high appreciation of the courtesy and kindness of the retiring President while in the chair. Mr. W. Lant Carpenter proposed a vote of thanks to the Lords of the Committee of Council on Education; Mr. Whipple moved the cordial thanks of the meeting to Prof. Clifton; Mr. Griffith and Prof. Adams proposed a vote of thanks to the secretaries, demonstrator, and treasurer; Prof. G. C. Foster proposed a vote of thanks to the auditors.—The meeting was then resolved into an ordinary one, and the Secretary read a paper by Dr. O. J. Lodge and J. W. Clark on the phenomena exhibited by dusty air in the neighbourhood of strongly-illuminated bodies, which we hope to print next week.

Mineralogical Society, February 12.—Rev. Prof. Bonney, F.R.S., president, in the chair.—Messrs. T. Vaughan Hughes and W. Semmons were elected members, and the Grand Duke of Leuchtenberg, M. E. Bertrand, and Prof. von Lang, corresponding members.—The following papers were read:—Note on a case of replacement of the quartz constituent of a granite by fluor spar, by the President.—On an arsenical copper ore, "garbyite," from Montana, U.S.A., by Mr. W. Semmons.—On an altered siderite from Alston Moor, by Dr. C. O. Trechmann.—Notes on a picrite (Palæopicrite) and other rocks from Gipps Land, and a serpentine from Tasmania, by the President.—Prof. Judd, on invitation by the President, submitted some slides of dust from the volcano of Krakatoa, which were exhibited under the microscope, and explained the principal features noticeable in these deposits.—The President exhibited some slides of dust from Cotopaxi, which had fallen on Chimborazo at the time that Mr. Edward Whymper was ascending the latter mountain.

SYDNEY

Royal Society of New South Wales, December 5, 1883.—Hon. Prof. Smith, C.M.G., president, in the chair.—Three new members were elected and seventy-eight donations received.—A paper on additions to the census of the genera of plants hitherto known as indigenous to Australia, by Baron Ferd. von Müller, K.C.M.G., F.R.S., was read.—Prof. Smith exhibited Stroh's apparatus for producing attraction and repulsion by vibrations of air.—The following specimens from the Solomon Islands, collected by Dr. H. B. Guppy of H.M.S. *Lark*, were exhibited and described by Prof. Liversidge, F.R.S.:—1. White flint from Ulana or Contrariété Island. 2. Flints, including chips and cores, from Ugi, also a large flint tomahawk weighing about four pounds. The flints possess all the characteristics of those from the chalk of Europe, and cannot by mere inspection be distinguished from them. Prof. Liversidge remarked that some years ago Mr. Brown, the Wesleyan missionary, brought from New Britain a soft white limestone which was quite undistinguishable from chalk, not only physically but chemically, and pointed out that this discovery of flints afforded another very strong proof of the probable presence of true chalk of Cretaceous age in the South Sea Islands. 3. Samples of water from the fresh-water lake of Wailava in the Island of Santa Anna. 4. Water from the boiling spring in the Island of Simbo; temperature 212°. 5. Water condensed from one of the fumaroles in the Solfatara on the south-west point of Simbo, at an elevation of about 300 feet above the sea. 6. Water condensed from one of the fumaroles on the summit of the South Hill in the Island of Simbo, elevated about 1100 feet above the sea. 7. Two kinds of fruits ejected from the crops of pigeons shot on a small Island off the south coast of St. Christoval.

BERLIN

Physical Society, January 25.—Dr. Kayser spoke on the results of an investigation, recently published by Prof. Bunsen of Heidelberg, into the condensation of carbonic acid on smooth glass surfaces, results which did not coincide with those of other physicists, the speaker among the rest. Prof. Bunsen had found that the condensation of carbonic acid was a continuous process which could not be regarded as finished even after a period of three years. According to the views hitherto entertained, the process referred to came to a conclusion in a very short time. Dr. Kayser was of opinion that the diverging result of Prof. Bunsen's examination was to be explained on the ground that in his experiments he made use of an absorbing vessel stoppered by a greased glass cock. Carbonic acid appeared, however, to diffuse itself thoroughly through fat, as had been proved by an experiment set in operation some weeks ago. Two cruciform glass vessels were set up, one arm of which, directed downwards, passed into a capillary tube dipped in quicksilver, while the three other arms were closed up in one vessel by greased glass plates and hermetically sealed in the other. Both were filled with carbonic acid. In the grease-stoppered vessel the volume of carbonic acid showed a slow progressive diminution, but in the other vessel it continued unaffected. Anything like condensation of the carbonic acid was here quite out of the question, though on the other hand there was clearly a case of osmose through the grease, a subject which Dr. Kayser would further prosecute.—Prof. Vogel exhibited instantaneous photographs of various animals in motion—horses, cows, dogs, and stags—which had been executed by Mr. Muybridge in San Francisco. Prof. Vogel having explained the mode of their production, directed attention to particular pictures completely at variance with the representations of animals in motion hitherto customary among artists. When, however, whole series of these figures, which were occasionally very curious, were viewed through the stroboscope, it was recognised how true to nature these representations were.—Prof. Neesen laid before the Society two new apparatus—one a call-apparatus for telegraphic purposes, constructed by Herr Abakanowicz, which, from the small number of its vibrations, would exercise no disturbing influence on neighbouring conductors; the other an electro-magnetic tuning-fork constructed by Herr König, in which the quicksilver contact common in other instruments of the kind was replaced by a metallic contact.—Dr. Aron communicated a practical experiment he had made on an old frictional electrical machine. By the application of cacao-butter as grease for the amalgam, he elicited from an old machine, which was no longer able to be charged, beautiful sparks of four inches long, and he recommended this fat for trial, particularly in the case of old electrical machines.

VIENNA

Imperial Academy of Sciences, December 20, 1883.—F. von Hoehnel, on the mode of occurrence of some vegetable raw materials in stem plants.—F. Strohmer, on quantitative determination of pure aqueous solutions of glycerine by means of their refractive index.—E. Lippmann, on the action of organic hyperoxides on organic compounds (sealed packet).—V. Hilber, a recent land-snail found in the loess from China (second paper).—C. Auer von Welsbach, on the earths of the gadolinite of Ytterby (on a modification of spectral analysis).—A. Arche on cerite and its breaking up to cerium, lanthan, and didymium compounds.—E. Stefan, on the calculation of the coefficient of induction of wire coils.

January 3, 1884.—R. Andreasch, contribution to a knowledge of allyl urea.—R. Rumpf, on the andesin in the lignite of Trifail (Styria).—A. Wassmutt, on the heat produced by magnetism.—L. Fodor-Mayerhofer, contribution to the theory of the varying vertical sun-dial.—H. Zukal, studies on lichens.—M. Kretschy, researches on kynurinic acid.—S. von Wroblewski, on the use of boiling oxygen as a freezing mixture, on the temperature obtained thereby, and on the solidification of nitrogen.

January 10.—F. Hoehnel, on wood-tissue with a story-like structure.—T. Wolfberger and F. Strohmer, on a generally applicable method of analytical determination of acidity by weight (sealed packet).

CONTENTS

THURSDAY, FEBRUARY 28, 1884

THE GERMAN CHOLERA COMMISSION

DR. KOCH, as chief of the German Cholera Commission, has just issued his fifth report. When we commented on his first report, which was transmitted from Alexandria on September 17, 1883, we drew special attention to the discovery by that expert of certain bacilli which were found to swarm in the discharges and coatings of the intestines of cholera patients, which were certainly not due to post-mortem changes, and which were absent from the intestines of bodies dead from diseases other than cholera. Dr. Koch believed that these bacilli, which much resembled those found in cases of glanders, stood in some special relation to the operation of cholera, but he was not prepared to say whether invasion of the bacteria was the primary cause of cholera, or whether it was merely an effect of the cholera infection. At that time the epidemic in Egypt had reached its decline, the period which of all others is the least satisfactory for etiological investigation; and hence, apart from some further record confirming the existence of the same bacilli in other cholera bodies which had since been examined, the reports which Dr. Koch has transmitted to his Government between his first one and the one now under consideration have not dealt with any scientific discovery. But since November last the Commission have pursued their investigations in India, the city of Calcutta having been decided on as the head-quarters of their mission of inquiry; and it is to the results there obtained that Dr. Koch's last report relates. In the meantime, however, Dr. Straus had reported on behalf of the French Commission, and had expressed his belief that the bacilli discovered by Dr. Koch did not bear the relation to cholera which the German Commission attributed to them; and that, unlike Dr. Koch, who had found nothing noteworthy in the blood of cholera patients, he had discovered in that fluid a definite micro-organism, which he believed he had succeeded in cultivating in the laboratory.

At this stage the subject is again taken up by Dr. Koch, who now gives an account of the further labours of his Commission. Under conditions of the most favourable sort, experiments have been renewed in Calcutta with an unbroken series of cholera patients and cholera bodies, and at the outset it is stated that microscopical examination has in all cases confirmed the existence, both in the choleraic discharges and in the cholera intestines, of the same bacilli as those which had been found in Egypt. And further, that which had not been possible in Alexandria, namely, the isolation and cultivation in pure media of these special bacilli, is stated to have been successful in Calcutta, with the result that they have been found to exhibit under cultivation certain characteristic peculiarities as to shape and mode of growth which enable the Commission to distinguish them with certainty from other bacilli. The Commission, too, have sought, as far as possible, to exclude sources of error, and hence they have subjected the bodies of patients dying from diseases other than cholera to careful micro-pathological examination, with the result that they are able to say that it has not been possible to find bacilli similar to the cholera bacilli in any of the bodies of persons who had died of pneumonia, dysentery, phthisis, and kidney disease. Nor has it been possible to detect these bacilli in the intestinal contents of animals and in other substances commonly abounding with bacteria.

The inoculation of the lower animals with cholera discharges and other cholera material had, in Egypt, led only to negative results; and even if nothing further had been adduced as to this, we should in no way have re-regarded failure in this respect as invalidating any inferences that may be drawn by Dr. Koch and his fellow-workers as to the speciality of this bacillus, because it has been found impossible to transmit many of the specific infectious diseases of man to any other animal. We now learn, however, that several experiments made on animals have given results which allow of the hope of further success. Reviewing their more recent work, in this and other respects, the Commission are evidently hopeful of establishing an etiological relation between the bacilli in question and the cholera process, and this quite irrespective of success being attained in the reproduction of the disease in the lower animals. A telegram of more recent date than the report itself announces that Drs. Koch, Fischer, and Gaffky have discovered the same bacillus in a water-tank. If this be confirmed, it will be of value as proving that water, which, when polluted with excreta, has so often been alleged to be one of the principal means of conveying the cholera poison, is a medium favourable to the transmission of the "germ" from person to person, and the announcement comes aptly in connection with a report in which the German Commission announce that a diminution in the annual mortality from cholera in Calcutta from 10·1 per 1000 inhabitants before 1870, to 3 per 1000 since that date, is regarded by nearly all the physicians in that city as being solely due to the introduction of a water-supply of excellent quality.

Referring to the report of the French Commission, Dr. Koch declines to accept the conclusions of Dr. Straus as to the existence in the blood of organisms which are peculiar to cholera, and he expresses the belief that the alleged organisms are nothing but certain small, roundish blood-plates, which, not absent even in health, undergo a peculiar increase in the case of cholera patients, and which were referred to as far back as 1872 by Dr. D. Cunningham in his "Microscopical and Physiological Researches into the Nature of the Agents producing Cholera."

Whilst desiring to follow in the steps of Dr. Koch in observing an attitude of caution as to the meaning of the researches of the German Commission, we cannot but feel that the tendency of the reports as yet issued is favourable to the doctrine that cholera is associated with a specific organic contagion. A connection has already been established between specific disease on the one hand, and the staff-shaped bacilli of splenic fever, the spirillum of relapsing fever, and the microzymes of vaccinia and of sheep-pox on the other; and though it may still be doubtful whether these bodies should be regarded as actual generators of the diseases with which they are associated, or as mere carriers of infection, yet the advance which is being made is in the direction of the doctrine of the particulate nature of contagion. We may have to wait before there is sufficient evidence to warrant the application of this doctrine to the case of cholera, but we can congratulate Dr. Koch on the result of his labours so far, and at the same time trust that the example set us in this instance by the German nation may not be thrown away upon the people of this country, who, whilst having a higher interest than any other in ascertaining the real nature of cholera, allowed the opportunity of the Egyptian epidemic to pass by without attempting any scientific investigation as to its causes.

SCHOPENHAUER

The World as Will and Idea. By Arthur Schopenhauer. Translated from the German by R. B. Haldane, M.A., and J. Kemp, M.A. Vol. I. (London: Trübner and Co., 1883.)

As the Kantian leaven works, philosophy shows less and less of an inclination to quit what Kant described as the fruitful bathos of experience. No doubt many a structure is still reared around us, "pinnacled dim in the intense inane," but that is simply because philosophy, more than any special department of knowledge, is exposed to the inroads of the uninstructed. But here, as elsewhere, the honest inquirer will find a consensus of competent opinion which estimates these piles at their true value. Serious workers pass by on the other side without controversy, lest perchance they should be as those on whom the tower of Siloam fell. On the other hand, only confusion of thought can lead people to *identify* philosophy with science, and to suppose that, when they have reckoned over the list of the sciences, they may erect a stone to the great god Terminus. For, though the matter of philosophy is the same as that of the sciences (and not, according to the current myth, a spider-like product of intestinal origin), yet the point of view from which the common material is regarded is *ab initio* different. Science, in its whole extent (including psychology), deals with the world of objects, whereas the first task of philosophy is to remind scientific men of the abstraction which they have been making--and for their own purposes rightly making—by showing them that the world of objects is unintelligible without a subject to which it is referred. Having rectified this fundamental abstraction, philosophy proceeds, as theory of knowledge, to a critical analysis of the conceptions on which, as ultimate presuppositions or working hypotheses, the different sciences are based. The notion of the atom and of infinite space may be mentioned as two of the earliest cases where such criticism is required. The result of such a criticism is to show that no science can say of its "facts" that they are absolutely true, because they cannot be stated except in terms of the conceptions or hypotheses which are assumed by the particular science. But conceptions such as those of space or atom are found to dissolve in self-contradiction when taken as a statement of the ultimate nature of the real. It follows, therefore, that they must be regarded as only a provisional or partial account of things. The account they give is one which may require to be superseded by—or rather, which inevitably merges itself in—a less abstract statement of the same facts. In the new statement, the same "facts" appear differently, because no longer separated from other aspects that belong to the full reality of the known world. For the philosopher is essentially what Plato in a happy moment styled him, συνοπτικός, the man who insists on seeing things together; and philosophy, in her office as critic of the sciences, aims at harmonising the notions on which they respectively rest, and thereby reaching a statement of the nature of the real which may claim to overcome the abstractness of the several provisional stages represented by the different sciences.

Judged by this standard, it is to be feared, Schopenhauer's philosophy will be found wanting. Its interest is undoubtedly, in the main, more literary than scientific; and in his central dogma of a metempirical or transphenomenal Will, Schopenhauer shows himself quite the traditional "metaphysician." Taken as literature, high praise must be awarded to the style of his productions, which is very different from that of his heavy-footed countrymen generally. Pessimism was lately much in fashion, and Buddhism is still highly esteemed. The philosophic father of these things is tolerably sure, therefore, of an interested audience; and "the general reader" will find rich pasture in the aphoristic wisdom of the man of the world, his keen and often cynical psychological analysis, and his genuine appreciation of art, especially of music, which was almost the one redeeming feature in an otherwise ignoble character. Mr. Haldane and Mr. Kemp have done their work so well, that those who are drawn to the book by the literary reputation of the original will not have their enjoyment marred by the intrusion of foreign idioms, clumsy constructions, and the general lameness of the translation style. All praise must also be given to the clearness and accuracy with which they have rendered the philosophical terminology of the work.

But the translators would probably hardly have undertaken the task, had they not believed that there was more of value in Schopenhauer than what has just been allowed him. And, in point of fact, it is perfectly possible to divide Schopenhauer's work into two parts. The world presents itself to him under the twofold aspect of "Will and Idea." "The world as Idea" is the phenomenal world, the world of science, while Will—one mighty unconscious desire or force—is the inner or noumenal reality of which the phenomenal world is the outward expression. I appear to others, and to myself, as an organised body—that is, as an object or complex of ideas; but I also know myself, Schopenhauer says, on the inner side as Will. He next denudes this Will of the characteristics which belong to it in the conscious life, ignoring at the same time the other features which, equally with Will, go to constitute that life, and then, with a superb sweep of anthropomorphism, declares that Will, as an impersonal force, is the essence of all phenomena—the steam that drives the world. In support of this thesis, he fastens on obscure facts like those of instinct; and, though he scouts at the "Bridgewater Treatises," he argues from teleology in an exactly similar sense. But as no scientific reader is likely to be led away by Schopenhauer's reasoning here, it is needless to enter into any formal refutation of his positions. It is more to the purpose to draw attention to the side of the book which, though not so distinctly Schopenhauerian, and probably not so attractive reading as the collection of brilliant analogies on which his system is built, contains an acute, and, so far as it goes, a sound, criticism of certain false or inadequate views of the world. Schopenhauer claimed to be the true follower of Kant, and when he is speaking of "the world as Idea," we find ourselves on the general ground of the modern philosophical criticism which dates from Kant. Schopenhauer certainly neglects much that is valuable in Kant, and presents other elements superficially; but, perhaps for that very reason, he may be useful as a populariser of thoughts which, in one shape or another, it is essential for the modern world to master. We need only note here his insistence on the complete relativity of subject and object—a relativity which, of course, excludes the possibility of any causal relation between them—and his criticism of the ideas of space, time, and matter, leading him to the conclusion that the world of objects exists as a system of complete relativity, in which no individual objects can claim any reality except what consists in their necessary relation to one another. Any one reading these and similar passages must acknowledge that, where his doctrines are otherwise sound, Schopenhauer's clear and incisive style makes him an admirable interpreter. ANDREW SETH

OUR BOOK SHELF

Cours de Minéralogie. A. De Lapparent. (Paris: Savy, 1883.)

MINERALOGY was the father of Geology; but the son has for many years in this country shown great want of respect to his parent. A very large proportion of our geologists are extraordinarily ignorant of mineralogy. To them as well as to those who have not so seriously neglected that branch of science we recommend a perusal of the work before us. The object of its distinguished author (who has already rescued French Geology from the charge of possessing no modern text-book of native origin) is in the first place to simplify as much as possible the teaching of rational crystallography, as established by the works of Bravais and completed by Mallard, so as to bring it within the comprehension of all earnest students of minerals and rocks; and in the second place to put geologists in possession of the knowledge which they must acquire if they would apply themselves with any satisfaction and profit to the study of the microscopic structure of rocks.

The volume is divided into three parts. In the first of these, entitled *Geometric Crystallography*, M. De Lapparent states the laws of crystalline symmetry and shows in detail the forms of which each system is composed, these forms being rigorously classed and deduced from each other according to the method of Bravais. Tables and stereographic perspective diagrams are added.

The second part, or *Physical Crystallography*, is devoted to the explanation of the physical, and especially the optical, properties of crystallised matter. It concludes with an analysis of the different crystalline groups, with which, following Mallard, the author connects the phenomena of isomorphism and dimorphism.

The object of the third part is the *Description of the Principal Mineral Species.* The author adopts a system of classification which is entirely new, and which might be called the geological system of mineralogy, because it is based upon the part which each species plays in the composition of the earth's crust. From this point of view minerals are divided into four great classes:—(1) silicates or elements of the fundamental rocks. (2) Elements of mineral veins. (3) Metallic minerals. (4) Combustible minerals.

The work consists of 550 pages, with 519 figures inserted in the text, a chromolithographed plate, and an index comprising 3500 names, from which a knowledge can be obtained of all terms employed in mineralogy.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Remarkable Sunsets

THE remarkable and beautiful atmospheric phenomena which within the last four or five months have so powerfully attracted attention in all parts of the world, made their appearance here about the same time that they did in England and on the continent of Europe. It is true that as early as October 14, 1883, something similar was noticed at Santa Barbara, about 280 miles south-east of this place; but the characteristic phenomena were not observed here and at other positions on the coast of California until after the middle of November, 1883. I first observed it on the evening of November 24, when it presented a very striking appearance. That afternoon the sky had been overcast with dark clouds, and the south-east wind had brought a slight rainfall. Towards sunset a bright portion of sky appeared at the western horizon, extending to an altitude of about 10°, while the dark hood of clouds enveloped the remainder of the celestial vault. At 6 p.m. the lurid redness (almost angry) of the western horizon attracted universal attention; it had the appearance of a sky illuminated by an immense conflagration. Doubtless the effect was heightened by the contrast with the dark canopy of clouds. Similar appearances, more or less conspicuous, presented themselves during the remaining days of November, and in a less striking manner (when the weather was favourable) during the month of December, both after sunset and before sunrise. At a quarter past six on the morning of November 29 the eastern sky emitted such a brilliant ruddy light as to arrest my attention by the peculiar red illumination of the window-curtain of my bedroom. On looking out, the whole eastern sky was seen to be drenched in gorgeous red. During the month of January, 1884, the "upper-glows" (as Miss Ley appropriately designates them) became much less conspicuous.

At the period when the phenomena were most conspicuous, the atmosphere during the day was not perfectly clear, although the sunlight was not obscured to any considerable extent:—there was always observed a thin veil of fleecy clouds covering the heavens, and a *whitish glare* manifested itself about the sun, extending to a distance of about 20° or 25° from his centre. It is evident that the suspended matter producing these phenomena must have been above the region of the loftiest cirri, for ordinary changes of weather and disturbances in the atmosphere did not modify the appearances.

But the manifestations presented by the sky seem to have been so nearly identical in all parts of the globe, that detailed descriptions of them, as exhibited here, are unnecessary. It was, however, evident that the phenomena were less pronounced on this coast than they were in many other countries. This was indicated by the fact that, wherever the phenomena were sufficiently developed, the sun during the day was encircled by more or less distinct coloured halos or coronæ; whereas at this place it amounted to nothing more than a *whitish* glare about that luminary. The Rev. S. E. Bishop writes me from Honolulu, that these chromatic circles around the sun were constantly observed in all of the Hawaiian Islands from September 5 to December 15, 1883; and I notice that they were observed in England as frequent accompaniments of the upper-glows.

While the large size of these coloured circles might (as I have indicated in a letter to *Science*) seem to connect them with the well-known ice-crystal halos of 22° radius, yet I am disposed to regard this chromatic feature of the phenomenon as mainly due to the diffractive action of the impalpable dust-particles suspended in the lofty supra-cirri regions of the atmosphere. Nevertheless, inasmuch as the experiments of M. Coulier and Mr. John Aitken show that the presence of dust-particles in the air as nuclei is essential to the condensation of aqueous vapour, it is by no means improbable that *ice* may be associated with these phenomena. For, as these lofty regions must, even within the tropics, be far above the plane constituting the lower boundary of the term of perpetual congelation, the condensed vapour must necessarily assume the form of aggregations of ice around these nuclei. Hence the diffractive coronæ may be associated with imperfectly developed ice-crystal halos.

It seems to me scarcely necessary to invoke—as Mr. Rowell has done (NATURE, vol. xxix. p. 251)—the repulsive agency of electricity to account for the persistent suspension of the volcanic dust, even in these regions of rarefied air. If the attenuation be sufficiently great, there will be no sensible subsidence of the dust-particles. Faraday found that even metallic gold, when minutely divided, required months to subside when suspended in water; and some forms of insoluble mineral matter remain suspended in water for an almost indefinite period. Now, the dust-particles constituting the nuclei of condensation for fogs and clouds are absolutely *ultra-microscopic* in smallness; hence their suspension, even in rarefied air, may be prolonged almost indefinitely. Moreover, it is possible that air may possess some degree of *viscosity;* in which case the indefinitely attenuated dust-particles might have no tendency to subside, and could only be removed from the atmosphere by those meteorological agencies,—such as the condensation of vapour,—which tend to augment their size.

Mr. D. Wetterhan (NATURE, vol. xxix. p. 250) refers to Mr. Kesselmeyer's hypothesis of the atmospheric origin of meteorites put forth some twenty years ago, which ascribes them to the condensation of metallic and other vapours issued from volcanoes. If I am not mistaken this hypothesis was advanced by Biot near the beginning of the present century. The *high velocities* of meteorites is overwhelmingly *fatal* to their *terrestrial* origin.

JOHN LE CONTE

Berkeley, California, February 1

THE recent sunsets were nearly or quite as remarkable in the Rocky Mountain region as they were in Europe, and the phenomena were very similar. There was the same peculiar fire-red after-glow continuing for two hours after sunset, &c. These unusual appearances began to attract attention soon after the middle of November. They were most brilliant during the last week of November, but continued at intervals until early in January. The carefully kept meteorological record of Prof. F. H. Loud, of Colorado College, shows that the atmospheric pressure varied considerably during the latter part of November, but there was no apparent accompanying change in the after-glow. The sunrises were also quite brilliant, but less so than the sunsets. Late in November I began to observe the wide chromatic belt which surrounded the sun, and at midday usually reached from near the sun to the horizon. Somewhat similar appearances and chromatic halos are not uncommon here, and it was not until after several weeks of comparison of colours that I became convinced that the tints seen around the sun during the time of the remarkable sunsets were somewhat different from those ordinarily seen. By degrees the brick, or fire-red, and other abnormal tints of the twilight hours have given place to the ordinary prismatic colours, and a similar but less marked change could be seen in the colours observed near the sun during the daytime. These day colours were brightest when the sky was overcast with thin clouds or filmy cirri, though plainly visible when there was no cloud to be seen. The prevailing day tint is usually a peculiar dull purple, but during the time of the red after-glow the common colour was duller, more like a yellowish brick-dust.

Colorado College, February 8 G. H. STONE

"Probable Nature of the Internal Symmetry of Crystals"

IN reply to the important criticisms offered by Herr L. Sohncke on my new theory published in NATURE of December 20 and 27, 1883 (pp. 186 and 205)—

Taking first those relating to the geometry of the subject; the following explains why only the five symmetrical arrangements of points in space described in my paper are taken as the basis of the theory.

If it is the case that, prior to the act of crystallisation, the chemical atoms of a body fall into some symmetrical arrangement, it is natural to suppose that they do so through some influence they exert on one another—such, for example, as mutual repulsion—and that a similar influence is exerted by each atom of the same kind on atoms around it. And if this be so, there will be no *stable equilibrium* of the forces thus exerted *until the atoms are very evenly distributed throughout the space allotted to them.*

Now although, as Herr Sohncke has shown, there is a large variety of symmetrical arrangements of points in space in which the points are disposed around every one point of the system in precisely the same manner as around every other, it would appear that only four of these regular systems, the first four described in my paper, signally fulfil the requirement of even distribution, these four systems being distinguished from all the rest by the property that, *if the nearest points grouped around any point of either of these four systems are joined, the solid thus outlined has its edges all equal.*

And further, although the fifth system described in my paper is not one of Herr Sohncke's *regular* systems, its points are more evenly distributed through space than those of any of these systems except the four just referred to. In this system the property is found that either lines joining the nearest points around any point of the system, or lines joining the next nearest, in all cases outline a solid whose edges are all equal.

As the five systems I have in my paper too vaguely distinguished as "very symmetrical" thus stand alone, and moreover, if my views are adopted, they appear to be adequate to all cases of crystallisation, I still incline to think that the chemical atoms of bodies about to crystallise always have one or other of these five kinds of symmetrical arrangement. If I am wrong in this, and some other symmetrical arrangements are admissible, the general lines of the new theory will not however be affected.

Next, as to the bearing of the theory on chemical valency and the usual conception of a chemical molecule, it may be remarked that, while there is no clear knowledge of the nature of the union between the different sorts of atoms in a compound by which to test the new theory, this theory appears to receive support from the phenomenon of electrolysis. For the fact that one *ion* is liberated at one pole, the other at the other, while *no apparent alteration takes place in the fluid between the poles*, goes to show that any particular atom can change its partners without dissolving the chemical ties subsisting between the several atoms of the compound, and thus favours the view that similar atoms equally near to a particular atom are similarly related to it.

As to my supposition that the expansion, or contraction, occurring in the act of crystallisation, is due to the increased or diminished repulsion exerted by *some only* of the atoms of a body on surrounding atoms, it is, perhaps, interesting to notice that if this conception could be extended to the gaseous state, and the expansion to the state of gas of any compound attributed to the agency of certain atoms in each molecule, or ideal unit, to the exclusion of the rest, the simple relations found subsisting between the volumes of compounds and the volumes of their uncombined constituents might in this way be accounted for:—Thus the fact that aqueous vapour has a volume two-thirds that of the added volumes of the hydrogen and oxygen of which it is composed would be explained if all the gaseous expansion of this compound is due to the hydrogen atoms only.

Muswell Hill WM. BARLOW

"Mental Evolution in Animals"

MR. FARADAY does not seem to have quite understood one point in my comment on his letter. I said that whether the action of the skate was accidental or designed, "in either case, under the conditions, and more especially the 'attitude' described, seizure of the food at the proper moment can only be ascribed to the sense of smell." When we remember the form of a skate, it is certain that, under the conditions described, the animal could not *see* the approaching food, and therefore Mr. Faraday's illustration from the cricketer would only hold if the cricketer continued to hit the ball after he had been blindfolded.

I do not care to continue this discussion; but I may say that as the glass wall of a tank is not an object upon the solidity of which a skate would be likely to calculate, and as the sense of smell in this animal is so highly developed that it might easily give rise to "the appearance of co-ordination" described, I still think that the incident was probably accidental. Any other piece of food happening to approach the mouth would no doubt have been seized in just the same way.

GEORGE J. ROMANES

Instinct

WERE it merely for the sake of reiterating my views, I should not feel justified in commenting upon Mr. Romanes' letter on instinct in last week's NATURE (p. 379). He seems, however, to have understood my "subjective verification" in a sense somewhat different to that which I intended to convey by that expression. I venture, therefore, to beg a little space in these columns for explanation.

There is but one method in human psychology—that of introspection. By this method I obtain certain results. These results I communicate to my neighbour, and he by introspection verifies them for himself. This I call "submitting the results to the test of subjective verification." In this way and in no other can a science of human psychology be constituted.

I remember once seeing a schoolfellow caned. He did not flinch, but grew deadly pale. "Did it hurt much?" I asked afterwards, in schoolboy fashion. "Hurt! Who cares for pain? I was caned for a lie that I never told." I can remember to this day the indignation that his words roused within me. I could verify to some extent the true nature of his feelings. How can I verify the feelings of my dog? The feeling that I infer may be as wide of the mark as the mere pain I fancied my schoolfellow smarted under. Without myself becoming a dog, I can never know the true nature of my dog's feelings.

Mr. Romanes contends that "the involuntary groan of pain, the pallor of fear, and a thousand other unintended expressions of emotions, as well as a thousand other unintended expressions of thought, are, as it is proverbially said, 'more eloquent than words.'" In this I cannot agree. The groan, the pallor, tell plainly of some intense feeling; of its nature they can tell us little. So do the actions of animals testify to some corresponding mental states; of their nature we can form but a dim conception. Out of such dim conceptions no science of comparative psychology can, as it seems to me, be constituted.

Whether this is common sense (for which, by the way, in these matters I have not quite so much reverence as Mr. Romanes) or "an ingeniously constructed argument of scepticism," I must leave others to judge.

In conclusion let me thank Mr. Romanes for his letter, and assure him that I shall give to his objections to my physiological theory of instinct that weight which I feel to be due to the opinions of one from whose writings I have learnt much and hope to learn more.

C. LLOYD MORGAN

University College, Bristol, February 25

Protection by Mimicry—A Problem in Mathematical Zoology

UNDER the above heading in the *Japan Weekly Mail* of February 3, 1883, we drew attention to what appeared to us an error made by Mr. Alfred R. Wallace in a letter to NATURE regarding the protection gained by two distinct species of insects of distasteful nature assimilating in appearance when subject to the attacks of young and inexperienced birds. The article was sent to Mr. Wallace, who by letter, and in an article in NATURE, vol. xxvii. p. 481, without hesitation, acknowledged the correction, saying that he had misstated Dr. Müller's proposition. He then gives Dr. Müller's own words, which are:—"If both species are equally common, then both will derive the same benefit from their resemblance—each will save half the number of victims which it has to furnish to the inexperience of its foes. But if one species is commoner than the other, then the benefit is unequally divided, and the *proportional advantage* for each of the two species which arises from their resemblance is *as the square* of their relative numbers." This alters the question altogether. Mr. Wallace had stated it, through an oversight, quite otherwise. He said:—"The number of individuals sacrificed is divided between them in the proportion of the square of their respective numbers." Such was what we took objection to; and we showed that it was not according to the squares, but to the simple numbers.

Mr. Wallace carries out his article, which is accompanied by one by Mr. Meldola (p. 482), to show by examples how it is that, notwithstanding the *loss* is in direct ratio to the numbers of each species, the proportional *saving* through resemblance is inversely as the squares; and he further says:—"The advantage will be measured solely by the fraction of *its own numbers* saved from destruction, not by the proportion this saving bears to that of the other species." On this Mr. Meldola remarks:—"The fact that these numbers stand to one another in the ratio of" the squares, "is a mathematical necessity from which I do not see how we can escape." Now even if this latter statement were strictly correct, we fail to see how it affects Mr. Wallace's statement. We shall show, however, that it is not correct but only an approximation when the number eaten by the birds is a small percentage, for as this becomes greater the ratio of proportional advantages increases considerably above that of the squares.

The proportional advantage that either species has after imitation over its former state (before imitation), appears to be according to the fraction of its original number remaining. Because while in its former state, should it lose one half its number, it would have one-half left, while if it after imitation lost only one-fourth, it would have three-fourths remaining; a clear advantage of one-fourth over one-half, or 50 per cent. This, however, is not a simple case for an example when we come to consider the relative numbers of the two species; we will therefore put it thus:—A has double the number of B. Supposing that when dissimilar A loses 30 per cent. then B loses 60 per cent. But after assimilation both lose in the same proportion, namely, 20 per cent. A has consequently an advantage, over its former state, of 10, and similarly B of 40. But in the former state the remainder of A not lost was 70 per cent., while that of B was 40 per cent., so that A's real advantage is 10 on 70 or 14·2857 per cent., and B's 40 on 40, or 100 per cent. These two numbers do not bear Dr. Müller's ratio of 1 to 4 (the squares of the numbers) but a greater, namely, 1 to 7 = $1^2 \times 40$ to $2^2 \times 70$.

The following examples will illustrate the increasing ratio:—

1. A to B as 2 to 1.

If when dissimilar A loses 20 per cent. then B loses 40 per cent., the remains being for A, 80 per cent.; for B, 60 per cent. When similar each loses $13\frac{1}{3}$ per cent., leaving remains of $86\frac{2}{3}$ per cent.

The advantage to A therefore is the excess of $86\frac{2}{3}$ over 80 on 80 = 8·33 per cent., and the advantage to B is the excess of $86\frac{2}{3}$ over 60 on 60 = 44·44 per cent. These advantages compared to each other are as 1 to 5·33 (according to Dr. Müller 1 to 4).

2. A to B as 3 to 1.

Dissimilar A loses 20 per cent.; B, 60 per cent. Remains 80—40.

Similar A loses 15 per cent.; B, 15 per cent. Remains 85—85.

Advantage to A excess of 85 over 80 on 80 = 6·25 per cent.

Advantage to B excess of 85 over 40 on 40 = 112·5 per cent.

Ratio 1 to 18 (Müller 1 to 9).

3. A to B as 4 to 1.

Dissimilar A loses 20 per cent.; B, 80 per cent. Remains 80—20.

Similar A loses 16 per cent.; B, 16 per cent. Remains 84—84.

Advantage to A excess of 84 over 80 on 80 = 5 per cent.

Advantage to B excess of 84 over 20 on 20 = 320 per cent.

Ratio 1 to 64 (Müller 1 to 16).

Dr. Müller's squares require to be multiplied by the remains per cent. (taken also inversely) of the two species when dissimilar, to bring out the proper ratios. Thus: 1 to 4 (the squares) in the first example, multiplied by 60 and 80 respectively, give 60 to 320 or 1 to 5·33. In the second 1×40 to 9×80 = 40 to 720 or 1 to 18. And in the third, 1×20 to 16×80 = 20 to 1280 or 1 to 64.

It will be understood therefore that, whether we reckon the proportionate advantage that each species obtains over its previous state of existence by the mimic, or calculate the ratio of proportionate advantage of mimicry between the two, the comparison has to be made with the state each would have been in had not mimicry taken place, indicated by the proportion of survivors each would then have had. If we ignore this, the comparison is untrue. What we want is the advantage a species which adopts mimicry has over one which fails to do so. So that if we speak of one numerous species A, and two equal non-numerous species B and B′; if B mimics A, while B′ mimics no species, B receives protection, and thus has an advantage over B′, which in particular cases may amount to so much that, while B survives, B′ may become exterminated. This is perhaps the simplest way of putting it.

It must be remembered, however, that B does no harm to A by mimicking it; on the contrary, the act of mimicry is of advantage to A over its former state of existence as well as to B; but A being the more numerous the advantage is less. Still after the assimilation neither has an advantage *over the other*.

Proportionally they suffer from the ravages of the birds equally; the percentage of losses is the same; they are on equal terms. No matter how long they continue the association, neither gains nor loses on the other; though through one being more numerous it loses more individuals, yet equally in proportion with the other. So that, if one is twice as numerous as the other at the time of assimilation, it must always—other conditions being equal—remain twice as numerous.

We now give the mathematical reduction:—

Designation of species	A		B
(1) Original number	a	>	b
(2) No. lost without imitation ...	e	=	e
(3) Remains without imitation ...	$(a - e)$		$(b - e)$
(4) No. lost with imitation ...	$\frac{a}{a+b}e$		$\frac{b}{a+b}e$
(5) Remains with imitation	$a\left(1 - \frac{e}{a+b}\right)$		$b\left(1 - \frac{e}{a+b}\right)$
(6) Excess of remains due to imitation, or *absolute advantage* (3)-(5)	$\frac{be}{a+b}$		$\frac{ae}{a+b}$
(8) Ratio of excess to remains without imitation (6) : (3), or *proportional advantage*	$\frac{e}{a+b} \cdot \frac{b}{a-e}$		$\frac{e}{a+b} \cdot \frac{a}{b-e}$
(9) Ratio of proportional advantage of B to proportional advantage of A	$\frac{a(a-e)}{b(b-e)}$ or $\frac{a^2}{b^2} \frac{1 - \frac{e}{a}}{1 - \frac{e}{b}}$.		

From (8) we see that, if $e < b < a$, there is a proportional advantage to both, the mimicry "is twice blessed," but the proportional advantage to B is greater. If e is zero, there is no advantage to either. If $e = b < a$, the prop. advantage to B is infinite, while that to A is still finite; this is as it ought to be, seeing that to B it is a case of "to be or not to be," of existence with mimicry or extinction without. And in this extreme case it must be evident to every one that the ratio of $a^2 : b^2$, both terms finite, cannot be the ratio of the infinite advantage of B to the finite advantage of A. The greater e the greater are both advantages.

From (9) we see that, if e is small compared to b and a, the ratio is nearly $a^2 : b^2$ (Müller's law), but the larger e is the further it deviates from that law, the ratio becoming rapidly greater than $a^2 : b^2$, and approaching infinity as e approaches b.

To conclude, we may point out that Müller's law, as given in his own words and quoted above, is incompletely enunciated, and but for the numerical examples, it might lead any one astray as to what the law is. It ought to have *the ratio of* interpolated between "and" and "the *proportional*"; then "*advantage*" and "*square*" ought both to be plural; "relative" ought to be respective; and, lastly, the fact that the ratio is inverse should be explicitly stated.

Finally we enunciate our law. Let there be two species of insects equally distasteful to young birds, and let it be supposed that the birds would destroy the same number of individuals of each before they were educated to avoid them. Then if these insects are thoroughly mixed and become undistinguishable to the birds, a *proportionate advantage* accrues to each over its former state of existence. These *proportionate advantages* are inversely in the duplicate ratio of their respective original numbers compounded with the ratio of the respective percentages that would have survived without the mimicry.

This last "ratio compounded" corrects Müller's law, but we still think with Mr. Wallace that the law, even when corrected, has not much bearing on the question that the individual absolute advantages (6) above, together with the probable value of e and the ratio $a : b$ indicated by relative frequency of capture, solve the whole question. In our first paper above mentioned we established formulæ for calculating these last-named items, although in a different manner from and quite independent of Muller's law, which we had not then seen.

THOMAS BLAKISTON
THOMAS ALEXANDER

Tokio, Japan, November, 1883

Christian Conrad Sprengel

I BECAME acquainted with Christian Conrad Sprengel's work, "Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen" (Berlin, 1793) in 1850 at the University of Berlin through Prof. C. H. Schultz-Schulzenstein, who brought it forward in one of his lectures on botany, praising Sprengel's good observations and illustrations, but making his teleological views appear so irksome as to dispose his hearers rather to depreciate and reject the book than be attracted to it by respect. The value of Sprengel's treatise in its bearing on the theory of selection was first recognised by Charles Darwin, whose writings recalled the remarkable book to my mind, and induced me to buy it, which I did at a very cheap rate at an old book-shop. K. MÖBIUS

Kiel, February 18

Circular Cloud Bows

I FANCY that the phenomenon described by Mr. Fleming in your issue of January 31 (p. 310) is not a very uncommon one. It has twice fallen to my lot, when in Switzerland, to be a witness of these spectral shadows.

On the first occasion I was with a party of three on the mountains to the north-east of Montreux, almost opposite the Cape de Moine. It was midwinter, and the day was very cloudy, even in the valleys, while the high ground on which we stood, and all the surrounding peaks, were completely swathed in mist. Suddenly, and under the impulse apparently of a blast of wind from below, the mists around us were almost entirely dissipated, and a few sickly gleams of sunshine filtered through the fog. At that moment we saw gigantic images of ourselves projected on to the wall of vapour enshrouding the Cape de Moine, immediately opposite the point where the sunbeams had permeated. The effect was very transitory, and, so far as I remember, there were no prismatic colours.

The circumstances under which I saw the second appearance were as follows:—

In August last I was standing, just before sunset, on the summit of the Niesen, in company with a friend. The day had been very hot, and we were just remarking on the extraordinary difference in temperature between our elevated position there and our situation a few hours before on the Lake of Thun, when we saw some scattered wisps of cloud rising out of the depths below. These increased rapidly, both in size and number, uniting as they rose, till the whole abyss presented the appearance of a seething cauldron, from which was escaping a dense cloud of steam. The prospect towards the east was quickly blotted out, while the sky in the opposite quarter remained as clear as before.

We then saw dim and fragmentary signs of prismatic colours in the curtain of cloud, and these became more defined and vivid as the thickness of the cloud increased. Finally there appeared a very distinct circle of rainbow hues, with our own figures looming, weird and awful, in its centre. Both images were visible to myself and my companion, though each could see the other's reflection more distinctly than his own.

Mr. Whymper, in his "Ascent of the Matterhorn," mentions an instance in which the prismatic colours assumed the shape of crosses. This effect, occurring as it did soon after the fatal accident which marked the conquest of the mountain, filled the minds of the guides with superstitious horror. From my own experience on the Niesen I can well imagine that, as Mr. Whymper suggests, this form could be accounted for by the supposition that there were several circles interlaced, and that only segments of them were visible from the point at which he and his companions stood.

Perhaps some of your readers may be able to explain the exact atmospheric conditions under which these appearances become possible. E. H. L. FIRMSTONE

Bewdley, February 21

On the Absence of Earthworms from the Prairies of the Canadian North-West

IN NATURE of Jan. 3 (p. 213) Mr. Robert M. Christy writes on the absence of earthworms from the prairies of the North-West. I can confirm his statements, and extend them to cover the prairies of Kansas, the Indian Territory, Idaho, and Washington Territory. In all the above-mentioned territory of the United States the soil is more or less alkaline, and it seems to me that to this cause the absence of earthworms may be attributed. Ants and burrowing beetles, or the larvæ of the latter, are, however, common, and no doubt do much service in the manufacture of plant-food, as well as in the destruction of decaying material. At Boise City, Idaho, some enthusiastic disciples of Izaak Walton imported and successfully reared the coveted bait for their fish-hooks in soil suited to the habitat of the Lumbricidæ. TIMOTHY E. WILCOX

Vancouver Barracks, Washington Territory,
January 30

P.S.—Are earthworms found in Arabia and Egypt?

ZOOLOGICAL RESULTS OF THE WORK OF THE UNITED STATES FISH COMMISSION IN 1883

IN the summer of 1880 the United States Fish Commission steamer *Fish-Hawk* began her first work in dredging upon the Gulf-Stream slope seventy miles south of Rhode Island, working in from 75 to 600 fathoms of water. Upon this steep submarine bank several hundred species of Invertebrates were found which proved to be new to the American coast. Many were entirely new, others had been described from the Mediterranean and the deep waters off the west coast of Europe, and some were identical with fossils from the Italian Tertiary and Quaternary deposits, this being true of the shells more particularly. These species have long since been described in American scientific publications, and two subsequent summers of work in this region have brought to light numerous new and additional species, and at the same time very nearly exhausted the region. The *Fish-Hawk*, built for the purpose of serving as a floating shad-hatching station to work in the shallow inlets of Chesapeake Bay, was, during the summer, when she could not carry on her intended work, made use of for dredging purposes, work for which she was not well suited, for her shallow draft and round bottom rendered her unsafe when far from land and liable to encounter rough weather. She could make trips only when pleasant weather was assured for at least twenty-four hours, thereby losing much valuable time which could have been saved if a perfectly seaworthy vessel had been at the command of the Commission.

Accordingly in 1882 an appropriation was obtained, and early in 1883 the *Albatross* was launched, and made her first trip shortly afterwards. So much has been written about the *Albatross* that a mere passing notice will suffice. She is a 1000-ton iron vessel, 234 feet long, and drawing 12 feet of water. On the port side, near the bows, the sounding-machine is placed. Just forward of the pilot-house is the dredging-machine, and here, in a clear space left for the purpose, the rougher work, picking out the specimens from the mud, &c., is done. Aft of the pilot-house, with a chart-room intervening, are the two laboratories and a store-room,—an upper and lower laboratory, and the store-room beneath. The finer sorting and microscopic work is done in the upper laboratory, this being lighted by a skylight and four deck-windows. The library is in this room. In the laboratory beneath are cases of bottles ready for use and for those containing specimens, and a bench is placed on two ends of the room, where rough sorting can be done. In the room below this, bottles, jars, tanks, dredges, nets, and all apparatus used in the work are contained. Alcohol is carried in a large copper tank. In the upper laboratory are two copper tanks each of 32 gallons capacity, one containing fresh water, the other 95 per cent. alcohol. By means of faucets each can be drawn from its respective tank. The rest of the ship, with the exception of a few state-rooms reserved for naturalists, is given over to machinery and quarters for officers and crew. She is manned from the navy, and is under the command of Lieut. G. L. Tanner, U.S.N. Electricity is used for lighting, Brush incandescent lights being used for ordinary purposes, while an arc lamp suspended from the rigging lights the deck so well that work can go on as well by night as by day. Engineer Baird, U.S.N., chief engineer of the vessel, has succeeded in making an incandescent light that when lowered to 100 fathoms will neither be crushed nor extinguished. Used in connection with some deep-sea trap, this will undoubtedly give good results in capturing such quick-motioned fish as would avoid the trawl but would be attracted by brilliant light. The apparatus in use is the best which the past experience of the Fish Commission, U.S. Coast Survey, and European dredging expeditions could suggest. The vessel is so constructed that she can go backward as easily as forward. When the sounding-wire is running out, she can go completely around it without causing it to depart from its perpendicular. That the *Albatross* is perfectly seaworthy and that the machinery and apparatus and the vessel itself are in the best condition has been proved by the numerous trips made during the year just passed, and by the rough weather encountered. Starting early in 1883 upon her trial trip, she went into water as deep as 1200 fathoms. Afterwards numerous trips were made in the deeper waters off the southern coast of New England, some lasting a month. The principal work was done in from 1000 to 2000 fathoms, the deepest work done on the United States coast by an American expedition. Several successful hauls were made in 2400 fathoms, and one in 2950 fathoms. This latter is the deepest successful recorded haul made with a trawl as far we can find out. Soundings were taken in 3000 fathoms. The naturalist in charge is Mr. James E. Benedict. The *Albatross* has just started on a cruise to the West Indies, where work will be done both on the shores and in the deeper outer waters.

The previous explorations of the *Challenger*, *Blake*, Norwegian, and French deep-sea dredging expeditions, investigating similar regions in the North Atlantic, have rendered the results obtained by the *Albatross* much less remarkable than they would otherwise have been. Notwithstanding this, and the fact that some worked very near the field chosen by the *Albatross*, many new species —some of them of a very remarkable character—were taken, often in great numbers. The bottom in all the hauls deeper than 1000 fathoms was of globigerina ooze, the absence of pebbles and sand being a well-marked and universal fact. Whenever mud was obtained from any locality, it was thrown into a tub of water, stirred, and allowed to settle, and by repeating this several times a perfectly pure deposit of Foraminifera was obtained. Each sounding and mud from each station was treated in a similar manner, so that samples, and often large quantities, were obtained in this manner, so that material was furnished for a complete monograph of the group. Over fifty species have been found in a partial examination of a few hauls. Every variety, both in form and in colour, is represented in these shells. Numerous new species of Gorgonians and Pennatulids were found in many localities. In these soft bottoms, where no stones are to be found, such animals or colonies of animals as must have some firm basis of attachment are almost entirely wanting. Sponges, barnacles, and hydroids are very rare, occurring at times upon the bare stalks of Lepidisis or upon some dead shell. Frequently, barnacles and Actinians are attached to these stalks, fastened in a cramped manner, the base completely surrounding the stem. The barnacles found here are very remarkable, usually being stalked, but one was taken which was sessile. A common mode of fixation among the Pennatulids is by means of a bulb-like process which projects into the mud. Acanella, Lepidisis, and their allies fix themselves by branching, root-like projections. A number of specimens of an undetermined species of Umbellifera were taken. Three new species of Epizoanthus, or, more probably, new genera allied to Epizoanthus, were obtained, each with a new hermit crab. Other genera of Actinians were rare, owing to the few opportunities for attachment. The most abundant starfish was a new species of Zoroaster named *Z. diomediæ*, found in 1200 fathoms. An Archaster-like species was the most interesting, on account of its immense madreporic plate. Several other species of Archaster, and at least one of Solaster, were also taken. Starfishes from these depths belong to the two very opposite genera Asterias and Archaster, or their near allies. *Ophiomusium lymani* and *armigerum* formed the greater bulk of Ophiurians, but we dredged, in smaller quantities, *Ophioglypha convexa*, several species of Ophiocantha, and a number of other species not yet determined. One species of soft, flat sea-urchin was quite abundant, and another much larger one was taken in smaller numbers. *Echinus norvegicus*, previously found only rarely in the dredgings of the Commission, was obtained in great quantities in 1000 fathoms. Several other species of Echinus and a number of Spatangoids formed the best part of the collection of Echini. Holothurians were represented by many forms. One, resembling Leptosynapta in form and in its anchor hooks, another similar to Molpadia, and several others having the form of the typical Holothurian, will undoubtedly prove to be new. The most peculiar species of Holothurian were two new forms taken in great numbers from several localities. They are new species belonging to genera described from the *Challenger* Expedition; one will be called *Benthodites gigantea*, the other *Euphronides cornuta*. We can describe them no better than by giving the names applied by the sailors, Benthodites being called the "lump of pork," and "animated boxing-gloves," while Euphronides was christened "Old Boot," and its resemblance to an old, unblacked, low shoe was certainly remarkable. As the specimens of Benthodites tumbled from the trawl-net, they looked very much like pork, and reminded one of boxing-gloves, on account of their size and apparently useless bulk. In the 2950-fathom haul, a specimen of a Tunicate, allied to Boltenia, was taken, and a number of shrimps.

Several new and remarkable Cephalopods were dredged during the summer. Pleurostoma, Bela, and allied genera were taken in great variety and abundance. One species of Pleurotomella was very large. A Dentalium, differing in no respect from *D. striolatum*, excepting in size, it being often nearly two inches long, was very abundant in from 1000 to 1500 fathoms. *Nucula reticulata*, *Cryptodon ferruginosus*, and several other species had their range extended as deep as 1500 fathoms. *Dolium bairdii* was obtained, and several specimens of a species which differs from Dolium only in the fact that it has an operculum, which would lead to the inference that it is a Buccinum. The Mollusca probably have more new species than any other group.

In several of the 200 to 400 fathom hauls, *Calliostoma bairdii* was taken. This species is remarkable from the fact that it is one of the few animals which, when taken from the cold bottom waters, will survive and flourish when placed in the aquarium. It is one of the few shells found in our deep water which has a truly tropical appearance. Many Annelids, mostly very minute, were taken at nearly every locality. It is probable that many will prove to be new. *Hyalinæcia artifex*, a worm which secretes a horny quill-like tube, was encountered in some of the shallowest dredgings.

Crustacea were represented by many new and interesting forms, especially of shrimps, including many very curious types. In 2300 fathoms we dredged a shrimp nearly a foot in length, and an Amphipod 3 inches long. Some very odd species of crabs, and hermits furnishing types for entirely new genera, were taken on several occasions. Collossendes, that gigantic Pycnogonid, was dredged many times, and several other large species were also taken. One specimen measured over 2 feet from the end of one leg to the opposite extremity of the other. Notwithstanding this remarkable length of legs, the body was less than an inch long, and an eighth of an inch in breadth. To support this great length of legs, a branch of the stomach extends into the base of each leg. The fish were perhaps the most remarkable, in point of curious structure, aberrant forms, and marked specialisation. One, *Gastrostomus bairdii*, forms the basis of a new order, and is one of the most remarkable recently-described types of primitive anatomical structure, and, especially as regards the skull and branchial apparatus, it presents a remarkable phase of specialisation. Its nearest ally is a Eurypharynx, described by M. Vaillant. It is at present in the hands of Mr. John Ryder and Prof. Theodore Gill, the former studying the anatomy, the latter working out its systematic position. Together they propose to publish a complete monograph of the species. Another remarkable fish has no external traces of eyes. Most animals from the bottom have well developed eyes, although their use is unknown, for, unless some such light as phosphorescence is common, they must live in nearly absolute darkness. Some shrimps and a few other species have no eyes whatever. There are as many as fifteen new species of fish described from the *Albatross* summer collection, most of them belonging to new genera, while one or two families have been added. The field of deep-sea research is as yet just begun, and with what remarkable results. Hundreds of new animals, belonging to entirely new types, have helped to fill up gaps in the animal kingdom which had been left unfilled after a thorough examination of all the shallow waters. Such groups as Crinoids, for a long time supposed to be extinct, are now found quite abundantly and in considerable variety in certain localities. And when the whole ocean bottom has been examined as thoroughly as some portions of the North Atlantic, who can tell what curious forms may be found?

The collections obtained have been placed in the hands of the best American naturalists. Prof. L. A. Lee, of Bodoin College, Maine, has the Foraminifera, Mr. Jas. E. Benedict and Prof. H. E. Webster the Annelids, Prof. S. I. Smith the Crustacea, who will work up the greater bulk, but will turn a few groups over to other naturalists. Mr. Sanderson Smith and Prof. H. E. Verrill will work up the Mollusca, Alexander Agassiz the more important Echini, and the rest of the Invertebrates will be studied by Prof. Verrill. It is not yet determined who will study the Sponges. The fishes are being worked up systematically by Prof. Theo. Gill, and Mr. Ryder is studying the anatomy of the more interesting forms.

RALPH S. TARR

AFRICAN SPIDERS[1]

THE paper above noted forms Part III. of an important and interesting series upon the Arachnida of Africa, and was first published in *Annali del Museo Civico di Storia Naturali di Genova*, vol. xx. pp. 5–105. Its subject-matter comprises the collection of Arachnids formed by Count Orazio Antinori in the kingdom of Scioa in the years 1877–1882. Before entering upon the details of this paper it will be well to notice briefly the two preceding ones of the same series. Part I. (published in the same *Journal* in 1880) states that the object of the series is to bring together all the existing materials in the shape of papers and other works on African Arachnida and present them on one plan and method in accordance with the following five zoological provinces:—(1) *Mediterranean* (extending nearly to the Tropic of Cancer, and in-

[1] *Memoire della Società Geographica Italiana*, vol. ii. parte quarta, pp. 1–103 (Roma, 1883). Spedizione Italiana nell'Africa Equatoriale. Risultati Zoologici. IV. Aracnidi di Scioa, e considerazioni sull' Aracnofauna d'Abissinia, per il Prof. P. Pavesi.

cluding the Azores, Madeira, Canaries, and Cape de Verde Islands); (2) *Oriental*, or, rather, *Central and Oriental African*; (3) *Western African* (from the Gambia to the Congo); (4) *Southern* (included by a line drawn from Kalabini to Limpopo, and comprising a portion of the eastern coast to the Mozambique); (5) *Malagasic* (*i.e.* the Lemur country with Madagascar). Various expeditions and other means by which materials have been obtained are mentioned, and a bibliographical list is given, in the introduction, of the numerous published works and papers on African Arachnida from the days of Linnæus to the present time. The Arachnida described and recorded in this first part are from Tunis, while the second part (published *loc. cit.* vol. xvi. 1881) simply contains an account of a collection of Arachnids from Inhambane (in the southern region), with some considerations on the Arachno-fauna of the Mozambique, of which a list of species is also added.

The Tunisian collection described in Part I. numbers 115 species of six orders: *Scorpionidea*, 6 species (Scorpiones, 5; Pseudoscorpiones, 1); *Solpugidea* (Solifugæ), 4; *Phalangiidea* (Opiliones), 4; *Araneidea* (Araneæ), 96; *Acaridea* (Acari), 5. Of the above, two new genera, and eleven new species (all but one of the latter—a pseudo-scorpion of a new genus) belong to the Araneidea. As might be supposed, the essential character of the Tunisian collection is South European or Mediterranean. Very different from these are the arachnids described and recorded in Part II. from Inhambane and the Mozambique. Here we have, though the number of species is very scanty, the true tropical character. Only 54 species are recorded, comprised in 43 genera, 20 families, and 5 orders. The larger part (35 species) belong to the *Araneidea*, of which 1 genus and 4 species are new. Coming now to the Arachnida recorded and described in Part III. from Scioa (in the eastern zoological province) we have 71 species belonging to 49 genera, 18 families, and 4 orders. A general catalogue is also added of Abyssinian Arachnida, which, including those from Scioa, number 124 species. It is noted as remarkable that no scorpions were contained in the collection from Scioa, and that 30 of the Arachnids recorded are new to science; also that only 12 of the Scioan species are common to the rest of Abyssinia.

The author enters into some other considerations on the distribution of the Arachnids of Abyssinia; but the researches and materials on which his observations are based appear as yet to be too scanty to sustain any very general conclusions. At the same time it must be acknowledged that the plan on which the author has worked, of bringing the materials of so large and varied a region as the African peninsula under the geographical divisions announced in the introduction to Part I. is a most useful one, and the work he has done so far is undoubtedly a valuable contribution to arachnological science. O. P. C.

MR. BURNHAM'S DOUBLE-STAR MEASURES

THE recently published volume of the *Memoirs of the Royal Astronomical Society* contains a further series of measures of double stars by Mr. S. W. Burnham, made with the 18-inch refractor of the Observatory at Chicago. This series comprises measures of 151 double stars discovered by this eminent observer, which brings up the number of such objects discovered by him during the last ten years to no fewer than 1013, amongst which are included some of the most interesting stars of this class; also measures of a selected list of double stars, 770 in number, made chiefly in the years 1879 and 1880, with an appendix, the results of observations of several objects, as late as the middle of the past year. Every one who is interest d in this branch of astronomical science will read with much regret one remark in Mr. Burnham's introduction: he writes:—"The present catalogue will conclude my astronomical work, at least so far as any regular or systematic observations are concerned." He expresses himself modestly respecting his own labours—"In a field so infinitely large, one can accomplish but little at the most, and how much, or how little, the astronomers of a few centuries hence can perhaps best decide. . . . At this time I may venture to claim that my work in this field has been prosecuted with some enthusiasm, and for its own sake only, and that my interest has not been divided among several specialities."

But a higher estimate of Mr. Burnham's work in this particular line of observational astronomy to which he has devoted himself may be justly taken. To read of the discovery of upwards of a thousand double stars within a limited period by one observer, we might almost suppose we were living in the days of Sir William Herschel, when the heavens were comparatively an open field, and had not undergone the wide and close exploration which they had done when Mr. Burnham commenced his work. He has had, it is true, the advantage of instruments of the finest class, and we may believe an unusually acute vision; but he must have exercised an extraordinary and most meritorious amount of patience, perseverance, and care in the discovery and accurate measurement of such a list of double stars, and it will be gratifying to the astronomical world that such well-directed exertions have met with so exceptional a success.

Among the more noteworthy stars included in Mr. Burnham's new Catalogue (the fourteenth), which may be considered a continuation of that published in vol. xliv. of the same *Memoirs*, the following may be mentioned:—

1. 126 Tauri (β 1007), "a most remarkably close and difficult pair, one of the closest known"; magnitudes 6·0 and 6·2. With a power of 1400 there was only a slight elongation.

2. B.A.C. 346; Mr. Burnham thinks the principal star may be variable, and he is certainly correct in his surmise. Heis gives it as a naked-eye star 6·7 m, Gould 7·0 m., and it has been several times noted 8 m; while the writer has recorded it as low as 9 m.

3. β 117; a star with a proper motion, according to Argelander, of 0"·438; measures in 1883 show a common motion of the components; their distance is 2"·2.

4. ζ Sagittarii; detected by Winlock, probably a retrograde motion of 225° in less than fourteen years; and evidently a change of 48° in less than three years, by Mr. Burnham's measures alone. It is an object for large instruments in the other hemisphere.

5. β Delphini (β 151).—A very rapid binary; since its detection by Mr. Burnham in 1873, there has been an increase in the angle of about 180°, and a diminution in distance from 0"·6 to 0"·25. He thinks "it may prove to have, with the single exception of δ Equulei, the shortest period known."

Mr. Burnham collects the measures of δ Equulei, and infers a period of revolution of about 10·8 years. Measures should be easy again in 1885.

6. 85 Pegasi (β 733).—The close pair was not measurable in 1882; the angle was about 323° at the epoch 1883·75. The mean annual motion is about 12°·5, at which rate the period would be less than thirty years.

In the introduction to the Catalogue will be found references to the publications where the thirteen previous ones are to be found.

MEASURING THE AURORA BOREALIS

THE study of the height of the aurora borealis above the earth's surface is, it will be easily conceived, of the greatest importance in understanding the nature of this phenomenon. Unfortunately the height of the aurora has always been, and is to some extent still, a moot point in natural science. There are, of course, not wanting estimates and observations relating to this question, but the general results of these, particularly of the earlier ones, are very contradictory. There seems, however, to be every probability of this problem being very soon solved.

As a basis for the measurements of the aurora we have generally selected the arcs or the more pronounced solitary streamers, when they have been clearly and simultaneously observed from two points situated some distance from each other, the apparent height or position in each place having been determined by comparisons with, and measurements of, stars. In consequence, however, of the rapid shifting both of appearance and position of the auroræ, this method is difficult and unsatisfactory, and these drawbacks may to a great extent explain the very divergent results which have been obtained by the same.

In order to give an idea of the manner and principle of measuring the auroræ in their simplest form I venture to describe the method I have been in the habit of following.

On March 17, 1880, a great aurora was observed at the 145 stations which I had established over the southern part of Norway, the west coast of Southern Sweden, and in Denmark. One of the characteristics of this phenomenon was a large broad arc, or, perhaps more correctly, band, which for a long time spanned the sky from east to west. In Bergen (Norway), where my own observatory was established, it remained for some time in the zenith, then moving a little to the south, but at the stations lying further north it was seen in the south, while at those south of Bergen it was seen in the north.

By its characteristic internal repose and slow motion this remarkable band was especially suited to establish the identity of this aurora at the various stations and to serve as a basis for its measurement. It had apparently, when in its most southern position, no connection with the types which appeared simultaneously in the north, the latter being streamers which it was impossible, from their rapid change of form and appearance to observe connectedly at the various stations.

If the various reports of this auroral phenomenon be examined, not the slightest doubt will remain of the object seen being the same, *i.e.* that the same arc was observed at the most southern as well as the most northern stations. The further we move southwards however—away from the same—the more the apparently observed height diminishes, until we find that at the most southern points it was seen merely as an ordinary low-lying arc. In Bergen no trace of an auroral phenomenon was seen south of the band in question, and the reports from the stations south of this place all agree that neither was any seen there. From this we may conclude with certainty that the auroral arc observed in the zenith of the horizon of Bergen was the identical one seen at all the southern stations, and that the line of demarcation of the phenomenon seen from that place was the absolute southern extension of the band.

Before it is possible, however, from the observations before us to measure the height of the arc, it is necessary to ascertain its direction and its position in space relatively to the localities on the surface of the earth from which it was seen. In the main the point of culmination of ordinary auroral arcs is in the direction of the magnetic north of the place of observation, and the arcs themselves follow approximately the magnetic parallels. I found, however, from careful calculations that the apex of this arc deviated some 10° west from the magnetic meridian, and that its course or strike was at an angle of about 25° with the geographical parallel circles.

The calculation of the height of the arc rests on the following principle. If in Fig. 1 S and S′ denote points of observation, C the centrum of the earth, and P two points in the aurora borealis situated in the same perpendicular plane through S and S′, whose angles above the horizon h and h' have been determined at each station, and the longitude and latitude of each place is known, it is possible (by a well-known trigonometrical formula, viz. $\cos d = \cos (l - l') \cos b \cos b' + \sin b \sin l'$, where l and l' indicate the longitude and b and b' the latitude of the two places, and d the distance or great circle between the two) to find the arc S S′, which is equal to S C S′. From this again S S′ ($\frac{1}{2}$ S S′ = sin $\frac{1}{2}$ S C S′) is found. Further, $\angle\ x = x' = \frac{1}{2}$ S C S′. One knows, therefore, in the triangle S P S′, the side S S′ and the angles P S S′ and P S′ S, so that its other parts, as for instance P S, may be ascertained by means of some simple trigonometrical calculations. If P S is known, we further obtain, in the triangle P S C, S C, which is equal to the radius of the earth, and the angle P S C = $90° + h$. From this P C is found, and, subtracting S C, the perpendicular height of P above the earth's surface is determined. Finally, if ∠ P C S is ascertained, the point on the earth above which P is situated perpendicularly is found.

In practice the matter is, however, not quite so simple. The method presupposes thus that P lies in the same

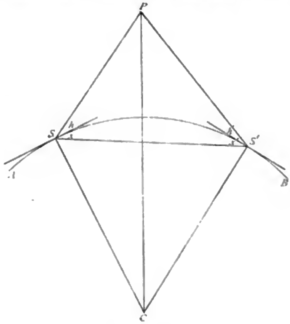


FIG. 1.

vertical plane as both points of observation, which would rarely occur, but still it retains its adaptability, even if P only indicates a point in the upper or lower edge of the auroral arc, the culminating point of which has been determined in both places, provided that these lie in the same plane perpendicularly in the longitudinal axis of the circle, or may at all events be referred to such a common plane.

It is, however, far more difficult to overcome another drawback. Provided that the arc has a perceptible thickness in relation to its horizontal breadth, those parts of the upper or lower edge of the arc which present themselves to the various observers cannot always be referred to the same parts of the arc, in consequence of the circumstance that the apparent breadth, particularly with the lower arcs, is due to a combination of both the real breadth and thickness of the arc.

If *a*, *b*, *c*, *d* in Fig. 2 represent the circumference of a circle observed from the points A, B, C, assuming that the line of demarcation of the arc north and south is parallel with the inclination needle, the point *a* will denote the upper (southern) edge for A and B, for C on the other hand *b*; and, in a similar manner, the lower (northern) edge is determined by the point *d* for A and B, *c* for C, &c.

Now if the determination of the apparent height of the upper edge for A and C is taken as a basis for calculation, the height of the same cannot be ascertained therefrom, but from the crossing point of the lines A *a* and C *b*, and so forth. A great many other variations may also be met with according to the dimension and position of the arc. Generally, however, when the arc lies on one side of both places of observation, the edges observed in the respective places are identical.

In the following simple manner I have succeeded in referring the various places of observation to the vertical plane of Bergen, where my own observatory is situated, in order to find the arc S S' in Fig. 1. The direction of the arc I have, in accordance with observations, let form an angle with the circles of latitude of 25°. I have constructed a globe with the circles on a large scale in Mercator's projection, on which the various stations have been denoted. Through the place "Bergen" a straight line is drawn under an angle of 25° with the circles of latitude, while the perpendicular distance of the various stations from this line has been determined in the construction and by direct measurements. The stations whose observations are so complete that the angle of the arc above the horizon has been determined have been combined with Bergen. I have succeeded in forming nineteen such combinations. The heights of the arc calculated at these

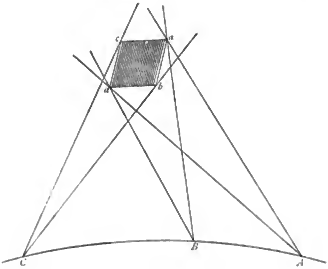


Fig. 2

stations vary somewhat, but not very much, and if an average is taken we find that the value of the height of this arc above the earth's surface was most probably 146·95 km.

It further appears that the observations were not exact enough to obtain an estimate of the thickness of the arc, so that we can only accept the figure given above as an average one, *i.e.* an average of the distance of the uppermost and lowest layers from the surface of the earth.

If we compare the height arrived at in this case with those obtained through previous researches, we shall find that it agrees to some extent with the value of the arcs measured in recent times. They differ, however, greatly from old ones. Thus Prof. Fearnley finds, through observing sixteen auroral arcs from *one* spot, in Christiania, by an ingenious theoretical method, that the average height in these cases was 27·15 geographical miles, or 201·5 km. Newton found, by the same method, that the average height was 130 English miles, or 209·3 km., while Nordenskjöld, by a similar method, has come to the conclusion that it is 190 km. The French expedition established at Bossekop during 1838-39 obtained no reliable statistics on this point, owing to the small distance between the two points of observation, viz. 15·6 km. But from the results obtained it seems that the height must be sought between 100 and 200 km.

In opposition to this Bergman fixes the height at 753 km., Boscovich at 1328 km., and Mairan at 780 km. More in correspondence with our result Dalton found the height of the auroral arc to be 241 km., and Backhouse found the three measured by him to lie between 81 and 160 km. On the other hand, Franklin found at Cumberland House (North America) that several auroræ which he measured had a height only of 11·3 km. In fact, the *savants* who have studied the aurora borealis in the Arctic regions appear to agree that it does not attain the height given above as the results of researches further south.

I have here only mentioned a few of the very divergent values obtained in measuring the aurora borealis, but I

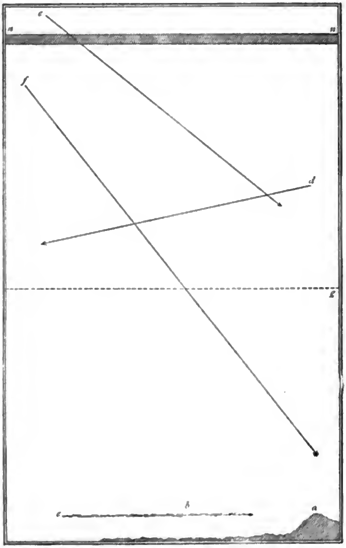


Fig. 3.

do not believe it will be of any service to append more, as the values range from 0 to 2000 km.

In Fig. 3 I have attempted to illustrate the height of the aurora referred to by me by comparing it with other well-known heights. The scale is 1 mm. = 1 km. Below is drawn a profile of Norway from Bergen in a direction E. 25° N. The heights here range to upwards of 5000 feet. Above *n n* indicates the arc of the aurora in its height of 146·95 km. The thickness given is wholly approximate, and probably too small. For comparison is inserted, *a*, the highest mountain in the world (Mount Everest, 8839 m.); *b*, the greatest height reached by man (Glaisher and Coxwell in their balloon on September 5, 1862, 31,800 feet); *c*, the estimated height of the cirrus clouds (25,000 feet); *d*, the plane of the August meteors—beginning and ending (155 and 98 km.); *f*, the point of appearance and disappearance of the large meteor which was seen on March 4, 1863, in England, Holland, Belgium, and Germany (134 and 26 km.); and finally *g*, the hypothetical height of the atmosphere (10 geographical miles = 74 km.).

With regard to the results of the measurements of the aurora which I effected during last winter at Kautokeino, in conjunction with the stations at Bossekop and Sodankylä, I may be brief, from the circumstance that the observations made at the latter station are not to hand, while the material at my disposal requires a more careful analysis than I have as yet been able to bestow upon it.

I must, however, state that a preliminary examination of the observations made in the plane Kautokeino-Bossekop has led to the important discovery that the aurora borealis, at all events in this locality, lies in a plane at least 100 km. above the earth. I have examined all the observations made simultaneously at the two stations, and have not found the slightest indication of the aurora descending to a level in which it would only be visible at one of them, while there seems to be no reason for assuming that the types observed were not identical, when due regard is paid to the difference in the height above the horizon of the two stations.[1] The distance between Kautokeino and Bossekop is about 107 km.

I have, on the principle indicated in Fig. 1, made a series of preliminary measurements of the lower edge of auroræ observed at both stations, having selected only those where there cannot be the least doubt as to identity, from which I have obtained the following values in kilometres:—76·0, 79·9, 84·6, 93·6, 97·7, 98·2, 99·0, 100·0, 100·6, 107·0, 116·6, 124·1, 124·9, 131·9, 141·6, 144·9, 149·0, 163·6.

If the average of these eighteen measurements is taken, the average height of the lower edge will be 113 km., *i.e.* a result which is in perfect harmony with the later observations referred to above.

To give any definite results of the studies of the thickness of the arcs, the length of the streamers, &c., is, of course, impossible, until the material has been carefully sifted. I may here in passing observe that we must in all estimates of the height of the aurora borealis be content with approximate figures; this lies in the nature of the case, apart from inaccuracies in the measurements which it is impossible to avoid. The aurora borealis has, in common with clouds, no absolutely defined and fixed line of extension, either downwards nor upwards. We must therefore rest content with ascertaining only approximately the height of the plane in which the aurora borealis appears.

That the aurora generally appears at a height of 100 km. or more above the earth's surface does certainly not preclude the possibility of its appearance on some occasions much nearer the earth. In fact there are a considerable number of reports in our hands which imply that this is really the case. Thus observers aver that they have seen auroræ below the clouds, in front of mountains and icebergs and coasts, and even on the very ground. These assertions have been greatly doubted as being the result of the imagination, or optical illusions, but with what justice I will not venture to say. For my own part I can only say that during my long stay at Kautokeino I had unfortunately often enough occasion to observe auroræ and clouds simultaneously, but although always paying the closest attention to this particular point I have never seen even a fragment of an aurora in front of or below the clouds. Even the most intense development of light, colour, and motion occurred always above what seemed to be the very highest-lying clouds.

[1] The experiences of Prof. Lemström at Sodankylä (NATURE, vol. xxvii. p. 389), which seem to point in a different direction, I intend to discuss on another occasion.

When the entire material relating to the study of the aurora borealis has been collected from the various international circumpolar stations, sifted and carefully analysed, the question of the height of the aurora borealis will not, I believe, long remain one of the unsolved problems of nature. Until then the reader must remain content with the discoveries I have indicated in this paper.

SOPHUS TROMHOLT

COUNT DU MONCEL

COUNT THEODORE DU MONCEL, whose death we briefly announced last week, was born at Paris on March 6, 1821. His father had been a General of Engineers under Louis Philippe, and the son was at one time destined also for the army. When but eighteen years of age he showed a predilection for scientific pursuits, and published two treatises on perspective, treated mathematically and artistically. He was also at this time an enthusiastic archæologist and traveller. In 1847 he published a volume entitled: "De Venise à Constantinople à travers la Grèce," illustrated with lithographic plates drawn by himself. His family objected to his democratic pursuits, and became estranged from him. In consequence he determined to adopt science as a profession. But not having studied at the Ecole Polytechnique, nor at the Ecole Centrale, he lacked those scholastic recommendations without which, in France, promotion is so difficult. A professorship being absolutely closed to him, he became a scientific writer, and devoted his attention chiefly to electricity. In the years which followed he zealously sought to acquaint himself with every new discovery and invention which was made; and his industry in collecting and disseminating information on electric science was immense. During the years 1854-1878 he published at intervals in five volumes, his well-known "Exposé des Applications de l'Electricité," a work which, though it relates chiefly to inventions and instruments now superseded by newer forms so abundantly poured forth during the past few years, nevertheless maintains its place as a standard work of reference in electric technology. Since 1878 Count du Moncel published several volumes containing popular expositions of various branches of the science. His work on the Telephone and Microphone has been translated into English; so also has his work on Electric Lighting, and that on Electricity as a Motive Power. Thoroughly in his element as a writer for the scientific press, and more of a journalist than a man of science, Count du Moncel nevertheless distinguished himself by a series of valuable contributions to science, chiefly in the form of papers read before the Académie des Sciences. His researches on the properties of electromagnets and on the conductivity of badly-conducting bodies are worthy of mention. To du Moncel we owe the observation that the variation produced by pressure in resistance offered at the point of contact between two conducting bodies—a phenomenon well known before his time—is more marked in certain bodies than in others, wood-charcoal being one. In this observation he laid the foundation for the subsequent applications of this principle made by Clérac and by Edison. Du Moncel was also an inventor, and obtained a gold medal at the Exposition of 1855 for the collection of instruments exhibited by him, including an electric water-indicator, an electric anemograph, an electric recorder of improvised music, a recording galvanometer, and sundry telegraphic instruments. From 1860 to 1873 du Moncel was occupied as electrician to the administration of telegraphs; but he quitted the post somewhat abruptly in 1873 in consequence of disputes in the administration. In 1874 he was elected a member of the Académie des Sciences, in which body he was very active in bringing forward accounts of all discoveries in his favourite science. It was he who thus successively introduced to the Academy the Bell telephone, the Hughes microphone, and the Edison phonograph. He was very prominently connected with the Electrical Exhibition at Paris in 1881. From 1881 until his death he held the editorship of the journal entitled *La Lumière Électrique*, which was founded by him, and to which he was an unceasing contributor. Whether he was a great scientific genius may be doubted, and whether in some matters he did not assume the attitude of partisan rather than that of historian is also perhaps open to debate; but none can deny that he had by his diligence and talents won himself a very important place in the ranks of science. The *rôle* of scientific journalist may be said to have almost been created by him, and he was always anxious to maintain the dignity of science and to advance the interests of scientific workers. It would be difficult to fill up the void left by his sudden decease.

NOTES

M. FAYE read to the Academy of Sciences, on Monday, a report drawn up by the Academical Committee appointed to prepare for the election of the three French delegates to the Meridian Congress of Washington. The Committee, whose conclusions have been adopted by the Academy, declines to take any final step, and will ask the Minister to appoint a certain number of delegates of several public administrations in order to deliberate in common with them and give final advice.

THE Committee appointed by the Academy of Sciences to report on the proposal to sell the Paris Observatory grounds, has held its first meeting. M. Wolff, Member of the Section of Astronomy, read a note, which will be printed, opposing the scheme. He said, *inter alia*, that the Government had constructed an Observatory at Meudon, which was almost complete, and that he was certain that M. Janssen, the present director, would lend his instruments and grounds to any astronomer wishing to execute special work which could not be executed in the interior of Paris. M. Janssen, who was present, said that he should be most happy to comply with any wish expressed by a competent observer, the Observatory not being his private property, but belonging to the Government.

THE Meteorological Observatory of Sentis, in the Canton of Appenzell, Switzerland, at a height of 8094 feet was established in August 1882, and the regular observations began with September 1 of that year. This observatory, which, from its position and height, is *par excellence* the high-level meteorological station of Switzerland, is maintained at an annual cost of 6000 francs, raised jointly by the four neighbouring cantons, the learned societies, and the Alpine Club of Switzerland, and is further subsidised by 1000 francs from the national grant for meteorology. A brief *résumé* of the results of the first year has been received. The eye-observations are made five times daily; the results at these hours, however, are only given in full as regards the force of the wind. These are of some interest, as showing that, so far as regards the observing-hours, viz. 7 and 10 a.m. and 1, 4, and 9 p.m., the mean diurnal force of the wind, for each of the twelve months beginning with August 1882, is least at 1 p.m. We look forward with no small interest to a fuller report than the one now before us of the diurnal results for each month of the barometric, thermometric, hygrometric, and rain observations from this invaluable addition recently made to the high-level stations of Europe.

A CURIOUS tidal phenomenon took place on the morning of the 21st inst. on the west coast of England. The following communication (dated Feb. 21) to the Secretary, Meteorological Office, from Ellis Roberts, Trinity Buoy Keeper, Aberdovey, contains the leading circumstances connected with the occurrence:—"Afternoon of the 20th (civil time), it blew strong (6 to 7) from south-south-west and south-west, increasing towards midnight to very heavy gale (force in the squalls, 10 to 11) with heavy rain. I retired at 11. Barometer at 29·31, falling. I cannot say when it moderated, but at 6 a.m. the sky was beautifully clear, with moderate breeze about west (force 3 to 4). The time of high water for this bar, by the Liverpool almanacs, this morning tide would be 2h. 33m., but from some observations that I have made for eighteen months that I have been living here, the time of high water in the river off the village would be about 3h. 5m. to 3h. 10m. I wish to make this remark on account of the times the phenomenon took place. About 6.30, or near half ebb, I noticed the barometer had risen to 29·34 or ·35, with beautiful, fine, clear sky; moderate breeze (about 3) from west-south-west, but the stream nearly slack when it ought to have been running *ebb* about two knots; very heavy sea on the bar. At 6.50 the vessels were fairly swung to the flood, which was running about 1 to 1½ knot, and the water was fast rising. At 8·15 water again nearly slack, with light breeze (about 2) from south to south-south-east; very fine, but clouds beginning to form in the south-west and west. At 8.30 the water was falling; at 9, water falling very fast, ebb running 2½ to 3 knots; at 10.45, water beginning to rise for the natural tide. As there is no gauge for the rise and fall at this place, I cannot give the *correct* rising and falling, but I will give them according to the best of my judgment. The afternoon tide of the 20th was noticed to be very low, much lower than could be expected from the state of the wind and weather. But this morning's tide rose fully *six* feet above the ordinary level, or nearly to the height of the tides at full and change, with the moon's parallax 59′ to 60′ (this tide had fallen as usual, or rather more rapidly, up to nearly half ebb). I cannot exactly say how much the water had risen before I noticed it, but the unnatural tide rose after I noticed it over 2 feet 6 inches; and from 8.30 to 10.15 the same had fallen over 6 feet, although the wind had shifted to the westward, with passing showers and hard squalls. Barometer all the time very steady at 29·34 or ·35. Now, 4 p.m., it is slack water, ships lying head to wind, but a lower tide than any that I recollect in this river with the wind as strong from the westward. I have heard it reported that there was heavy thunder and lightning in the neighbourhood, but I neither saw nor heard any." Similar occurrences are reported from the Dee, near Chester, and from the Mersey.

THE Second Teyler Society of Haarlem offers a gold medal of the value of 400 florins for a critical study of all that has been said for and against spontaneous generation, especially during the last twenty-five years. The competition is international, and further details may be obtained by applying to "La Maison de la Fondation du feu M. P. Teyler van der Hulst, Haarlem."

WE are asked to state that a society calling itself the "Society of Arts, Letters, and Science," has no connection whatever with the Society of Arts.

THE old Sorbonne and Collège Louis-le-Grand in Paris will soon be demolished, to be reconstructed on a larger and more magnificent scale. The same measure is to be applied to the Collège de France. All this part of the Latin Quarter will be quite remodeled, and will in a few years be unrecognisable.

THE Municipal Council of Paris has passed a resolution to exhibit, in each of the twenty town halls of that city, the meteorological notices issued every day by the French Office.

PROFESSOR MILNE of Japan has just made a new move in the direction of investigating seismic phenomena. He has made preparations for the establishment at Takashima, near Nagasaki, of an underground or catachthonic observatory. The workings in the coal-mine at that place not only extend beneath the island of Takashima itself, but also beneath the sea, and have a total length of about seventy miles. About 2500 people are employed there, and the output of coal is about 1200 tons a day. Owing to chemical decomposition going on in the workings, which are on the "post and stall" system, the temperature is so high that spontaneous combustion is constantly occurring. Prof. Milne visited places having a temperature of 110° F. This, together with the escape of fire-damp, make the mine very dangerous. The experiments which have been commenced, and which are to be continued systematically, are: (1) the observation of earth-currents, which so far appear to be but feeble; (2) listening in a telephone to the sound produced by the movement of a microphone placed in the solid rock; (3) the observation by means of a tromometer, or tremor measure, of earth-tremors; (4) the observation of two delicate levels to see if the seasonal movements of the soil on the surface exist also underground; (5) attempts to measure the influence of the tide, which rises there about eight feet every twelve hours, in producing a bend, or crushing in the roof of the mine. Observations on atmospheric electricity may subsequently be added. All these will be carried on in conjunction with tidal, barometrical, and thermometrical observations, as well as with those on the escape of fire-damp and the entrance of water to the mine. One practical object of these series of observations is to ascertain whether any of these phenomena are connected with each other, and especially with the escape of fire-damp in the mine. At present it appears that the gas shows itself about eight hours before a fall in the barometer, and therefore the indications of the latter are useless as danger warnings. On the *surface* of the earth tremors increase with a barometrical fall, and perhaps before it. Earth-tremors and the escape of fire-damp may, therefore, Prof. Milne thinks, be connected; but, whether practical results be obtained or not, the experiments will enable a comparison to be made between surface phenomena and those which are subterranean. The native company which now owns the mine, as well as the resident engineer there, have afforded every assistance to Prof. Milne in his investigations, and that gentleman, we are informed, will be glad to receive suggestions for improved or additional observations, from any scientific men in this country interested in the subject. Any communications intended for him should be addressed to the Imperial College of Engineering, Tokio.

THE Russian *Izvestia* publishes the results of the researches of M. Brounoff into the variations of temperature in consequence of the cyclones in Europe. He has taken seventy-six cases in which the meteorological bulletins showed the presence of a cyclone in Europe, and prepared a meteorological map for each of these days, showing the deviation of temperature from the normal, and the route of the cyclone. The average deviations of temperature in the regions of the cyclones appear as follows for different months: January, 3·7° Cels.; February, 2·2°; March, 1·2°; April, 0·2°; May, 0·0°; June, −0·7°; July, −0·2°; August, −0·4°; September, −0·1°; October, 0·2°; November, 0·9°; December, 1·4°. It results from these figures that, as might have been foreseen, during the winter the cyclones bring warmer air, and colder air during the summer. If the region of the cyclone be divided into four parts by two perpendicular lines traced through its centre, the two right parts widely differ from the two left, the deviations being for the former: winter, 4·6°; spring, 1·9°; summer, 0·7°; and autumn, 1·7°, all positive; while for the two left parts the deviations are all negative as well during the summer as during the winter, namely: −0·9° for the winter, −1·1° for the spring, −1·7° for the summer, and −0·9° for the autumn.

IT appears from a notice published in the last issue of the *Izvestia* that stone-age implements were used by Russians in Siberia at a time very near to our own. Thus, owing to the difficulty of having iron implements, and even iron, the Cossacks who occupied the valley of the Irkut at Tunka availed themselves of the numberless stone implements they found scattered on the hills around Tunka, where large manufactures of stone implements have been discovered. There are still people who remember also that their grandfathers were compelled to follow the advice of the Mongols, and to make use of nephrite hatchets; the tradition says also that there were Cossacks who understood themselves the art of making jade implements. Any one who knows the difficulties of obtaining iron in Siberia some thirty years ago, and even now, will not doubt the trustworthiness of the tradition. We may add also that the late Prof. Schapoff has found the settlers at Turukhansk largely using stone pestles and hammers, some of which were exhibited at the Irkutsk Museum, before it was destroyed by fire.

IN the last number of *Naturen* Herr Geelmuyden of Christiania describes the so-called "Jættegryder" giant-bowls of Orholm, on the east side of Christiania fjord. These curious geological formations, of which good drawings are given, are not only the largest of their kind in Scandinavia, but are of greater size than those of the well-known glacier garden of Lucerne, which have hitherto been considered as the most extensive of such natural depressions. In two of the upper cavities at Orholm, all of which lie on the edge of a steep fjeld, a few pine and birch trees have taken root and grown in a tolerably normal manner till they reached the level of the surrounding rock, when the branches have invariably been bent and distorted by the force of the winds, and their growth has been arrested. The depth of the depressions has not been determined, but the perpendicular inclination of the inner walls would lead to the inference that it is considerable.

MESSRS. CROSSLEY BROTHERS, of Manchester, have recently added an important improvement to their "Otto" gas-engine. This consists of a self-starting apparatus by means of which the engine can be put in motion by simply opening a valve. The apparatus consists of a small receiver into which the engine exhausts for a very short portion of its strokes the burnt gases which result from the ignition of the charge in the cylinder. These gases fill the receiver, and in the course of half a minute raise a pressure in it nearly corresponding to the pressure in the cylinder during the moment of ignition. These stored burnt gases are admitted again to the cylinder at the moment of starting by a very simple piece of mechanism, and thus put the engine in motion in much the same way as steam moves a steam-engine, thus saving the trouble of pulling the wheel round to get in the first charges.

ON January 22, at 8.47 p.m., a meteor was observed in the province of Kalmar, Sweden. It appeared in the north as a fire-ball, without trail, gradually descending to the earth, so slowly that some observers, in order that it should not become hidden from view by intervening houses, ran about 300 m., and still beheld the object. The speed decreased by degrees, and finally the ball seemed to remain stationary and then went out. No whizzing noise or report was heard. The object was observed for a minute and a half. Its path was not regular but marked by great deviations. When first seen its size and lustre was like that of Jupiter, and its point of issue 50° above the horizon, while when disappearing it was 10° above the horizon. It seemed to increase in size as it descended. Its slow speed was particularly remarkable, as it differed so greatly from that of ordinary meteors.

THE Anthropological Society of Paris is constituted as follows for 1884:—President: Dr. Hamy; Vice-Presidents: Drs. Dureau and Letourneau; Secretary: Dr. P. Topinard; Assistant Secretaries: M. Girard de Rialle, Dr. Prat, and M. Issaurat: Committee of Publication: Drs. de Quatrefages, Matthias Duval, and Thulié.

THE death is announced of Dr. Gotthilf Heinr. Ludw. Hagen, with whose name for the last sixty years progress in the domain of hydrotechnics in Germany is closely associated. He died at Berlin on the 3rd inst., having nearly completed his eighty-seventh year.

THE death is announced of Dr. A. Bernstein, the well-known author of the "Naturwissenschaftliche Volksbücher." He was born at Danzig in 1812, and died at Berlin on the 12th inst.

ON February 18 an earthquake was felt in several parts of the Department of Algiers. Its duration was very short. The *Turkestan Gazette* states that as many as ninety distinct shocks of earthquake have been felt at Oosh since November 14. Other shocks have also recently occurred at Viernoe and Tashkend. A violent earthquake is also reported from the Birvari district (province of Bitlis, on Lake Van, in Asiatic Turkey) on February 10. Great damage was done, as many houses fell.

MR. W. WHITAKER desires us to point out in reference to the article on the "Geological Survey of the United Kingdom," printed in the last number of NATURE (p. 395), that some of the bulkiest publications of the Survey have appeared since 1855. He favours us with a list of these, in which we are glad to observe his own "London Basin, pp. xii. 620."

IN consequence of a generally expressed wish from many hundreds of intending participators at the forthcoming Ornithological Congress at Vienna, the Committee of the Congress has altered the date for the first meeting from April 16 to April 7. As the Ornithological Exhibition will be held from April 4 to April 14, the ornithologists present in Vienna at that time will have an opportunity of seeing the Exhibition, while at the same time attending the Congress. Numerous Belgian, Danish, French, German, Austrian, Italian, and Russian men of science will meet in Vienna upon that occasion.

THE German Government has issued an edict concerning the preservation of prehistoric burial-mounds which may be discovered henceforth upon German soil.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. W. Graeme; a Sambur Deer (*Cervus aristotelis* ♂) from Ceylon, a European Flamingo (*Phœnicopterus antiquorum*) from Southern Europe, presented by Mr. James McGregor; a Vulpine Phalanger (*Phalangista vulpina* ♂) from Australia, presented by Mr. A. H. Lowder; a Pine Marten (*Mustela martes*), British, presented by Mr. Edward de Stafford; a Common Hare (*Lepus europæus*), British, presented by Mr. G. Pottier; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Master A. J. Neill; two Laughing Kingfishers (*Dacelo gigantea*) from Australia, presented by Dr. Evans; a Black-footed Penguin (*Spheniscus demersus*) from South Africa, presented by Mr. F. Bloor; a Greek Tortoise (*Testudo græca*), European, presented by Miss M. L. Fergusson; a Stump-tailed Lizard (*Trachydosaurus rugosus*) from New Holland, a Bearded Lizard (*Amphibolurus barbatus*) from Australia, presented by Mr. J. W. Bostock; a Pike (*Esox lucius*) from British fresh waters, presented by Mr. Charles D. Hoblyn, F.Z.S.; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♀), a Campbell's Monkey (*Cercopithecus campbelli* ♀) from West Africa, a Ruddy Ichneumon (*Herpestes smithi*) from India, a Bactrian Camel (*Camelus bactrinus* ♂) from Central Asia, three White-crowned Pigeons (*Columba leucocephalus*) from the West Indies, purchased.

OUR ASTRONOMICAL COLUMN

THE SOLAR ECLIPSE OF 1806, DECEMBER 10.—When Rümker was on the point of leaving England to undertake the direction of the observatory erected by Sir Thomas Brisbane at Paramatta, N.S.W., he came into possession of a letter addressed to Maskelyne by Admiral Bligh, Governor of the colony, containing observations of a solar eclipse on December 10, 1806, which was described as almost total; the observations were made at Government House, Sydney Cove, with a three-feet achromatic and two chronometers by Arnold; Rümker communicated the Admiral's letter to Zach, who published it in vol. v. of his "Correspondance Astronomique," with the places of the sun and moon from Delambre and Burckhardt, and the longitude of Sydney Cove, which be had deduced from Bligh's observations. Employing Burckhardt's Lunar Tables and the last Solar Tables of Carlini the elements of this eclipse will be found to be approximately as follows:—

G.M.T. of conjunction in R.A. 1806, Dec. 9 at 14h. 19m. 14s.

	°	'	"
R.A.	256	19	1
Moon's hourly motion in R.A. ...		35	3
Sun's ,, ,, ...		2	45
Moon's declination	23	1	8 S.
Sun's ,, ...	22	52	2 S.
Moon's hourly motion in decl. ...		0	5 S.
Sun's ,, ,, ...		0	14 S.
Moon's horizontal parallax		56	16
Sun's ,, ,, ...		0	9
Moon's semi-diameter		15	20
Sun's ,, ,, ...		16	15

The eclipse was therefore an annular one: it was central and annular with the sun on the meridian in longitude 143° 23' E. and latitude 32° 23' S. Admiral Bligh's position was not within the annular phase, but on making a direct calculation for it, we find the greatest eclipse at 0h. 41m. p.m. local mean time, magnitude 0·92. Perhaps this is the first eclipse that was astronomically observed at Sydney, and it may be noted in connection with Mr. Russell's historical account of the progress of astronomy at that place, of which we gave some account last week.

THE LATE PROF. KLINKERFUES.—Ernst Friedrich Wilhelm Klinkerfues was born at Hofgeismar in Hesse, on March 29, 1827. He was attached to the Observatory of Göttingen as assistant in 1851, under Gauss; he became provisional director of that establishment in 1859, and in 1868 was confirmed in that appointment. Since 1863 he was one of the professors in the Philosophical Faculty at Göttingen. He was an able practical and theoretical astronomer, and discovered the comets 1853 III., 1854 I., 1854 III., 1854 IV., 1855 II., and 1857 V.; the first of these, which bore his name very generally while under observation, was telescopically observed in full sunshine, and only a few degrees from the sun's place by Mr. Hartnup at Liverpool, and by Schmidt at Athens. In 1860 Klinkerfues proceeded to Cullera in Spain for the observation of the total solar eclipse in July. His work in theoretical astronomy included a method of determining the orbits of the binary stars, and he was the author of a valuable theoretical treatise on the science. When, on the occurrence of the great meteor shower of November 27, 1872, it was found that the meteors followed the track of Biela's comet, and the comet itself was supposed to be close to the earth on that day, Klinkerfues thought it might be found opposite the radiant of the meteors in Andromeda, and accordingly telegraphed to Mr. Pogson at Madras to this effect, "Biela touched earth November 27, search near θ Centauri." It will be remembered that, in consequence of this telegram from Klinkerfues, Mr. Pogson actually detected a comet in the vicinity, but was only able to obtain its place on two mornings; so that the orbit could not be determined. There was a divided opinion at the time as to its connection with Biela, and perhaps this may now be said to be more than doubtful, notwithstanding the singular circumstances attending its discovery. Klinkerfues died suddenly at the Observatory of Göttingen on January 28.

GEOGRAPHICAL NOTES

MR. H. H. JOHNSTON leaves London to-morrow for Zanzibar, to conduct an expedition to Mount Kilimanjaro. The expenses of the expedition are borne by the Royal Society and the British Association, the object being to form as large a collection as possible of the flora and fauna of the highest mountain in Africa.

ANOTHER attempt will be made this year to rescue the United States observing party in Lady Franklin Bay, under Lieut. Greeley. This party, twenty-five in all, went out in August 1881 and in 1882 and 1883 unsuccessful attempts were made to reach them. This year four vessels will be sent out, one of them H.M.S. *Alert*, which we are glad to know has been presented for the purpose of the search to the United States Government. It is to be expected that with such a formidable expedition the Greeley party will be reached, and we fervently hope brought home, though it is to be feared that some at least must have succumbed to the hardships of three winters in 81° N.

THE fourth German Geographical Congress will meet at Munich from April 17 to 19 next. The preparations are now being made. The main subjects for discussion are: the present state of Polar investigation; the innovations relating to the standard meridian; the Glacial epoch; and the mode of drawing large-sized maps for schools. Numerous travellers and investigators have promised to read papers.

DR. WILD of St. Petersburg, the President of the International Polar Commission, is now sending out invitations for the Polar Congress which is to meet at Vienna on April 22 next. All the leaders of the International Polar Expeditions of 1882 are expected to attend.

DR. ZINTGRAFF of Berlin is about to follow Dr. Chavanne to the Congo, by order of the Brussels National Geographical Institute. His special investigations are to be of an ethnological nature.

HERR L. STEINEGER informs *Naturen* that his fortnight's stay in Kamchatka in May, 1883, proved fairly satisfactory. The complete success of the expedition was, however, interfered with by the exceptionally late snowfalls, which had buried the whole district round Petropanlovski under a layer of six to nine feet of snow, the surface of which melted daily under the scorching sun only to be frozen again at night. Among other interesting points he has noted the presence of four distinct species of the sea-eagle in Kamchatka, while Europe and the whole of the North American continent had only one species of this magnificent bird. One of these four, which Herr Steineger has named *Haliaetus hypoleucus*, is distinguished from *H. leucocephalus*, *H. albicilla*, and the giant *Thalassaetus pelagicus*, by the dazzling whiteness of some parts of the body and its generally lighter colour. Herr Steineger's collections, which have been sent on to Washington, include the bones of a complete skeleton of the sea-cow, seventeen sea-calves, three skins of the Kamchatkan Alpine sheep, a considerable number of crania of the Cetacea, of which three would appear to belong to new species. Besides these and some 700 skins of birds, with a large number of mammalian crania, he sends back a large and interesting collection of fish, crustaceans, land and freshwater mollusks, and numerous fossil and living plants.

AFTER having done so much in restoring to our maps the old bed of the Amu-daria, the Russian explorers seem to be inclined now to take a quite opposite view. Thus, Prince Hedroits, geologist of the Amu daria Expedition of 1880, after having explored the eastern part of the Uzboy, came to the conclusion that the total want of river-beds in the ravine and the presence of Aral-Caspian mollusks in it are a sufficient proof that the water of the Amu never ran on the stretch between the Sary-kamysh lakes and the Caspian. Now, M. Konshin—a mining engineer who has recently explored the western part of the Uzboy—arrives independently at the same conclusion with regard to the western part of the supposed old bed of the Amu. He considers that its passage between the Greater and the Smaller Balkhan Mountains is a recent strait of the Aral-Caspian Sea, and that the western part of the Uzboy is merely a remnant of the outflow towards the Caspian of the brackish water of the Sara-kamysh lakes. The ravine of the Uzboy would be thus one of the numerous *sors*, or elongated lakes, the likeness of which to beds of rivers had already struck Pallas in the Astrakhan steppes, where the Daban-gol has a length of sixty miles. The view of M. Konshin may be summed up as follows:—The immense Sara-kamysh depression, 4400 miles wide, and at some places 280 feet below the level of the Aral, formed at a geologically recent time a single basin with the Aral; the fossils found on its borders show that it was filled up with at least brackish water. This lake had an outflow into the Caspian; but for 130 miles west of Sara-kamysh there is nothing like a river-bed. The likeness begins only west of Balla-Ishem, where the Uzboy begins. This channel, however, was filled up, not with the sweet and muddy water of the Amu, but with a brackish and rather pure water of the Aral-Sara-kamysh Lake. In fact, in this channel, on its whole stretch from Balla-Ishem to the Caspian, one finds everywhere the typical Aral-Caspian *Cardita*, *Dreyssena*, *Neritina*, and *Hydrobia* in the most perfect state, whilst there are no traces at all of a fluviatile flora or fauna, nor any traces of human settlements. However opposite to current opinion, this view of the Uzboy surely has much to be said in its favour.

THE same geologist publishes in the *Isvestia* of the Russian Geographical Society an interesting account of his explorations in the Kara-kum desert, between Kyzyl-arvat and Khiva. He considers the bad reputation of this desert quite exaggerated. In the neighbourhood of the Caspian and Lake Aral the Kara-kum sands offer a great many difficulties to the traveller. Geologically speaking they have quite recently emerged from the sea, and the *barkhans*, or sandy hills, are devoid of vegetation and move freely before the wind; the same is true with regard to the neighbourhood of Sara-kamysh and the Uzboy. But farther in the steppe the sands are older, and the brushes which cover them render them quite stable, so that the Akhal-Tekkes like better to stay in the steppe, and return to the oasis only for the needs of agriculture. The routes are quite comfortable, with exclusion of steeper ascents and descents on the slopes of the *barkhans*; and the cisterns (*kaks*) when kept in order contain plenty of water; while the steppe yields throughout the year abundance of food for the horses and camels. The *barkhans* are often intermingled with *takyrs*, that is, with places covered with firm clay, on whose surface small canals collect rain-water and bring it to a common basin called *kak*. The *sors*, or elongated ravines, the sandy bottom of which is impregnated with brackish water, are most numerous, especially in certain parts of the steppe; in the neighbourhood of the Akhal-Tekke oasis they run in numerous parallel lines for several dozen miles in length. The Uzboy, which M. Konshin visited at Kurtysh, is a ravine, sometimes crossed by hills of sand, at the bottom of which one perceives a narrow serpentine of brackish water. The Tertiary beds are covered there with a fine dirty dust filled with remains of the Aral-Caspian *Dreyssena*, *Neritina*, and *Cardium*. Above Kurtysh the supposed old bed of the Amu can be distinguished only by these marine remains. Notwithstanding the most careful search, M. Konshin failed to discover any traces of fluviatile deposits at Shikh, where the Charjuy bed of the Amu is traced on our maps. The hills at Shikh are remarkable as a rich mine of very pure sulphur (62 per cent.) One of them would contain at least 160,000,000 cwt. of pure sulphur, and sulphur appears on the surface of very many of them.

DR. REGAL, travelling for the Geographical Society in Central Asia, has returned to Tashkend through Sarafshan and Samarcand, after visiting Hissar, the Mura Pass—never before explored—the town of Karatag, and Baldshan, Duwsy, Rushan, and Shignan. Dr. Regal intends to start again in a few weeks for Baldshan, and in the spring to continue his explorations as far as the Kashgar frontiers.

COLONEL PREJEVALSKY, with his Cossacks, must be now in Mongolia, on his way towards Thibet. The other well-known explorer of the Turcoman region of the Transcaspian, M. Lessar, is ag in on his way to the scene of his geographical triumphs along the Persian frontier to complete his work for the General Staff. He will probably be absent another year or a year and a half.

THE Director of the Russian Observatory at Peking, Dr. Fritsche, who made last winter a journey through Southern China, from Peking to Kai fong-fu on the Huan-Lo, has determined on his route the positions and the magnetic elements of forty-six places. A few days after his return to Peking he left again and went, *via* Changhai kuan, on the Gulf of Pe che-li, to Tsitsigar Mergen, Aihun, and Blagoveschensk, on the Amur, determining the positions and magnetical elements of sixty three new points.

A CORRESPONDENT in *Naturen* draws attention to a curious narrative of an expedition to high northern latitudes, undertaken in 1266, at the instigation of priests belonging to the Monastery of Garde in Greenland. This narrative is derived from an Icelandic transcript of the so-called "Hauksbok," compiled about 1300 by the Norsk law-expounder, Hauk Erlandsön. It must be observed, however, that the particulars of the Garde Expedition are not to be found in the still extant parts of the original manuscript of the "Hauksbok," from which various pages have been lost. Notwithstanding the absence of this conclusive proof, northern scholars are inclined to accept the later transcript as a *bonâ fide* version of the original before the loss of its missing parts, and if this assumption can be maintained, we have evidence that the Northmen advanced four days' journey north of 76°. The object of the expedition, we are informed, was to discover what lands and people were to be found north of the Christian Station at Garde, and whether the much dreaded Skröllinger or native Esquimaux occupied those unknown regions in any formidable numbers. The seamen, we are told, saw many islands on which there were traces of the presence of these people, but they were unable to land, owing to the number of bears which, together with numerous seals and whales, frequented the coasts. In reference to the high latitude said to have been reached by these early explorers, and which is inferred from the description of the height of the sun on St. James's Day (July 25), it may be observed that a runic stone was found in 1824 in 72° 55′ N. lat., about twenty miles north-west of Upernivik, the northernmost existing Danish station. The inscription, which records that three men, whose names are given, erected the stone as a landmark, concludes with six runic characters, which have been variously interpreted to indicate the years 1135 and 1235.

FROM his scientific expedition to Anatolia, Syria, Egypt, India, Indo-China, China, and Japan during the years 1880–83, Dr. Emil Riebeck has lately returned to Europe laden with ethnological and archæological treasures of all sorts. This splendid collection, on which the enterprising explorer has expended no less than 30,000*l*., has during the past few months formed a chief attraction to naturalists in Berlin, where it has been on exhibition at the Kunstgewerbe Museum. Here the available space was not sufficient to allow of a thoroughly systematic arrangement of the objects, which however have been roughly disposed in three main geographical groups:—(1) Western Asia and Africa; (2) India and Further India; (3) East Asia (China and Japan). Some idea of the immense variety of articles here brought together may be had from the detailed catalogue of Dr. Riebeck's "Asiatic Collection," recently issued by Messrs. Weidmann of Berlin. From Palestine and Syria we have objects of every description; while the articles from Somaliland, which are very numerous, illustrate almost every phase of the social life of the little known inhabitants of that region. Several specimens are shown of the masks used in Ceylon at the "devil dances" performed during illness. The masks represent divinities of the Hindu mythology, rakshasas or demons, nāgakanyās or snake masks, lions, tigers, crocodiles, negroes, Mussulmans, Malays, &c. India is largely represented. From Burmah, where the Irrawadi was ascended as far as Bhamo, were brought many costly articles, such as royal coronets and dresses, alabaster and gilt wooden statuettes of Buddha, masks of strolling minstrels and players, amber rosaries, richly carved consols, lacquer ware, ornamental drinking vessels, writing materials, &c. A visit to Bangkok yielded models of Siamese floating houses, fishing gear, agricultural and industrial implements, &c. Amongst the most characteristic objects from China are brightly painted clay models of popular types, bronze vases, chased, inlaid in silver, and studded with gems; shallow dishes of "imperial bronze" (yellow picked out in red), silver teapots, artistic articles in jade, rock crystal, and marble, &c. The rich and varied Japanese collection comprises specimens of all the most characteristic productions of the country, especially Satsuma porcelain and other ceramic ware, illustrating the development of Japanese porcelain from the sixteenth to the nineteenth century. During the first part of his journey Dr. Riebeck was accompanied by Dr. Moock, who, after escaping from many perils amongst the Bedouin tribes in the Moabite country, was drowned in crossing the Jordan, and now lies buried in Jericho. During the visit to Egypt he was attended as far as the Nubian frontier by Dr. Schweinfurth, who again accompanied him in March 1881 to the south coast of Arabia and the Island of Socotra. During the rest of his wanderings throughout the Far East Dr. Riebeck had for his associates M. C. B. Rosset, who joined him in Germany, and Dr. Mantei, whom he engaged in Egypt after the untimely death of Dr. Moock.

IN the March part of *Good Words* Mr. Edward Whymper gives some particulars of his journeys in Greenland which have not been heretofore published; and states that he found the height of the interior in the latitude of Umenak (about 70° 30′ N.) considerably exceeded 10,000 feet. Mr. Whymper says that from the various mountains he has ascended on the eastern side of Davis Straits he has had continuous views of the glacier-covered interior of Greenland between about 68° 30′ and 71° 15′ N. lat., and that there is no break or depression within those limits, and that the country is everywhere so absolutely covered by snow and glacier that not a single rock or crag can be seen.

ON THE PHENOMENA EXHIBITED BY DUSTY AIR IN THE NEIGHBOURHOOD OF STRONGLY ILLUMINATED BODIES[1]

IN 1870 Dr. Tyndall described the dark or dust-free plane which rises from a hot body in illuminated dusty air, and gave two explanations of the dust-freeness of this dark space. Another explanation was suggested by Dr. Frankland. In 1881 Lord Rayleigh re-examined the phenomenon, and discovered that a cold body gave a similar down-streaming plane. He also suggested a totally different explanation. The writers discuss all these suggested explanations, and see reasons for rejecting them all. They have, moreover, observed that the dark plane rising from a hot body is only a prolongation of a well-defined dust-free *coat* of nearly uniform thickness under ordinary circumstances surrounding the body, and they point out that this dark coat is the thing really requiring explanation, the dark plane being merely due to the up-carrying of portions of this coat by convection currents.

The preliminary experiments were described in a letter to NATURE last July (vol. xxviii. p. 297).

The dark coat is found to increase in thickness with the temperature of the body, becoming very thick at high temperatures, say 1000° C., but being narrow for temperatures only a few degrees above the air. When the temperature of the body is the same as that of the air surrounding it, the dust-free coat is either non-existent or exceedingly thin. The thickening of the coat by a rise of temperature is interfered with by convection-currents, which sweep the outer portions off more rapidly than they can be renewed, and so make the coat thinner than it otherwise would be. By means of a blast of air the coat can be almost wholly or entirely blown away; but convection-currents are never able to sweep it off, for the same cause which increases the convection-currents also broadens and assists the formation of the coat. The coat can be seen on round rods of all materials, on flat plates, both horizontal and vertical, on hollow and irregularly shaped pieces, and in general on every substance whatever. Nevertheless the behaviour of certain bodies is peculiar, and is detailed in the paper; such bodies, for instance, as a stick of phosphorus, which itself gives off smoke, a volatile solid like camphor, moistened solids like soaked carbon, liquids like sulphuric acid water and ether, and thin films of glass or mica. Other substances examined are: copper, iron, zinc, electric-light carbon, charcoal, glass, mica, selenite, selenium, Iceland spar, tourmaline, potash, rock-salt, bismuth, silver, chalk, and all kinds of paper. In every case the method of examination was as follows:—A glass box was mounted in front of the nozzle of an electric lantern, and the body to be examined was supported in any convenient manner, so as to be about the middle of the box, and to be well illuminated. Smoke was introduced, the lamp turned on, and the effect examined by looking along the length of the body at right angles to the light. Sometimes a microscope was used, but it was not necessary except for measurements. A hand lens is useful. For smoke, tobacco was the most common, but ammonic chloride was used when a distinctly volatile smoke was desired, and magnesic oxide whenever a non-volatile and incombustible smoke was wanted. Any kind of smoke serves equally well. Hydrogen and carbonic acid and other gases have been used as well as air: in hydrogen the coat is much thicker, in carbonic acid a little thinner, than in air. The effect of pressure on the dark coat was examined, and it is found that the coat broadens as the pressure diminishes. An increase in pressure of 4½ atmospheres renders the coat very thin and sharp, and at the same time causes the convection-currents to be sluggish.

The writers considered that it would be very instructive to examine whether a dark coat and plane could be observed when a warm body was immersed in a dusty *liquid;* and they accordingly devoted a good deal of attention to this point. After failures with mastic and other substances, they succeeded in observing a very thin, dark coat on the surface of an iron wire immersed in water

[1] Abstract of a paper by Oliver J. Lodge and J. W. Clark, read at the Physical Society, February 9.

holding rouge in suspension, with a dark plane rising from it. It is not always easy to obtain the dark coat in liquids, however, and its thickness is enormously less than it is in air. Moreover, the results are less definite and satisfactory. In gases the thickness of the coat may be anything below the eighth of an inch, according to the circumstances of the case, but its commonest width is more comparable with the hundredth of an inch. On a carbon rod in an electric beam the coat is about half a millimetre thick, no other heat being applied. Glass shows a perfect coat and dark plane, but for some reason or other very thin films of glass (·0003 inch thick) behave differently, and it is sometimes by no means easy to see any coat at all. It may be that such thin films are unable to absorb enough radiation, or it may be that the cause is more deeply seated. It can hardly be that they give off their heat too rapidly, because the convection-currents set up by them are very sluggish. It is pretty certain that they fail to absorb radiation; for a plate of rock-salt in a perfectly dry atmosphere behaves in the same way. In ordinary air, a lump of rock-salt is able to absorb sufficient radiation to give a satisfactory dark plane. The behaviour of thin films is under further investigation. Covered with lampblack they act perfectly well. Incidentally it has been noticed that films of freshly-blown glass adhere together though cold, giving the black spot; but that when films are a day or two old they refuse to adhere, doubtless because of the condensed air-sheets with which they have coated themselves. The slow formation of these condensed sheets, as studied recently by Bunsen (*Wied. Ann.* February 1884) is of great interest.

The effect of electrifying rods from which a dark plane is streaming is not marked except when the potential is high; 100 volts or so produce a little effect, positive potential broadening the coat, negative potential narrowing it. As soon as a brush discharge occurs, the effects are violent and the air is rapidly cleared of smoke, the particles being deposited on all the surfaces near. Various electrical phenomena can be conveniently examined by means of smoky air and a strong beam of light. Thus a flake of mica, on being examined for its coat one day, showed a curious phenomenon. The dust aggregated on its surface in little bushes or trees, and its edge became fringed with long aggregations of dust particles. Our first thought was that mica was photo-electric, but we now think that it had been perhaps electrified by casual pressure. This also is still under investigation. Tourmaline shows all its pyro-electric properties exceedingly well by being simply illuminated in dusty air. If mica be written on with a blunt point, a sheet of paper intervening, the writing becomes manifest when it is exposed to dust. We find, however, that a brass plate is capable of acting in a similar way, and we are not prepared to be content with a mere electrical explanation. We are probably here dealing with phenomena allied to those known as *Hauchbilder*, which are supposed to be connected with the condensed air-sheet on the surface of solids; though their explanation may also be associated with vapour-condensing nuclei on solid surfaces. The phenomena connected with the settling of dust on surfaces by gravitation have also been investigated, and it is found that so long as a body is warmer than the air it keeps itself free from dust; except that just at the top, where the air is stagnant, the excess of temperature being only small, a large particle or two may drop on. The dust-free coat is not an absolute barrier to dust: it marks the region into which dust is not carried *by convection-currents*; but other causes may drive dust into this region. Thus it may be blown into it either from outside or through a hole in the rod itself if it be hollow; or the rod may give off smoke, or the dust may, as stated, occasionally drop into the dark region by common gravitation. The persistence of the dust-free plane at a distance from the body which produced it is dependent on the motion of the dust particles *with* the air stream-lines; whatever drives dust across stream-lines interferes with and tends to obliterate detached dust-free regions. All dark streaks in smoky air are commonly the wiped-off coats of bodies.

We have been led to a fairly complete explanation of the whole phenomenon, and though it is impossible to attribute every case of dust-freeness to one single well-defined cause, we see reason to believe that the main causes in ordinary operation are two, viz. :—

1. Molecular bombardment.
2. Gravitative settling.

We were long under the impression that the sheets or films of condensed gases which are known to exist on the surface of all bodies were connected with the dark coats, and had some share in their production; and this view was pressed home by an observation of the surface of warm water in dusty air. The evaporation of the water drives back the dust and keeps a clear space of some thickness above the water; and if the water be linearly heated by a platinum wire stretched just beneath its surface and warmed by a current, the dark coat streams upward in a fine and well-defined dust-free plane. The up-streaming of the portion above the wire causes the remainder to become thinner, until there is an evident equilibrium between the rate at which the evaporation reproduces the dark coat and the rate at which the convection current carries it off. That the dust is kept off a solid, say a warm copper wire, by an evaporation and continued renewal of its condensed air-sheet, we think decidedly improbable, but we are convinced that the dust particles are driven away from the solid by some form of molecular bombardment, possibly such as goes on from the vanes of a Crookes' radiometer. There is, however, a very great difference between the two phenomena; the Crookesian layer is supposed to correspond with the mean free path, and this is enormously less than the thickness of a dust-free coat. A possible suggestion is that the dust-free coat represents something more like the extreme free path of the molecules, the dust particles being so easily moved that they are driven away by the blows of even a few molecules. A simpler and more satisfactory mode of putting the matter is this. The temperature of the air near a warm solid decreases gradually as we recede from its surface. Consequently a dust particle in the neighbourhood of the solid has warmer air on one side of it than on the other; in other words, it receives heavier and more numerous blows on one side than on the other, and accordingly is driven away from the warm body. Whenever the temperature of air is steadily different in successive layers, there the dust particles must get driven in the direction of decreasing temperature at a rate depending on the temperature slope. This is not complete, however, because the extra temperature really shows itself as a diminution of density, not as an increase of pressure. The explanation is further elaborated in the paper, which will appear in the *Philosophical Magazine* for April. The conduction of heat across the air near a hot body is itself an interesting problem. So also is the distribution of up-streaming velocities. The maximum velocity of convection occurs at some distance from the body, being often distinctly outside the dust-free coat.

Some few cases of the dust-free coat and plane can hardly be explained in the manner now indicated. We point out, however, that gravitation is an effective cause certainly in operation, which of itself is competent to account for the formation of dust-free spaces when circumstances are favourable. Dust is always settling or falling downward relatively to the air in which it is. The velocity of relative fall depends on the size of the particle, on the density and viscosity of the gas, but not on the motion of the gas. Immediately below a solid body round which gentle currents are rising, there is a small region of nearly stagnant air; out of this dust slowly falls, leaving it free, and if then part of it is dragged round the body by the currents, it contributes to the dark coat and to the ascending dark plane. Underneath horizontal plates, also, this gravitation-settling of the dust assists and broadens the coat. But there is also a coat on the upper surface; and this coat gravitation, so far from producing, does its best to spoil. A few of the larger particles are in fact seen to fall occasionally through it on to the surface of the body, their weight being too great for the bombardment to sustain. In the case of a *cold* body the down-streaming currents deposit a good deal of dust on the upper surface of the body, and so that portion of air which has grazed the surface passes on dust-free. The tendency now is for the warmer air outside the dust to bombard it on to the cold surface. This goes on all over the upper half of the body, but over the lower half a coat is visible when the cold is not too great, but it is only fairly thick at the bottom of the body when it forms the base of the inverted dark plane. A smooth vertical surface of ice gives no dark coat, and the maximum velocity of the particles in the descending current is apparently little, if at all, distant from the actual surface. Finally the writers call attention to a paper just read at the Royal Society of Edinburgh by Mr. John Aitken. They have only seen an abstract of this paper at present, but it appears that Mr. Aitken has been travelling over much of the same ground as they have, and that he has arrived on the whole at fairly the same conclusions. The abstract of Mr. Aitken's interesting paper was printed in NATURE of January 31 (p. 322).

AGATES

THE following letter was addressed by the writer in 1871 to Mr. Joseph John Murphy, and though not originally intended for publication, is now published with the writer's consent :—

St. Andrews, November 4, 1871

DEAR SIR,—I have on my return found your note as to agates. Though I have been at work on the subject in different ways for many years, I have not found myself in a position yet to publish. In fact I cannot yet say that I *know* much as to how they have been formed, though I do know, or rather am able to show, that they have not been made in the manner usually supposed.

The late Principal Forbes conceived that they had been formed by concentric deposition round a central nucleus :—this I showed him to be untenable. Others conceive that siliceous matter in a state of fusion has been poured into cavities through an opening, such opening being called the "point of infiltration." I am able to show that this so-called point of infiltration is an orifice of escape or exit of something.

Fully to state how (from examination of their mode of occurrence, experiments upon the decomposibility of trap rocks under the action of carbonated water, section of agates in every conceivable direction, experiments upon their powers of absorbing liquids, and from microscopic examination) I conceive agates to be formed would call for indeed a long statement.

I will attempt briefly to put it thus :—

Igneous rocks are being poured forth from a volcanic vent, in perfectly fluid or at least plastic flow ; some are dense, some scoriaceous, some frothing, and so when solidified are vesicular, or perchance even hold in suspension bubbles of included water, this latter holding in solution (red-hot solution) solids afterwards to separate as rheolites. Should the air-bubbles of the vesicular rocks arise through the plastic mass while it is motionless, these bubbles will be more or less rounded or pear-shaped. Should the solidifying rock, however, become crystalline or porphyritic, as generally is the case with amygdaloids, the separating crystals of labradorite, &c., will more or less roughen the sides, and so destroy the smooth and rounded figure of the cavity ; while, if the lava-flow continues its motion while the bubbles are still rising, their shape will be more or less flattened or altered :—try bubbles in flowing treacle.

Stage the first.—An empty cavity of any shape.

Stage the second.—The rock, while solidifying, may contain an excess of a magnesian mineral, which is exuded into the cavity ; or this excess of magnesian compound (magnesia not being, to any large extent, a *natural* constituent of the mass of a trap) may be held as vapour in the cavity, to be, on cooling, deposited on its sides. This forms in Scotland, Faroe, Iceland, &c., the layer of celadonite or delessite ; at Giant's Causeway, of chlorophœite, which, on the extraction of the afterwards filled-up cavity, forms the "skin of the pebble."

Stage the third.—One of two processes, the first very doubtful. The cooling and shrinking rock holds in a state of *liquidity, from heat*, an excess of colloidal silica which is exuded into the cavity forming a chalcedonic druse. But, admitting the process, it must here stop, and a *solid* agate could not thus be formed. This seems to have been the view of Sir George Mackenzie.

The other process I pin my faith to. The thoroughly solidified—indeed the now *old*—rock is having its felspar (labradorite or other) decomposed by water holding carbonic acid in solution. I have proved that this process is rapid and continuous, and agate-holding traps are all rotten ; the colloidal silica, with a certain quantity of *tridamyte* is taken up by this water, and transfuses into the cavity ; the silica is there solidified—probably the layer of delessite is the coagulation. We have now a cavity slightly lined with chalcedonic matter, containing, within, water more or less pure, while without (that is outside of the now double skin, delessite and first layer) we have a strong solution of colloidal silica constantly supplied. Endosmose and exosmose are set up with all their resistless force. The *strong* solution finds its way through the two or any number of increasing skins : the *weak* water is forced out through the "point of infiltration," and so in its passage out thins all the successively deposited layers *at that place*. By this continuous flow of colloidal silica (held in solution by liquid) through the already coagulated or deposited layers, continuous coagulation of the silica in the yet hollow agate, and continuous extrusion of the residual water, we have the ultimate filling up of the cavity, and a solid agate formed.

The adhesion of agates to the containing rock is slight in most cases from the so-called "skin" being magnesian and soapy.

The "point of infiltration," instead of being at once filled up, as would result from the inflow of coagulable silica, is in reality the last point filled up, being truly the point of escape : indeed it frequently is not altogether filled up, *remaining an open tube*.

The microscope shows on a cross section the concentric layers of coagulated silica, soluble in alkalies ; the crystals or fibres of *tridamyte* cross these layers at right angles, radiating like a rheolite from the skin, and it is always along the sides of these crystals that intruding and staining liquids find a way ; probably, therefore, along their sides also did the ingress of chalcedonic fluid find entrance. I remain very truly yours,

M. FORSTER HEDDLE

THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[1]

THE Lakes of Britain present us with some of the most interesting problems in our topography. It is obvious that the existence of abundant lakes in the more northern and more rocky parts of the country points to the operation of some cause which, in producing them, acted independently of and even in some measure antagonistically to the present system of superficial erosion. It is likewise evident that as the lakes are everywhere being rapidly filled up by the daily action of wind, vegetation, rain, and streamlets, they must be of geologically recent origin, and that the lake-forming process, whatever it was, must have attained a remarkable maximum of activity at a comparatively recent geological epoch. Hardly any satisfactory trace is to be found of lakes older than the present series ; perhaps Lough Neagh, which from its thick deposits and their fossils, has been referred back to Pliocene times, is the solitary exception. How then have our lakes arisen? Several processes have been concerned in their formation. Some have resulted from the solution of rock-salt or of calcareous rocks and a consequent depression of the surface. The "meres" of Cheshire, and many tarns or pools in limestone districts, are examples of this mode of origin. Others are a consequence of the irregular deposit of superficial accumulations. Thus, landslips have occasionally intercepted the drainage and formed lakes. Storm-beaches, thrown up by the waves along the sea-margin, have now and then ponded back the waters of an inland valley or recess. The various glacial deposits—boulder-clays, sands, gravels, and moraines—have been thrown down so confusedly on the surface that vast numbers of hollows have thereby been left which, on the exposure of the land to rain, at once became lakes. This has undoubtedly been the origin of a large proportion of the lakes in the lowlands of the north of England, Scotland, and Ireland, though they are rapidly being converted by natural causes into bogs and meadow-land. Underground movements may have originated certain of our lakes, or at least may have fixed the direction in which they have otherwise been produced. A very large number of British lakes lie in basins of hard rock, and have been formed by the erosion and removal of the solid materials that once filled their sites. The only agent known to us by which such erosion could be effected is land-ice. It is a significant fact that our rock-basin lakes occur in districts which can be demonstrated to have been intensely glaciated. The Ice Age was a recent geological episode, and this so far confirms the conclusion already enforced, that the cause which produced the lakes must have been in operation recently, and has now ceased. We must bear in mind, however, that it is probably not necessary to suppose that land-ice excavated our deepest lake-basins out of solid rock. A terrestrial surface of crystalline rock, long exposed to the atmosphere, or covered with vegetation and humus, may be so deeply corroded as, for two or three hundred feet downward, to be converted into mere loose detritus, through which the harder undecomposed veins and ribs still run. Such is the case in Brazil, and such may have been also the case in some glaciated regions before the glaciers settled down upon them. This superficial corrosion, as shown by Pumpelly, may have been very unequal, so that when the decomposed material was removed, numerous hollows would be revealed. The ice may thus have had much of its work already done for it, and would be mainly employed in clearing out the

[1] Abstract of fourth lecture given at the Royal Institution, February 26, by Archibald Geikie, F.R.S., Director-General of the Geological Survey of the United Kingdom. Continued from p. 397.

corroded debris, though likewise finally deepening, widening, and smoothing the basins in the solid rock.

The Hills and Hill-groups of Britain have all emerged during the gradual denudation of the country, and owe their prominence to the greater durability of their materials as compared with those of the surrounding lower grounds. They thus represent various stages in the general lowering of the surface. In many cases they consist of local masses of hard rock. Such is the structure of the prominent knobs of Pembrokeshire and of Central Scotland, where masses of eruptive rock, formerly deeply buried under superincumbent formations, have been laid bare by denudation. In connection with such eruptive bosses attention should be given to the "dykes" so plentiful in the north of England and Ireland, and over most of Scotland. In numerous instances, the dykes run along the crests of hills and also cross wide and deep valleys. Had the existing topography existed at the time of their protrusion, the molten basalt would have flowed down the hill-slopes and filled up the valleys. As this never occurs, and as there is good evidence that the dykes are not of higher antiquity than the older Tertiary periods, we may conclude that the present configuration of the country has, on the whole, been developed since older Tertiary time—a deduction in harmony with that already announced from other independent evidence.

Escarpments are the steep edges of hills in retreat. The British Islands abound in admirable examples of all ages from early Palæozoic rocks down to Tertiary deposits, and of every stage, from the almost unbroken line of cliff to scattered groups of islet-like fragments. The retreat of our escarpments can be well studied along the edge of the Jurassic belt from Dorsetshire to the headlands of Yorkshire, likewise in the course of the edge of the Chalk across the island. Not less suggestive are some of the escarpments of more ancient rocks, such as those of the older Palæozoic limestones, the Old Red Sandstone of Wales, the Carboniferous Limestone and Millstone Grit of Yorkshire, and the Coal Measures of the Irish plain. Our volcanic escarpments are likewise full of interest—those of the Lower Old Red Sandstone along both sides of the Tay, of the Carboniferous system in Stirlingshire, Ayrshire, Bute, and Roxburghshire, and of the Tertiary series in Antrim and the Inner Hebrides.

SUN-GLOWS AND VOLCANIC ERUPTIONS IN ICELAND

IN reply to the inquiry despatched to me by NATURE with last mail, whether any remarkable sun-glow had been observed recently in Iceland, and which, I learn, has been observed in nearly all parts of the world, and whether any volcanic eruption had lately taken place in the island to which the same might be attributable, I beg to relate, as regards the first of these points, that on November 23, between 5 and 6 p.m., I noticed for the first time an unusual and striking purple intensity of the sky, a phenomenon which was also observed on the subsequent mornings and nights. I did not attach much importance to this phenomenon at the time, through the circumstance that I was told that sunrises and sunsets were generally attended by very intense auroræ here, and since then I have had so few opportunities of seeing the sky free from clouds that I have not observed any similar phenomenon. I learn, however, on inquiry here, that the same glow was observed once or twice before Christmas by several persons. On one occasion, January 30, the sky was perfectly clear several hours after sunset, but there was no unusual glow.

With regard to the second point, as to recent volcanic eruptions in the island, I have not much new information to transmit (NATURE, vol. xxix. p. 343). The only thing we know as to this is that a man has written a letter to an Iceland paper stating that on October 8 and 9 last year he was at a farm about three geographical miles east-north-east inland from the well-known fishing village Seydisfjord, on the east coast, when he saw, on the first-mentioned day, in the direction of the unexplored gigantic volcanic mountain, the Vatnajökull, about 130 geographical miles in extent, in the south-eastern corner of the island, two columns of fire, and on the following morning, in the same direction, two columns of smoke. He adds that a similar phenomenon was observed on the farm two days previously. It is also reported to us here that ashes have fallen in Seydisfjord.

It is most probable that these eruptions have occurred in the same place where similar phenomena have been observed several times in recent years, viz. in the neighbourhood of the Kverk Mountains on the north side of the Vatnajökull, and that there are, in all probability, several volcanoes in activity in this district, which is utterly unapproachable to explorers.

There is, however, no reason to assume that eruptions of any magnitude have recently taken place in any other part of the island, as such an occurrence would soon have been reported by some means or another to us here.

If, therefore, the remarkable sun-glows of which I read are attributed to terrific volcanic eruptions, the latter must be sought in other localities than Iceland.

SOPHUS TROMHOLT

Reykjavik, Iceland, February 1 (by mail February 8)

COMPOSITE PORTRAITURE ADAPTED TO THE REDUCTION OF METEOROLOGICAL AND OTHER SIMILAR OBSERVATIONS [1]

IT has often been remarked that one of the main, if not the chief, of the difficulties the meteorologist has to contend with, is the enormous amount of preliminary labour which has to be expended in the not very pleasing task of forming the observations he may wish to discuss into tables, casting the columns of figures so obtained, and then computing the means. Should, as in many cases nowadays, his original material be in the shape of curves, *e.g.* barograms, thermograms, or anemograms, he has first to reduce these to figures by tabulation, before he can attempt any step towards their reduction.

The deterrent nature of these preliminary operations not unfrequently forms a complete bar to the entering upon most interesting investigations with a view to the advancement of the science, in the case of persons unable to devote sufficient time to such labour, which may almost be termed drudgery. To cite examples, a glance at the recently published papers in the *Proceedings of the Royal Society*, by Prof. Balfour Stewart (vol. xxv. p. 577) and by Mr. C. Chambers (vol. xxxiv. p. 231), in which they endeavour to trace a possible intimate connection between solar and terrestrial phenomena, will show the immense amount of calculation they had to perform in order to arrive at their results—how, for instance, preliminary means had to be taken of three days' observations and the result assumed to be a corrected value for the middle day of the three, then, after the whole series had been so treated, a second or even a third set of averages computed. The author has also a lively recollection of the excessively tedious calculations required to eliminate in a somewhat similar manner the effect of disturbances in the discussion of the Kew magnetic observations for the late Sir E. Sabine. With the view of arriving at results by a shorter cut, the author has been led to consider the possibility of employing a method suggested by an examination of the highly ingenious system of composite portraiture invented by Mr. Francis Galton, F.R.S., and utilised in his anthropological studies.

Mr. Galton's method of experiment is based upon the fact that certain groups of people possess certain physiognomical features in common. This agreement of feature is usually characterised by the term "family likeness." In order, therefore, to select this particular element from the others, and to obtain a picture in which it is most strongly defined; or, in other words, to form a characteristic portrait of the group of individuals, Mr. Galton employs a series of photographs. These, representing a large number of men or women, are first reduced to the same scale, and then projected successively upon a sensitised photographic plate, having been previously so arranged that the eyes or other salient feature shall always fall on the same portion of the plate.

In this manner a negative is eventually obtained which gives a print depicting a countenance which, although resembling but partially any one of the component portraits, gives a fair typical picture of the group of individuals. Among other results Mr. Galton has detected the likeness existing in various classes of criminals, and also in patients suffering from the same disease, as well as the more marked features transmitted through the different members of a family.

Since in meteorological investigations the desire is to select and to identify the one particular variable running through a group of phenomena, it has appeared to the author, arguing by analogy, feasible to perform this operation by a method somewhat resembling that just described. Supposing, for example,

[1] By G. M. Whipple, B.Sc., F.R.Met.Soc., F.R.A.S., Superintendent of the Kew Observatory, Richmond (from the *Quarterly Journal of the Meteorological Society*, vol. ix. No. 48).

it is desired to determine the true curve of diurnal variation of the wind velocity at any given station. In the case of proceeding by the ordinary routine of hourly sums and means, it will be found that the occurrence of a high wind or gale on a single day will vitiate the results for a considerable period of time.

If, on the other hand, instead of doing this, a drawing or photograph be made on one sheet of the daily curves for a few weeks, it will be found that the traces for the days free from storms will lie so fairly close together or upon one another, that little difficulty will be found in selecting or drawing through them a curve representing the general run of the group. Several sets of curves having been so treated, the typical curves must be in turn themselves superimposed, and through them another curve drawn, which will be still less affected by abnormal movements; so eventually the true curve of diurnal variation would be arrived at.

In the case of subjecting photographic traces, *e.g.* barograms, thermograms, electrograms, magnetograms, &c., to this treatment, it would be advisable to employ secondary impressions or prints from the original curves, in order that the composite produced might consist of dark lines on a white background; not the reverse, which would be comparatively useless for the purpose.

For the reduction of anemograms, rain, and sunshine curves by this method, it will be necessary to make drawings or tracings first from the curves, giving the hourly values separated, as is done in the diagrams published in the *Quarterly Weather Reports* of the Meteorological Office and in the Kew *Times* curves.

Another application of the method of composite drawing will serve to facilitate the acquisition of a knowledge of the general distribution of weather systems over large tracts of the earth's surface. To do this, a series of weather charts should be taken, and selecting certain prominent features, such as the centres of cyclonic and anticyclonic disturbances, day by day their positions should be marked off upon one chart. This being done in a sufficient number of cases and combined, a repetition of the process would enable a determination to be made of the average distribution of these systems for a given season.

The author illustrated his proposed applications of the method of composite portraiture by three examples, which were exhibited to the meeting of the Society. The data treated in every case were chosen at random, and therefore may be considered as indicating the applicability of the process to meteorological work in general.

In the first example the mean diurnal variation in the wind velocity at the Kew Observatory, Richmond, was determined for three months—August to October, 1879. Taking the hourly values of the rate at which the wind was blowing from the Meteorological Office publications, they were plotted down on a conveniently open scale, a fortnight's superimposed curves being on a sheet. Through the fourteen curves so drawn in pencil a mean curve was traced in red. This roughly represented the average daily variation during the fortnight.

The pair of fourteen-day curves being superimposed on a third sheet, a third trace drawn between them was assumed to be the mean trace for the month, and finally combining the three so derived months' traces, it became easy to draw the final curve showing the mean diurnal variation of wind velocity during the quarter in question.[1]

The second experiment was an attempt to obtain a monthly mean of the barometer directly by the graphic method. Taking advantage of a self-registering aneroid being on trial, its traces were utilised for the month January 8 to February 7, 1883. These were copied off on a sheet of tracing paper, ruled so as to comprise one day's curve only. The tracing paper was then folded vertically, so as to compress the curves, and the mean positions of the traces were drawn on the folds. After four foldings a point was readily fixed upon as the position of the mean of the month, and the value of this point referred to the scale of the instrument. The resulting value for the mean barometric pressure of the month very satisfactorily agreed with the value determined by calculation from the barometer readings taken daily at the Observatory.

The third series of illustrations represented the general positions of the centres and the contours of the areas of maximum and minimum barometric pressure over the Atlantic during January, February, and March, 1881. A number of blank charts were worked off by the chromograph, on tracing paper, to the scale of the international synchronous charts of the U.S. War Department Signal Service. Tracings were made on one sheet in blue pencil of the cyclonic centre for each day of the month, and then on another a similar set of tracings in red of the anticyclonic centres. Having from these drawn the prevailing positions and areas of the systems for the month, it was easy to draw another chart with the general distribution for the quarter. The diagrams were seen, on comparison, to differ materially from those drawn for the monthly means of the observations. In suggesting the composite method of treatment of meteorological data, the author is fully aware that a somewhat similar process has been already applied in the determination of the radiant points of shooting stars, and would also desire to state that the process is not by him considered as equalling or even approximating in accuracy that of employing the harmonic analyser in computing the periodical variations of the elements. As, however, that instrument is not at the command of many investigators, he is of opinion that the labour of reduction may in many cases be saved by making use of the graphic or composite, instead of the purely numerical, method.

[1] It must be remarked that a due proportion should be preserved between the scales of the ordinates and abscissæ, for unless this is done the combined traces may appear merely as a mass of confused lines. Such was the case in some experiments made by the author, when he attempted to derive mean curves directly from the zinc templates engraved at the Meteorological Office for the Quarterly Weather Reports, kindly placed at his disposal by Mr. Scott.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Dr. Hans Gadow, Strickland Curator, has been approved as a Teacher of Comparative Anatomy; Mr. L. Humphry, M.B., as a Teacher of Pathology; and Mr. F. H. Neville as a Teacher of Practical Chemistry.

Messrs. J. W. Hicks, R. D. Roberts, and A. S. Lea are appointed Examiners in Natural Science in the Special Examinations for the ordinary B.A. degree.

The Examiners' Report on the Special Examinations in Natural Science states that there was no improvement in the book work, but the practical work was more intelligently done. The few candidates in Geology did well. Botany was ill done. In Zoology the candidates did well.

Mr. J. A. Lyon (Clare College) has been appointed to the new office of Superintendent of the Mechanical Workshops.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale de Belgique, November 3, 1883. On the anatomy and histology of a new species of derostoma (*D. benedenii*), by M. Francotte.—Report on the work still required to complete the geodesic survey of Belgium, by Capt. Delporte.—Observations on the periodic shooting stars made at Louvain in 1882-83, by M. Terby.—Influence of magnetic disturbances on the scintillation of the stars, by M. Charles Montigny. The paper is accompanied by various comparative tables showing the intensity of scintillation before, during, and after the magnetic disturbances in dry and wet weather.—Summary report on the researches undertaken at the Ostend biological station during the summer of 1883, by Edouard van Beneden. Amongst the remarkable objects fished up near this station were a torpedo of unusual size (*Torpedo marmorata*), a fine specimen of *Labrus maculatus*, an *Amphioxus lanceolatus*, and an unknown species of Scopelidæ, referred by Günther of the British Museum to the Odontostomus, or some allied genus.—On the observation of very rapid movements, especially when occurring periodically, by M. J. Plateau.—Analytical study of the volcanic ashes which fell at Batavia during the eruption of Krakatoa on August 27, 1883, by M. Renard. The author concludes that these ashes are formed by the pulverisation of a fluid igneous mass, whose particles, projected by the expansion of the gases, are subjected to rapid cooling during their passage through the atmosphere. Nothing was detected to indicate the direct action of vapour of water in volcanic disturbances.—On the perfect elasticity of solid bodies chemically defined. New analogy between solids, fluids, and gases, by W. Spring. Here are embodied some of the results of the researches conducted by the author for several years on the action of pressure on solids reduced to a powder. The main object of these researches was to ascertain by experiment whether it be possible by means of pressure permanently to diminish the volume occupied by a given weight of a solid body chemically defined. As a general result, a slight increase of density was obtained under a pressure of 20,000 atmospheres. But, this once realised, most bodies resisted all further permanent diminution of volume. Some even retained their specific weight intact under extreme pressure.—Observations on M. van Beneden's last note respecting the discovery of fossil iguanodons at Bernissart, by E. Dupont. This communication closes the controversy.—Note on the literature of international law before the publication of Grotius's "Jus belli et pacis" (1625), part ii., by Alph. Rivier.—A literary study on the position of words in the Latin sentence, by J. Gantrelle.

Journal of the Russian Chemical and Physical Society, vol. xv. fasc. 8.—On dipropylacrylic acid, by A. Albitsky.—On the action of iodide of allyl and zinc on epichlorhydrine, by M. Lopatkin.—On an accessory product obtained during the preparation of diallyl carbinol, by W. Shestakoff.—On the action of iodide of allyl and of isobutyl on acetone, by A. Shatsky.—On the hydrocarbon C_8H_{14}, by S. Reformatsky.—On the refracting power of $C_{12}H_{20}$, by A. Albitzky.—Attempt of a theory of dissolutions, by W. Alexeyeff.—On $C_{21}H_{20}$ and the products of its oxidation, by W. Hemilian.—Analysis of a phosphorite from Nijni-Novgorod, by N. Lubavin.—On some phenomena of remanant magnetism, by P. Bakhmetieff.—On the changes in the galvanic resistance of selenium under the influence of light, by N. Hesehus. It depends chiefly upon allotropic dissociation of the molecules.—On the characters of the intramolecular force, by M. Bardsky, being a mathematical discussion of its dependence upon temperature.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, vol. xxviii. No. 4.—Demonstration of several propositions relative to the numerical function $E(x)$, second paper, by V. Bouniakovsky.—Contributions towards palæontology, by M. Schmalhausen (with two plates); being a description of fossil plants of the Jura coal-basin of Kuznetsk, in the Altay (*Thyrsopteris prisca* and *Rhiptozamites gœpperti*), from North-West Mongolia, at the sources of the Yenisei, on the high plateau of the Ulu-khem (*Bornia radiata, Neuropteris cardiopteroides, Lepidodendron veltheimianum, Rhiptozamites gœpperti, Czekanowskia rigida*, and *Phœnicopsis angustifolia*), and from the Djun-khairkhan Mountains (*Asplenium argutulum* and *spectabile*, and *Czekanowskia rigida*).—On the sympathetic nervous system of the *Petromyzon*, by Ph. Owsiannikow.—On the camphor of the *Ledum palustre*, by M. Rizza.—Analyses of samples of water from thermal sources of Southern Altay (Byelukha-Rakhmanovka), and from a number of lakes and wells in the same region, by Prof. Carl Schmidt. Compared with thirty other thermal waters of Europe, Asia, New Zealand, &c. (the composition of which is given in a table), the Altay water shows a minimum of mineral substance.—Letter on natural history phenomena observed at the Lena Polar station, by Dr. Bunge.

Rendiconti of the Sessions of the Accademia delle Scienze di Bologna, March 14, 1883.—On a remarkable anatomical peculiarity observed in the eye of the swordfish (*Xiphias gladius*, L.) (one illustration), by Prof. G. V. Ciaccio.—Some observations on the *Mucor racemosus*, Fresenius, by Dr. F. Morini.

April 8.—A century of premature artificial births at the Lying-in Hospital of Bologna, by Dr. C. Belluzzi.—Chemical analysis of the meteorite which fell at Alfianello on February 16, 1883.—Researches on the *Phellandrium aquaticum*, by Dr. Leone Pesci.—Thermal and galvanometrical researches on the internal discharges of condensers, by Prof. E. Villari.—New studies on the polygenesis of crystallised minerals, by Prof. L. Bombicci.—Researches on the action of the magnet and of the thermal agents in hysterical hypnosis.—Observation on the series of functions, by Prof. C. Arzelà.—On the infinite products by analytical functions, by Prof. S. Piucherle.

SOCIETIES AND ACADEMIES

London

Royal Society, January 17.—"On the Electrolysis of Dilute Sulphuric Acid and other Hydrated Salts." By J. H. Gladstone and Alfred Tribe.

On March 1 last a communication was presented to the Royal Society by Prof. Frankland in which, among other things, the reactions the authors had described as taking place in the charging and discharging of secondary batteries were confirmed. Prof. Frankland expressed these reactions, however, by formulæ founded on the electrolysis, not of H_2SO_4, but of hexabasic sulphuric acid, H_6SO_6, in accordance with the views of Bourgoin.

The French chemist employed a divided cell, analysing the liquid in each compartment at the close of the experiment. He calls the increase of the acid in the positive compartment *a*, and concludes that 2*a* represents the amount of sulphuric acid electrolysed. This conclusion rests on the well-known theoretical views of Grotthuss, and, did his theory express all that goes on in the electrolytic processs, the method would readily discriminate between the actions represented by the following formulæ:—

	Before electrolysis		After electrolysis: Positive pole	Negative pole
(1.)	SO_3H_2O	=	$SO_3 + O$	H_2
(2.)	SO_33H_2O	=	$SO_3 + O_3$	H_6
(3.)	SO_3nH_2O	=	$SO_3 + O_n$	H_{2n}

But it was pointed out by Reuss, as far back as 1807, that, when electrolytic action occurs across a permeable diaphragm, a portion of the liquid may travel from the positive to the negative compartment of the compound cell by what is now called electrical endosmose. Daniell and Miller in 1844 pointed out that in electrolytic action there was also an unequal transference of the ions. Moreover, Daniell investigated the electrolysis of sulphuric acid of very different strengths by a similar method, and concluded that, for each equivalent of hydrogen liberated, the acid which passed across the diaphragm was not more than one-fourth nor less than one-fifth of an equivalent. Most of his experiments incline to the former. Did 2*a*, therefore, represent the amount of sulphuric acid electrolysed, it would appear from his results that *tetra*-, rather than *hexa*-, basic sulphuric acid was decomposed by the current. These discrepancies, both of observation and deduction, led the authors to make some experiments on the subject.

The apparatus employed consisted of a U-shaped tube of about 70 c.c. capacity, having a stop-cock in the centre of the horizontal part. The vertical parts of the apparatus were divided into millimetres, and the hole in the stop-cock packed with asbestos. The authors found that the closeness of the packing could be so nicely adjusted as to allow very little mechanical admixture of the fluids or electrical endosmose. In their experiments the current density was varied, and, unlike Bourgoin, they found that the increase of sulphuric acid in the positive compartment per equivalent of hydrogen set free decreased along with the decrease in the current density. The results are set out in the annexed table.

Current in milli-amperes	Time in hours	Increase of sulphuric acid in positive compartment for one part of hydrogen set free
32·8	20	9·17
33·4	6	9·5
72·3	2·5	10·3
72·7	2	9·4
106	2	11·0
117	2·5	10·5
215	1·5	12·05
220	1	12·04
229	2	12·31

It is necessary also to bear in mind the remarkable phenomenon called by the Germans "Wanderung der Ionen." Daniell long ago described an experiment in which he placed dilute sulphuric acid in the positive compartment and a solution of sulphate of copper in the negative. He found that when 15·5 grs. of copper had been deposited on the negative electrode there were 23 grs. of sulphuric acid in the same compartment. Now, as 15·5 grs. of copper are equivalent to 24 grs. of sulphuric acid, and as Bourgoin's formula allows for the formation of only half an equivalent of sulphuric acid, that is, 12 grs., it is evident that there was a considerable accumulation of that substance unaccounted for. In two similar experiments the authors obtained for 0·147 and 0·125 grm. of deposited copper 0·209 and 0·180 grm. of free sulphuric acid. The half equivalents would be 0·114 and 0·097 grm. respectively. If both compartments had been filled with sulphuric acid, some similar transference would doubtless have taken place, in addition to what is expressed in Grotthuss' chain of decomposition.

The authors conclude, therefore, that the method employed is incapable of determining whether it is H_2SO_4 or some hydrate which yields to the current.

Copper Sulphate

An examination of the chemical changes which accompany the electrolysis of a solution of copper sulphate appeared, however, capable of throwing additional light on the value of this electrolytic method. It is well known that water forms with $CuSO_4$ a definite hydrate, $CuSO_4 5H_2O$. Now, if in the electrolytic process the water of hydration suffers decomposition along with the $CuSO_4$, the primary chemical changes might be expected to be—

$$\text{(A.)}\quad CuSO_4 5H_2O = \overbrace{SO_3 + O_6}^{\text{Positive pole}} \quad \overbrace{Cu + 5H_2}^{\text{Negative pole}}.$$

But, if the water of hydration takes no more part in the electrolysis than the water of solution does, then the chemical changes would manifestly be—

$$\text{(B.)}\quad CuSO_4 = \overbrace{SO_3 + O}^{\text{Positive pole}} \quad \overbrace{Cu.}^{\text{Negative pole}}$$

Of course the collateral action—

$$H_2O = \overbrace{O}^{\text{Positive pole}} \quad \overbrace{H_2}^{\text{Negative pole}}$$

might also take place, but this would occur only with currents of considerable density. The method is obviously capable of discriminating between these two actions, even supposing a considerable quantity of the electrolyte travelled unchanged from one compartment of the apparatus to the other. For, in the first case, either free hydrogen would be liberated at the negative pole, or free acid formed in the negative compartment, equal to five-sixths of the total copper deposited; the free acid, and the five-sixths of the total copper, to which it is equivalent, being produced by the chemical action $5H_2 + 5CuSO_4 = Cu_5 + 5H_2SO_4$; equation A becoming—

$$CuSO_4, 5H_2O + 5CuSO_4 = \overbrace{SO_3 + O_6}^{\text{Positive pole}} \quad \overbrace{Cu_6 + 5H_2SO_4}^{\text{Negative pole}}.$$

On the other hand, if the action was in accordance with B there would be only a deposition of copper on the negative electrode, and no formation of free acid in the negative compartment. In the annexed table the results and particulars of the authors' experiments are set out:—

Experiment	Time in Hours	Free sulphuric acid: Pos. Compart.	Free sulphuric acid: Neg. Compart.
I.	1¼	·0766	nil.
II.	2	·0936	nil.
III.	3	·1868	·0191
IV.	3	·1501	·0204
V.	3	·2442	·0237
VI.	3	·2546	·0372

In none of these experiments was there any trace of hydrogen visibly escaping from the negative electrode, while, as will be seen from the table, there was no free acid formed in the negative compartment till two hours or more had elapsed. By that time some admixture in the horizontal part of the apparatus might reasonably be expected, but even in the greatest instance it is small as compared with the amount of salt decomposed.

Similar experiments were made with the sulphate of zinc, with similar results, no hydrogen being evolved, and little or no sulphuric acid appearing in the negative compartment.

We conclude, therefore, that it is not possible to determine the composition, or even to show the presence of a hydrated salt in aqueous solution by means of this electrolytic method.

Zoological Society, February 5.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. F. Day, F.Z.S., exhibited and made remarks on a specimen of a Dog-fish, of which the entire interior had been eaten out by Isopod Crustaceans of the genus Conilera.—Mr. G. F. Butt, F.Z.S., exhibited two specimens of a singular variety of the Red Grouse, shot in Westmoreland.—A communication was read from Mr. W. Leche, of the University of Stockholm, in which he gave an account of a collection of bats from Australia. Two new species were described and named respectively *Nyctinomus petersi* and *N. albidus*.—Mr. Sclater read some notes on the Lesser Koodoo (*Strepsiceros imberbis* of Blyth), with a view of confirming the distinctness of this Antelope from its larger relative, *Strepsiceros kudu*.—A communication was read from Mr. R. Bowdler Sharpe, containing the description of a new species of Bush-Shrike of the genus Laniarius, based on a specimen obtained in Ashantee by Mr. Godfrey Lagden, which he proposed to call *L. lagdeni*, after its discoverer.—Prof. Flower made some remarks on the chief points of interest exhibited by the Burmese Elephant now in the Society's Gardens.

Geological Society, February 6.—J. W. Hulke, F.R.S., president, in the chair.—Edward John Dunn was elected a Fellow, and Dr. Joseph Szabó, of Buda-Pest, a Foreign Member of the Society.—A delta in miniature—twenty-seven years' work, by T. Mellard Reade, F.G.S. The author described a delta deposit, which, during a period of twenty-seven years, had formed in the Rake reservoir (Rivington Waterworks) from materials brought down by a stream of that name. The reservoir at this part was divided by a road, water communication being maintained by a culvert, once eight feet high, now almost silted up. The author described the stratification of these deltas: that near the influx of the Rake consisted of peaty matter, gritty sand, gravel, shingle, and boulders of Millstone-grit up to about one foot diameter; the other chiefly of fine sand with some peaty matter. The former covered an area of 2508 yards, with an average thickness of 2 yards; the latter, an area of 430 yards, with an average thickness of 3 yards. These materials had come from the drainage-area of the Rake. This is estimated as 1·176 square mile, and the delta being estimated at 6306 cubic yards, and the time being 27 years, gives, as the annual rate of denudation over the whole area, 1/432 inch per annum, or 1 foot in 5184 years. The mean rainfall of the Rake Brook watershed for the last ten years was 49·57 inches per annum. In this calculation no account is taken of the finer materials which have doubtless been distributed over the rest of the bed of the reservoir. The author pointed out that this rate of denudation was rather more rapid than that of the Mississippi (1 foot in 6000 years), and that the arrangement of the materials under the varying condition of the stream illustrated the phenomena of larger deltas.—On the nature and relations of the Jurassic deposits which underlie London, by Prof. John W. Judd, F.R.S., Sec. G.S., with an introductory note on a deep boring at Richmond, Surrey, by Collett Homersham, A.M.Inst.C.E., F.G.S. An account of this appeared in NATURE, vol. xxix. p. 329.

SYDNEY

Linnean Society of New South Wales, December 27, 1883.—C. S. Wilkinson, F.G.S., F.L.S., president, in the chair.—The following papers were read:—On the localities of some plants from the southern parts of New South Wales, by Baron von Müller, K.C.M.G., F.R.S., &c.—Descriptions of Australian Microlepidoptera, No. 10, by E. Meyrick, B.A. This is a continuation of the Œcophoridæ of Australia, and deals with the genera *Philobota*, *Leistomorpha*, *Compsotropha*, and *Eriodyta*. About seventy new species are described.—Notes on the geology of the southern portion of the Clarence River basin, by Prof. Stephens. This was an account of the sugar lands of the Clarence, explaining the mode of their formation, and their relation to the Coal-measures which underlie them unconformably. The period of deposition of these latter rocks was also considered, and their immediate superposition upon the vertical Siluro-Devonian slates and quartzites described. The existence of a great north and south fault at the present outcrop of these rocks was demonstrated, and the probable existence of others near the present coast-line supported by various considerations..

PARIS

Academy of Sciences, February 11.—M. Rolland in the chair.—Note on Faraday's law (continued), by M. Ad. Wurtz.—Remarks on the slight horizontal and vertical vibrations of the ground observed at Abbadia, near Hendaye, for several years past, by M. d'Abbadie.—Note on the meteorite which fell at Grossliebenthal, near Odessa, on November 7/19, 1881, by M. Daubrée. In its outward appearance and microscopic structure it presents all the characters of the typical meteorite which fell at Lucé, Sarthe, on September 13, 1768, and which is already represented in the collection of the Natural History Museum, Paris, by fifty-four other identical specimens.—Description of an absolute calculating actinometer invented by M. G. A. Hirn. This delicate instrument is based on the principle of steam condensers, that a saturated vapour contained in a closed vessel acquires a tension corresponding with the minimum temperature of the walls of the receptacle. So far it acts with perfect satisfaction, and the inventor will report the numerical results as soon as he feels that they are absolutely trustworthy.—Report on the thunderstorms observed in France during the first six months of the year 1883, with complete and detailed tables of all the accidents caused by lightning in every part of the country during that period, communicated by the Minister of the Postal and Telegraph Department. The fatalities amounted altogether to nine persons and seventy-eight animals killed, and about fifty persons and seven animals injured, by lightning.—Report on the solar spots and faculæ observed at Rome during the year 1883, by M. P. Tacchini. The paper is accompanied by a table of dates, relative size, frequency, and number of the spots.—Observations on the Pons-Brooks comet at the Observatory of Nice, one illustration, by M. Perrotin.—Note on the appearance of the same comet on January 13 and 19, 1884, by M. Perrotin.—On the sudden modifications of form (wings, egrets, &c.), presented by the same comet during its passage through perihelion, by M. G. Rayet.—On the barometric disturbances caused by the Krakatoa eruption, as recorded by the Rédier barometer of the Observatory of Toulouse, by M. Baillaud.—On linear substitutions (mathematical analysis), by M. H. Poincaré.—Generalisation of Jacobi's theorem on the Hamilton equations, by M. J. Farkas.—On curves of the fourth order, by M. C. Le Paige.—On the propagation of light in a crystallised medium, by Madame Sophie Kowalevski.—On the distribution of potential in a liquid mass having the form of an indefinite rectangular prism, by MM. Appell and Chervet.—On Joule's electric law, by M. P. Garbe.—On the electric conductibility of greatly diluted saline solutions, by M. E. Bouty.—Note on several unsuccessful attempts recently made to liquefy hydrogen, by M. K. Olszewski. These experiments are reported in consequence of M. Wroblewski's statement that he has succeeded in liquefying hydrogen by expansion at a temperature of −186° C. by means of boiling hydrogen.—On a gas-burner yielding a white light by the incandescence of magnesia, by M. Ch. Clamond.—On the law of the thermic constants of substitution (thermo-chemistry), by M. D. Tommasi.—On the formation of the iodide of methyl and of the iodide of methylene by means of iodoform, by M. P. Cazeneuve.—Note on the monobromic methylchloroform $CCl_3 - CH_2Br$, by M. L. Henry.—On the albuminoid substances contained in milk, especially caseine, by M. E. Duclaux.—Fresh observations on the morphology, anatomy, and development of the parasites of the onion and other bulbous plants (*Tylenchus hyacinthi*, *Tylenchus putrefaciens*, &c.), by M. Joannès Chatin.—Remarks on the preparation of farmyard manure, by M. P. P. Dehérain.—On the presence of pegmatite in the diamantiferous sands of South Africa; observations in connection with M. Chaper's recent communication on the subject, by M. Stan. Meunier.—On some freshwater formations during the old and recent Quaternary periods, by M. Ph. Thomas.—On the arched waterspouts of the Indian Ocean (two illustrations), by M. Le Goarant de Tromelin.—Note on the particles of dust found in the snow that fell at Stockholm last December, by M. E. Yung.—Actinometric observations made at Montpellier during the year 1883, by M. A. Crova.

February 18.—M. Rolland in the chair.—Observations of the small planets made with the large meridian at the Observatory of Paris during the third and fourth quarters of the year 1883, communicated by M. Mouchez.—On the reciprocal displacements between fluorhydric and the other acids, by MM. Berthelot and Guntz.—On the law of modules or thermic constants of substitution, by M. Berthelot.—Remarks on a note by M. J. Luvini in connection with the controversies carried on in the eighteenth century on the subject of waterspouts and whirlwinds, by M. Faye.—Determination of the difference of longitude between Paris and the Observatory of Bordeaux, by MM. G. Rayet and Salats. The longitude of the meridian of the Bordeaux Observatory, as here rectified, is fixed at 11m. 26·444s. ± 0·008s.—Remarks in connection with the recent researches made on the propagation of the atmospheric currents caused by the eruptions of Krakatoa, by M. Foerster. The author disclaims priority for the observations made by him on this phenomenon, a priority which he awards to General Strachey, whose paper on the subject appeared in a recent number of NATURE (p. 181).—On the divisors of certain polynomes, and on the existence of certain primary numbers, by M. A. Genocchi.—On the composition of such polynomes as admit only of primary divisors of a determined form, by M. Lefébure.—On certain linear substitutions (mathematical analysis), by M. E. Picard.—On an equation of the *m* degree, which has never more than two real roots, by M. D. André.—On a differential equation of the third order, by M. E. Goursat.—On M. Levy's elastic curve, expressing the equilibrium of an elastic circular rod subjected to normal and uniform pressure throughout its whole length, by M. Halphen.—On the adiabatic expansion of the vapour of water, by M. Paul Charpentier.—Researches on the fluorhydrate of fluoride of potassium, and on its states of equilibrium in various solutions, by M. Guntz.—On the nitrous derivatives of hydride of ethylene, by M. A. Villiers.—On the probable number of homologous and isomerous rosanilines, by MM. A. Rosenstiehl and M. Gerber.—On a new compound arising from the preparation of the hexachloride of benzine, having the same centesimal composition as that substance, by M. J. Meunier.—On the constitution of milk, by M. E. Duclaux. The author reduces milk by a new method of analysis to the following elements:—

	In suspension	In solution
Fatty substance	3·32	—
Sugar of milk	—	4·98
Caseine	3·31	c·84
Phosphate of lime	0·22	0·14
Soluble salts	—	0·39
	6·75	6·35

—On the pigmentary function in the Hirudineæ (common leech, Nephelis, *Aulostoma vorax*, &c.), by M. Rémy Saint-Loup.—On the physiological development of the adult Comatule, by M. Edm. Perrier.—On a placentoid organ in the embryo of birds, by M. Mathias Duval.—Origin and mode of formation of the Belgian Devonian and Carboniferous limestones, by M. E. Dupont. The author explains the formation of the older marine rocks of organic origin by causes still in operation, and from this deduces a fresh proof of the value of the comparative method applied to the study of the past geological history of the globe.—On the variability of the composition and concentration of mineral waters, by M. A. Inostranzeff.

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THURSDAY, MARCH 6, 1884

RECENT TEXT-BOOKS ON TECHNOLOGY

1. *Steel and Iron.* By William Henry Greenwood. (London: Cassell and Co., 1884.)
2. *Bleaching, Dyeing, and Calico Printing.* Edited by John Gardner. (London: Churchills, 1884.)
3. *The Art of Soap-Making.* By Alex. Watt. (London: Crosby Lockwood and Co., 1884.)

ALTHOUGH the comprehensive system of technological examinations established under the direction of the City and Guilds of London Institute has been at work only a comparatively short time, it has already called into existence a considerable number of manuals and text-books designed to meet the special requirements of teachers and students in connection with those examinations. No doubt excellent works in certain branches of technology already exist, but many of these are scarcely suited to the purpose of the teacher, and most of them are in price beyond the means of the class which the Institute seeks to benefit. The action of many of our leading publishing houses in thus vying with each other in the production of series of low-priced handbooks of technology to meet a demand primarily created by the policy of the Institute is calculated not only to serve the interests of those preparing for examinations but also to react beneficently upon the general intelligence of our workmen. Numbers of these smaller works find their way into the hands of the better class of our mechanics, foremen, and apprentices, to whom the larger and more elaborate works, even when present in our free libraries, are as sealed books. On the whole, it may be said that the handbooks which have already appeared have been prepared with a rational appreciation of the needs of intelligent practical men. The majority of them are written or compiled by specialists, or by men who are well acquainted with the industries to which their works relate, and their descriptions and statements are made with the authority and discrimination which result from a practical knowledge of the manufactures of which they treat. The first and third of the works before us are excellent illustrations of this fact. In Mr. Greenwood's manual we have not only a comprehensive account of the present condition of our iron and steel manufacture, full of sound, practical information, but a very clear and accurate exposition of the scientific principles upon which the manufacture depends. The information is fully up to date; the illustrations are not mere pictures, but diagrams based upon original drawings, the majority of which have been reduced from scale plans of existing plant, and so arranged as to be readily understood by those who have only a slight experience of mechanical drawings. The chemical portion of the work makes no pretensions to be exhaustive, but it is accurate and sufficiently full. On p. 63, however, we notice that the composition of spiegeleisen is represented by the formula $FeMn_4C$, probably a misprint for $(FeMn)_4C$, although the evidence in support of the existence of any such definite carbide is very weak. A characteristic feature of the work is seen in the prominence given to such Continental processes as may possibly react upon English methods, as for example the Perrot revolving puddling furnace, and the various reheating furnaces of Bicheroux, Casson, and Ponsard. The chapters on steel are remarkably concise and complete. The author meets the well-known difficulty of definition by assuming that any compound of iron and carbon which is delivered from a vessel in a state of fusion and at once cast into malleable ingots may be considered as steel. This definition is perhaps not very rational or precise; it seeks to exclude cast iron on the ground of its immalleability, and wrought iron from the circumstance that in practice it is never obtained wholly fused; however, it is at least more accurate than that based upon the quality of hardening and tempering, which the so-called mild steels do not possess to any sensible extent.

The volume on "Bleaching, Dyeing, and Calico Printing" is a production of a very different character. It has not the slightest claim to originality, but is mainly a compilation, of some 200 pages, from the standard works of Crookes, Stenhouse, and Groves and Ure, and consists very largely of receipts and formulæ. The chapter on bleaching is fairly well done, especially the portion relating to linen bleaching; and the section on mordants is good so far as it goes. What there is of chemistry in the book is generally accurate, but the author would in nowise have diminished the air of practicality about his work if he had removed or replaced some of the barbarisms in chemical nomenclature affected by dyers. It is quite possible to be precise without being pedantic. The book is poorly illustrated and somewhat loosely put together.

Mr. Watt's book on "Soap-Making" is a thoroughly practical treatise on an art which has almost no literature in our language. The author is the son of the late Mr. Chas. Watt, the inventor of the well-known process of bleaching palm-oil for soap-makers, and he has been connected with that industry for many years. Soap seems to have been made in England only since the middle of the seventeenth century, but the manufacture made very little progress until the invention of the Leblanc process for converting common salt into carbonate of soda. The art received its second great impetus from the labours of the venerable Chevreul in the early part of this century, who, with Liebig, elucidated the theoretical principles upon which the manufacture depends. Mr. Watt's book shows what influence these researches have had upon the development of the art, not only directly, but as demonstrating to the soap manufacturer the importance of a knowledge of chemistry in its applications to his processes. The general theory of saponification is first explained, and is followed by a chapter on the arrangement of a soap factory and a description of the materials used in soap-making. The various methods of making hard soaps and cheapened soaps are then fully described, both by the old processes and by those of Hawes and Bennett and Gibbs, Rogers, and Berghart. The processes for manufacturing potash soaps and soaps for printed goods and silks are next explained, and there are special chapters on toilet and medicated soaps, alkalimetry and the methods of soap-analysis, and on the recovery of glycerine from spent lyes. We congratulate Mr. Watt on the success of his endeavour to fill a void in English technical literature.

T. E. THORPE

MARINE ENGINEERING

Die Schiffsmaschine: ihre Construction, Wirkungsweise und Bedienung. Bearbeitet von Carl Busley, &c. (Kiel, 1883.)

THIS is designed to be a manual and book of reference on marine engineering, for the use of engineers, naval officers, students, and others interested in steamships. The author is a marine engineer in the Imperial German service, and a professor at the Naval Academy of Kiel. He has laid down a most comprehensive scheme for the work, and the first and second divisions already published contain good evidence that the book when completed will become the standard German work on the subject.

Marine engineering has made great strides in recent years, and is now much more largely regulated by scientific methods than it was formerly. The earlier text-books have become obsolete to a great extent, and a demand has arisen for new works in which modern principles and practice should be represented. In response to this demand two or three excellent books have recently been published in this country; and Mr. Busley has determined to do a similar service for Germany. It is but right to say that his book will bear very favourable comparison with any book of the class yet published, and it surpasses all of them in the fulness and beauty of the illustrations, which are contained in separate atlases and printed in colours, on a scale which makes many of them virtually working drawings.

Theoretical investigation and practical information on the details of the construction and management of marine engines and boilers both find a place in this book. Its arrangement is admirable. First, there is a clear and succinct description of the principles of the mechanical theory of heat, followed by a discussion of the properties of steam. Next comes a chapter on combustion, including a summary of the conditions essential to good boilers, and a statement of the steam-producing powers of various kinds of coal. If there is not much novelty in this section of the book, it is full of useful information. In the fourth chapter there is a long discussion of the various matters affecting the performance and economy of marine engines; details as to coal-consumption in various types of engines, with methods for estimating the expenditure of steam and coal in ships of new design; definitions of horse-power, nominal, effective, and indicated; together with remarks on various systems of condensing steam, &c.

Following these introductory chapters, three others are devoted to marine boilers, their construction and management, including the best means of preserving them. These chapters are chiefly of a practical character, and will repay careful study, as they contain a most valuable summary of information and good rules for guidance. The eighth chapter is also of a practical nature, containing detailed examples of the auxiliary engines used for a vast variety of purposes in steamships. Amongst these may be mentioned the turret-turning and air-compressing engines of modern war-ships; steam-steering engines of various types; engines employed for heaving-up anchors and cables; others used in the production of the electric lights now generally carried by war-ships or large passenger steamers; pumping engines; steam-winches; ventilating machinery; appliances for condensing fresh water, &c. All of these and many others are described and illustrated in a manner which makes this portion of the book most valuable for reference. No similar summary of information on these important, if subordinate, portions in the equipment of a steamship has been previously published; and Mr. Busley deserves great credit for his perception of the necessity for and value of the information herein collected.

The ninth, tenth, and eleventh chapters relate to the construction and theory of the various types of marine engines which are or have been in use. Full descriptions and drawings are given of different systems—including some which are, as yet, only in the experimental stage; screw-steamers, paddle-steamers, and vessels driven by water-jets all come under review; and very valuable tables are given of the dimensions and particulars of the machinery in a large number of German, English, and French ships. Mr. Busley throughout displays a cosmopolitan spirit in his massing of facts, and this makes his book all the more valuable. The theoretical investigations include rules for estimating the engine-power required to attain the assigned speed of a ship; examples of the analysis of indicator diagrams for simple and compound engines; graphic processes for dealing with the slide-valves; and detailed investigations or descriptions of slide-valve gear, steering gear, &c.

This completes the contents of the first half of this book; the other half has yet to be published, we believe. If it maintains the high character of the part already given to the world, the book will be certain to achieve success. It has been produced in excellent style, both as regards letterpress and illustrations. Its chief value consists no doubt in the large amount of information respecting modern practice which has been brought together; but the treatment of the scientific branches of the subject will assist to secure its favourable reception by the classes of readers for whom it is especially designed.

OUR BOOK SHELF

Guide to the Calcutta Zoological Gardens. By John Anderson, M.D., F.R.S., Honorary Secretary and Treasurer. (Printed by order of the Honorary Committee of Management, Calcutta, 1883.)

ALTHOUGH the meritorious idea of starting a zoological garden at Calcutta was put forward by the well-known naturalist MacClelland as long ago as 1842, and several attempts were subsequently made to carry out the plan, it was not until 1875, chiefly, we believe, owing to the exertions of the late Mr. Schwendler, the telegraph engineer, that an appropriate site was obtained, and the present gardens were founded. After eight years of development the Zoological Gardens of Calcutta, under the energetic rule of the present Honorary Director, have attained a degree of arrangement sufficiently stable to allow of a "Guide" being prepared. Dr. Anderson's able pen has accordingly been employed in describing the institution which he has so well organised.

For a "Guide" Dr. Anderson's volume is perhaps rather bulky, and the type employed unnecessarily large. It is also, we may add, in our opinion a little too learned for a popular handbook. But the information contained in it, compiled as it is by one of the leading zoologists of India, may be generally depended upon, and so much can scarcely be said for some similar publications. At the same time we may remind Dr. Anderson that the statement that the sternum in *all* Picarian birds has a "double notch behind" (p. 94) is not quite correct, and that he has overrated the number of African rhinoceroses.

Judging from the "Guide," the series of animals now exhibited in the Zoological Gardens of Calcutta must be considerable, although no actual statistics are furnished to us on the subject. Several animals of special rarity are mentioned as in the collection, such as a specimen of Grant's Gazelle (*Gazelle granti*) from East Africa, and the *second* known example of the Hairy-eared Rhinoceros of Chittagong. It is also of great importance to learn that the phenomenon of incubation of one of the large Pythons has been witnessed in Calcutta as well as in European Gardens. On the whole, the naturalist will find many things to interest him throughout the present volume, though, as already said, some of the disquisitions are not perhaps quite suitable to a popular work.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Earthquakes and Air-Waves

In the *Comptes Rendus* of the French Academy of Sciences for February 18, 1884, there appears a communication from Prof. Förster of Berlin relative to a statement previously made in the *Comptes Rendus*, to the effect that it was from observations taken at Berlin that he had arrived at certain conclusions as to the propagation of the atmospheric disturbance caused by the last great explosion in the eruption of Krakatoa in August last.

Prof. Förster explains that the statement referred to was a mistake, and that he had in fact only reproduced, after verifying them by reference to the Berlin observations, the conclusions come to by me, as explained in a paper read before the Royal Society on December 17, 1883, the principal part of which was published in Nature of December 20 last (p. 181).

He adds that in his original note on the subject he had not mentioned my name as the author of the conclusions referred to, in consequence of the manner in which I had spoken of them myself.

Prof. Förster, while putting himself right on this point, has interpreted my own intention with great sagacity. For the light I may have been able to throw on the facts was in truth consequent on information put before me by the intelligent officers of our Meteorological Office, aided by a suggestion from Prof. Stokes, who like myself is a member of the Meteorological Council.

Such credit, however, as is due for bringing to notice the curious phenomenon in question may be fairly claimed for our Meteorological Office, as there is little reason to doubt that it would have remained unnoticed had it not been for the comparison of the several records of the continuously self registering instruments which the organisation provided from the public grant we receive has placed at our command, and which no individual effort could have supplied.

February 26 RICHARD STRACHEY

In the Jamaica Weather Report, No. 35, for November last year, I was unable to explain how it was that the Krakatoa air-wave had affected our barometer so strongly: the explanation is that Jamaica is very near the antipodes of Krakatoa (Nature, vol. xxix. p. 181).

The general effect of the disturbance at Jamaica was to produce a barometric depression, preceded and followed by small barometric elevations, according to the following table, which gives for local time the pressure of the atmosphere at the sea-level, expressed in inches of mercury at 32°, and corrected for diurnal variation :—

Kingston, Jamaica, 1883

		in.
August 26,	3 p.m.	29·972
26,	11 p.m.	·975
27,	7 a.m.	·982
27,	3 p.m.	·944
27,	11 p.m.	·983
28,	7 a.m.	·994
28,	3 p.m.	29·975

Now the impulse at Krakatoa occurred at 9.24 a.m. local time, and it reached Jamaica about 3 p.m. local time, or eighteen hours afterwards; consequently the average velocity of the wave was about 690 miles an hour—which is wholly in accordance with the velocity deduced by General Strachey from places in Europe and elsewhere.

But there was no great explosion at Krakatoa at 9.24 a.m., and it seems possible that this great air-wave was similar to the air-waves we always experience in Jamaica whenever there is a shock in Kingston sufficiently strong to be distinctly felt.

In August 1881 I published a Report on Earthquakes in Jamaica, No. 4, in order to call attention to the following facts :—

1. The atmospheric pressure oscillates for some hours before and after a shock, the lowest depression generally occurring at the time of the shock.
2. The wind generally lulls, so that "the weather" is hot and oppressive.
3. Clouds (stratus) gather over the sky after the shock.
4. The temperature of the air, if we allow for the cooling effect of (3), remains unchanged.
5. The rainfall is unaffected.

These facts have been fully confirmed by subsequent shocks. As an example let us consider the last shock which occurred on January 14 this year, and which was felt over nearly the whole of the island.

At Kingston it was felt as a sharp double-shock at 1.15 p.m.; the first shock lasted about three seconds, then there was an interval of about two seconds, which was followed by the second shock, lasting about five seconds. There was a strong sea-breeze blowing during the day, but a temporary lull occurred just before the earthquake.

The following table gives the pressure of the atmosphere at the sea-level, expressed in inches of mercury at 32°, and corrected for diurnal variation :—

Kingston, January 14, 1884

	in.
24 hours before the shock	30·061
16 ,, ,, ...	·047
8 ,, ,, ...	·043
At the time of the shock	·016
8 hours after	·024
16 ,, ...	·063
24 ,, ...	30·056

On January 13 the average amount of cloud was 7 per cent. of the whole sky, on the 14th it was 10, and on the 15th it was 43!

Further particulars will be found in the Jamaica Weather Report, No. 37, for January 1884, and it will here be sufficient to remark that the depression at the time of the shock was quite as strongly marked at the cinchona plantation, thirteen miles from Kingston, but 4850 feet above the sea-level.

It is needless to say that I am at a loss to account for the connection which most undoubtedly exists in Jamaica between earthquakes and air-waves; but it is evident that the latter may be connected with the former without any, the slightest, approach to volcanic explosion; and the Krakatoa air-wave was probably similar in all respects, except magnitude, to the waves we continually experience in Jamaica at the time of earthquake shocks.

Jamaica, February 7 MAXWELL HALL

The Remarkable Sunsets

At 8.45 a.m. to-day the sun seen from here through a light mist was of a slightly metallic and very pale sea-green colour. The mist was not dense enough to render objects at a distance of twelve yards indistinct, but beyond that distance they rapidly became invisible. There was no wind, and the mist seemed free from smoke. I could form no opinion as to its height. Half an hour later, in Manchester, the sun glowed with the ordinary coppery-red hue it assumes when seen through a thin fog.

EDWARD J. BLES

Moor End, Kersal, near Manchester, February 26

Instinct

I DO not think that the difference between Mr. Lloyd Morgan and myself on the point to which he returns in his last letter is so great as it at first appeared. For he now admits that "the actions of animals testify to some corresponding mental states," and therefore that from such actions we are entitled to infer something as to these states. His objection to comparative psychology as a science is thus reduced to the observation that our inference from bodily actions to mental states cannot be so clear or certain in the case of animals as in the case of men, where intentional sign-making, or language, comes to our assistance. Now this is precisely what I argued in my own communication to NATURE (p. 379), and also in my books. Therefore I do not consider that this is "an ingeniously constructed argument of scepticism"; I applied that phrase to the argument which denies the possibility of all or any ejective knowledge, both of men and animals.

Thus the only point of dispute between us is whether such conceptions as we can form of the mental life of animals are sufficient to constitute this mental life the subject-matter of a science—*i.e.* whether this mental life admits of investigation. And, so far as I am aware, Mr. Morgan is the only individual who has ever said that such is not the case.

GEORGE J. ROMANES

THERE is a remarkable instance of instinct displayed by the common magpie which I have not seen noticed in NATURE or anywhere else, although it has long attracted my attention and is well known to farmers in the west of Scotland. This bird may be seen each year, on the first Sunday of March (old style), very busily employed carrying small twigs of branches to renew its old nest or form a new one for the approaching breeding season. This particular day appears to be appointed for taking formal possession of the premises, as no more work whatever is done for some weeks after. The instinct which enables a bird to take the sun's altitude on a particular day in March is certainly a very rare gift, but any person who wishes to satisfy himself of its truth, and who lives in a locality where these birds breed, has only to rise early on Sunday, March 16, this year, to see them at work for himself. It would be interesting to know within what degrees of latitude this particular day is observed by these birds.

WM. BROWN

"Mental Evolution in Animals"

I AM as unwilling as Mr. Romanes to continue this discussion needlessly, but inaccuracy calls for correction. Mr. Romanes says that "the glass wall of a tank is not an object upon the solidity of which a skate would be likely to calculate." If he will read my original account of the incident again, he will find that the skate made himself absolutely sure of the solidity of the glass wall of the tank; he tried hard to seize the food, and failed because he could not get his head through the glass, and therefore his mouth could not touch the food. As for his being unable to see the food when the current lifted it, that is precisely my case. But he saw it clearly enough, and had tangible experience of the conditions, before he adopted the successful device. If the matter is worth noticing, it may as well be described correctly.

F. J. FARADAY

Manchester, February 29

I WILLINGLY apologise for making the remark about the glass wall without having first consulted Mr. Faraday's original account; but as, in "noticing" the matter in "Animal Intelligence," I quoted that account *verbatim*, I cannot allow that on the only occasion when I "described" the circumstances, I failed to do so "correctly."

G. J. ROMANES

Natural Snowballs

IT is nearly a year since I inclosed to you an account of the natural snowballs or snow-rollers which were to be seen in great numbers for many square miles in this vicinity on February 21, 1883. A friend has called my attention to a brief newspaper report of a recurrence of the same remarkable phenomenon on a larger scale in Oneida and Herkimer counties, in the State of New York. The rollers were formed by the wind on the night of Tuesday, January 22, and are said to have been "innumerable," hundreds being seen on an acre of ground. The measurements of the largest are the same as those which I made of the largest that I saw last year, 18 inches in length and 12 in diameter. But, whereas all of last year's were extremely delicate, so as to yield to the touch, it is reported that some of those seen in January were "solid and so firm that they could be handled quite roughly without breaking." I send these memoranda to you, thinking that you may deem them worthy of preservation in the columns of your journal.

SAMUEL HART

Trinity College, Hartford, Conn., U.S.A., February 16

Common Domestic Duck Diving for Food

WHEN at Buxton last August I spent a good deal of my time in watching and occasionally feeding the water-fowl in the ponds of the garden. On week-days the ducks received large contributions from the visitors, but on Sundays they apparently were on rather short commons, judging by their greater activity in searching for food, and constantly standing *on their heads* in the water so as to search the bottom for aquatic plants. Of course every scrap of plant to the depth of ten or fifteen inches (eighteen inches where the geese were) was cleared away.

I was surprised one Sunday to see a common domestic duck (female) diving in three or four feet of water, and searching along the bottom, as if she had been "to the manner born," for plants, which, when she found, were brought to the surface; some fifteen or twenty other ducks watched her proceedings with great interest, and made an immediate rush at her when she came up to share in the food, exactly as the widgeon pounce upon the canvas-back ducks at the mouth of the Delaware River and other favourite winter feeding-places of these delicious birds, which, notwithstanding their difficulties with their thievish tormentors, must manage to pick up a fairly good living, as when killed they are usually in fine condition.

I saw only one duck (a mallard) at Buxton make any attempt to imitate the clever diver, but his efforts were always ignominious failures. Had I been living in Buxton I should have endeavoured to get some eggs of this diving duck and had them hatched, with the object of finding out if the progeny inherited the peculiarity of the mother.

JOHN RAE

4, Addison Gardens, March 1

Circular Rainbow seen from a Hill-top

IN the evening of the first Sunday in last September, when, it will be remembered, there was a very severe storm, I was walking alone up the south side of the top of the Belchen, in the Black Forest; the sun was setting in the west over the Rhine, and for some time my shadow was thrown on the mist filling up the valley to the east of the Belchen, and around it was a most distinct rainbow, with all the usual colours. It was so striking that it at once suggested the halo one sees in religious pictures, except that it was round the whole figure, and not confined to the head. I thought this anecdote might interest those gentlemen who have already written to you about this beautiful phenomenon, and especially Mr. Maynard, who I see writes from the Black Forest.

W. HALE WHITE

4, St. Thomas's Street, S.E., March 1

Girton College

IN reference to a paragraph in NATURE (vol. xxix. p. 388) respecting the representation of the students of the College Hall of Residence, Byng Place, on their governing body, allow me to state that the students of Girton College have been represented on the College Committee for some seven years past. The representatives of the students are three in number, one retiring annually; they are elected by those students who hold the college certificate, and have been chosen, so far, from among themselves. As the certificated students keep up a more or less close connection with the College, and their representatives pay regular visits of inspection, the views of past and present students can be formally laid before the College Committee. This privilege is much appreciated by the students. If you have received no other letter to this effect, may I ask you to insert the above information?

CERTIFICATED STUDENT

February 26

ANTHROPOLOGICAL NOTES IN THE SOLOMON ISLANDS

IN my last paper on the physical characters of the natives of St. Christoval and the neighbouring islands (NATURE, vol. xxvii. p. 607) I drew attention to the variation which was presented towards the opposite extremity of the Solomon group by the Treasury Islanders, of whom I considered the natives of the large adjacent island of Bougainville would prove to be a more pronounced type. My observations during 1883, which were confined, however, to the islands of the Bougainville Straits, and did not extend to the large island of that name, have confirmed the existence of this variation in the type of the natives at the western end of the group.

Proceeding at once to the comparison of the inhabitants of these two regions, I find that the most important distinction lies in the form of the skull. The cephalic indices obtained from forty head-measurements amongst the men of the islands of Bougainville Straits (Treasury Island, Shortland Islands, Faro Island) ranged between 76 and 85; three-fourths were included between 79 and 83 (inclusive); and the mean was 80·6. Of the same number of measurements amongst the men of St. Christoval, half produced cephalic indices between 75 and 78 (inclusive); the range was 69 to 83; and the mean 76·7. In the first region therefore brachycephaly may be said to prevail; in the latter, mesocephaly. But in addition to being more brachycephalous, the men of Bougainville Straits belong to a noticeably taller and more robust race, their average height being 5 feet 4½ inches to 5 feet 5 inches, as contrasted with 5 feet 3 inches to 5 feet 4 inches in the case of the St. Christoval natives. I should also add that the hue of the skin is of a darker shade, corresponding to numbers 35 and 42 of the colour-types of M. Broca. The character of the hair resembles that of the natives of the eastern islands of the group in being frizzly and bushy; but there is introduced among the populations of these islands in the Bougainville Straits an almost straight-haired element, to which further reference will be made.

The inhabitants of the islands just alluded to are also distinguished from those of St. Christoval and the eastern islands of the group in many of their arts and usages, to some of which I can here only just refer. Cannibalism is rarely if ever practised among the natives of Bougainville Straits: it is, however, frequent amongst those of St. Christoval. Polygamy is more prevalent in the former region, where Gorai, the powerful chief of the Shortlands, possesses between eighty and one hundred wives, and Mulé, the chief of Treasury Island, owns between twenty-five and thirty. The patriarchal and despotic rule of these chiefs must be contrasted with the little authority which belongs to the majority of the chiefs in the eastern islands. The women of Bougainville Straits manufacture a kind of unglazed pottery, employing for this purpose a wooden trowel, a large smooth pebble 3 to 4 inches across, and a ring-cushion of palm leaf; a rudely-shaped saucer is first made from a lump of the clay; and upon this the vessel is built up, strip by strip. A large number of the houses in the principal villages of Faro—an island in the middle of the Straits—are built upon piles. I should here refer to the greater prevalence amongst the natives of the islands in Bougainville Straits of the cutaneous disease—an aggravated form of "body-ringworm"—to which I alluded in my description of the St. Christoval natives: four-fifths of the inhabitants of Treasury Island are thus affected; and half of the chief's wives are covered with this disease from head to foot.

From frequent observation of the different modes of wearing the hair which prevail among the Solomon Islanders, I am of the opinion that their variety is to be attributed more to individual fancy than to any difference in the character of the hair. According to his taste, a man may prefer to wear his hair close and uncombed, when the short matted curls with small spiral give a woolly appearance like that of the hair of the African negro. Should he allow his hair to grow, making but little use of his comb, the hair will hang in ringlets 3 to 8 inches long—a mode more frequent amongst the natives of the eastern islands of the group, and best described as the "mop-headed" style. More often from a moderate amount of combing, the locks are loosely entangled and the hair-mass assumes a somewhat bushy appearance, the arrangement into locks being still discerned and the surface of the hair presenting a tufted aspect. The majority of natives, however, produce by constant combing a bushy periwig in which all the hairs are entangled independently into a loose frizzly mass, the separate locks being no longer discernible. These four styles of wearing the hair—the woolly, the mop-like, the partially bushy, the completely bushy—prevail with both sexes, the fashion varying in different islands of the group. I am inclined to view the mop-headed style as the natural mode of growth, it being the one which the hair would assume if allowed to grow uncombed and uncut. The Solomon Islander unfortunately makes such a constant use of the comb that one rarely sees his hair as nature intended it to grow. When, however, a man with bushy hair has been diving for some time, the hairs, disentangling themselves to a great extent, gather together into long narrow ringlets—nature's *coiffure* of the Solomon Island native.

Amongst the natives of Bougainville Straits the hair is coarser and of a darker hue, corresponding to numbers 34 and 49 of the colour-types of M. Broca; whilst the lighter hue of the hair of the St. Christoval natives more accords with numbers 35 and 42. The diameter of the spiral when measurable varied between 5 and 10 mms.—its usual range throughout the group; but on account of the practice of combing it was often difficult to measure it with any accuracy. Here I may allude to the almost straight-haired element which has been infused among the inhabitants of Bougainville Straits. The individuals thus characterised have very dark skins, which for want of comparison might be termed black; the hue, however, nearly agrees with colour-type 42 of M. Broca; the hair, which is even darker, corresponding with types 34 and 49, is almost straight, often erect, and giving the person a shock-headed appearance; whilst it may in some instances tend to gather into curls of a large spiral. I was unable to detect any constant change in physical characters accompanying this variety in the growth of hair. The general colour of the iris amongst the natives of Treasury Island may be described as a deep muddy-violet, approaching nearest to number 11 of the colour-types of M. Broca.

The relation between the lengths of the upper and lower limbs in over thirty individuals was fairly constant, the mean intermembral index being 68. A steady index, giving a mean of 33·4, indicated the proportion of the length of the upper limb to the height of the body; but the corresponding index which my measurements gave for the lower limb was somewhat variable, and the mean 49·2 is therefore not so reliable. H. B. GUPPY

H.M.S. *Lark*, Auckland, N.Z., January 2

ON THE CLASSIFICATION OF THE ASCIDIÆ COMPOSITÆ

COMPOUND ASCIDIANS should undoubtedly be studied in the fresh condition. This becomes evident to any one who, after having admired the graceful forms, gorgeous colouring and transparency of tissue exhibited by the living animals on our western and southern coasts, or in such a favoured spot as the Chausey Archipelago, seeks in vain for these or any other beauties in the leathery repulsive-looking masses usually exhibited in a collection of Tunicata.[1] And it becomes painfully impressed upon one when working through a large collec-

[1] There are exceptions: some few species retain both form and colour fairly well when preserved.

tion which has been in alcohol for about ten years. Laborious dissection and the preparation of large numbers of sections are necessary to reveal characteristics which may often be seen in the living specimen by observation merely. And, what is of more consequence, there is a risk of being led into errors and misinterpretations by the abnormal contraction and distortions caused by the alcohol.

Such plates as those of Prof. Giard,[1] and of Dr. R. von Drasche's beautifully illustrated monograph on the Synascidiæ of the Bay of Rovigno,[2] which has just appeared, show how much can be made out from a natural representation of the living animal, and leave little or nothing to be desired so long as we must be content with some substitute for the actual specimen. In this important work von Drasche criticises Giard's classification of the Synascidiæ, and explains fully a scheme of his own which appeared in the *Zoologischer Anzeiger* for 1882. Many attempts have been made to classify naturally this difficult group, and this latest effort, although it has corrected some previous errors, appears still to be susceptible of improvement, especially as regards the interesting forms which occupy the borderland between simple and compound Ascidians. Some of these (the Clavelinidæ) are placed by Giard and von Drasche in the Synascidiæ, while in 1880 I tried to show that their proper position was amongst the Ascidiæ Simplices, and close to the genus *Ciona*. At the present moment I confess that I am unable to find a single satisfactory character by which to distinguish these two large groups, the simple and compound Ascidians.

Savigny, in 1815, in his "Observations sur les Alcyons gélatineux à six tentacles simples,"[3] first rescued the compound Ascidians from the Alcyonaria with which they had previously been associated, and demonstrated their affinity with the other Tunicata.[4] In the "Tableau Systématique" Savigny gives no formal statement of the characters distinguishing the two groups, but it is evident from some passages in his "3^e^ Mémoire" that he relied chiefly, if not entirely, for their separation upon the arrangement of the Ascidiozooids of the compound forms around a central cloaca—a character which he declared was visible even in the young embryo. In this latter point he was mistaken, and it seems rather singular that he should have laid such stress upon the union of the atrial apertures when we find that he describes and figures their separate and independent existence in *Diazona* and *Distoma*, two of the genera of his "Téthyes Composées." *Clavelina* in his system is placed next to the "Phallusiæ Cionæ" (= the modern genus *Ciona*) in the Ascidiæ Simplices.

Savigny classified the nine genera which he recognised amongst compound Ascidians by means of characters taken from the branchial and atrial apertures. But although such characters are most useful and constant marks of affinity in the simple Ascidians, they fail signally as applied by Savigny to the compound forms, and result in the separation of his closely allied genera *Didemnum* and *Eucœlium*, while *Diazona*, *Distoma*, and *Sigillina* are thrown together in one group, and *Eucœlium* is placed with *Botryllus*, a genus with which it has certainly no close relationship.

Lamarck's arrangement of the Tunicata, published about the same time, showed no improvement upon that of Savigny.

In 1841 Milne-Edwards[5] established the group of "Ascidiæ Sociales" as occupying an independent position between the simple and compound forms. This group (in which he placed the genera *Perophora* and *Clavelina*) he defines as comprising Ascidians which reproduce by buds as well as by eggs, and which live united by common radiciform prolongations, but which otherwise are free of all adhesion to one another. He distinguished the simple Ascidians as forms which never reproduced by gemmation and were never found in groups united by a common tegumentary tissue; while he separated the compound from the social Ascidians on account of their possessing a test common to all the members of the colony. If we unite the simple and social Ascidians, which I have shown in the Report upon the *Challenger* Tunicata there is reason for doing, we shall have, according to Milne-Edwards, the simple and compound Ascidians distinguished merely by the members of the colony in the latter being united by a common test, while in the former each individual has its own distinct tunic. This character, although better than the one made use of by Savigny, is, as we shall see later on, by no means an infallible guide.

Milne-Edwards formed a classification of the genera of compound Ascidians into "Polycliniens," "Didemniens," and "Botrylliens," which, with our present knowledge of the group, still seems fairly natural. These three divisions are distinguished by such anatomical characters as the relations of the other viscera to the branchial sac. In the "Polycliniens" the body has three regions—the "thorax," containing the branchial sac; the "abdomen," formed by the stomach and the greater part of the intestine; and the "post-abdomen," having the reproductive organs and the heart. In the "Didemniens" there are only two regions—thorax and abdomen—the reproductive organs and heart being placed on the intestine. In the third group, the "Botrylliens," the viscera form a single mass, in which the alimentary canal lies alongside the branchial sac.

This arrangement of the Ascidiæ Compositæ was generally accepted until 1872, when Giard published[1] his important memoir, "Recherches sur les Ascidies Composées ou Synascidies," in which is given a classification based upon the method of gemmation. He distinguishes three points of origin for the buds—the pyloric region of the alimentary canal, the reproductive organs, and the posterior end of the body. The latter region is the place of gemmation in his "Catenatæ," a group which contains three families—the Clavelinidæ, the Perophoridæ, and the Botryllidæ. But he gives no sufficient reasons for placing the first two families in the compound Ascidians, and, as von Drasche has pointed out, the third one does not really exhibit the essential character of the Catenatæ.

Giard's second group, the "Glomeratæ," is characterised mainly by the formation of ovarian buds. It corresponds to Milne-Edwards' "Polycliniens," in addition to half of the "Didemniens." The remainder of the "Didemniens" correspond to Giard's third group, the "Reticulatæ," and are characterised by gemmation taking place from the pyloric region. This seems a natural and well-defined section, including two families, the Didemnidæ and the Diplosomidæ, but the "Glomeratæ" cannot stand without several changes which von Drasche suggests, and which really reduce it merely to Milne-Edwards' section "Polycliniens." Upon the whole, there can be little doubt that Milne-Edwards' classification is preferable to that proposed by Giard.

We come now to Dr. von Drasche, the latest authority, who, both in his preliminary note[2] and in the detailed memoir,[3] wisely abstains from any attempt to form main divisions, and merely groups the genera in a series of carefully chosen families. Of these the Botryllidæ corresponds to Milne-Edwards' section "Botrylliens," while the Didemnidæ and Diplosomidæ are identical with Giard's families bearing the same names. The Polyclinidæ

1 "Recherches sur les Ascidies Composées ou Synascidies" (*Archives de Zoologie expérimentale et Générale*, t. i. 1872).
2 "Die Synascidien der Bucht von Rovigno." Ein Beitrag zur Fauna der Adria, von Dr. Richard von Drasche (Wien, 1883).
3 "Mémoires sur les Anim. sans Vert."
4 The class Tunicata was established by Lamarck in the year following—1816.
5 "Observations sur les Ascidies Composées des Côtes de la Manche" (*Mém. Instit. France*, vol. xviii.).

1 *Arch. de Zool. expér.*, t. i.
2 *Zoologischer Anzeiger* for 1882, p. 695.
3 "Die Synascidien der Bucht von Rovigno" (Wien, 1883).

and Distomidæ do not correspond exactly to any of Giard's families, but the former is Milne-Edwards' "Polycliniens" without change. A new family, the Chondrostachyidæ, has been formed for the reception of Macdonald's *Chondrostachys* and von Drasche's *Oxycorynia*, remarkable forms in which the Ascidiozooids are placed upon a common peduncle penetrated by large canals. I am inclined to admit the necessity for this new family, and several undescribed and interesting forms obtained during the *Challenger* Expedition will, I hope, take up a position within its bounds. The two remaining families of von Drasche's system, the Clavelinidæ and the Perophoridæ, I would still maintain are more closely allied to the simple than to the compound Ascidians. They correspond to Family IV. Clavelinidæ of my arrangement of the Ascidiæ Simplices.

Dr. von Drasche does not define the Synascidiæ, and from one or two passages in his work it seems probable that he is in very much the position in which I now find myself, viz. unable to find any character or combination of characters which will serve to distinguish simple from compound Ascidians. Reproduction by gemmation and the formation of colonies in the latter group will not hold, since it is possible to pass from *Ciona*—a typical simple Ascidian—to *Distoma* and the very heart of the compound Ascidians through the following series of forms, which shows a perfect gradation of these characters :—*Ciona*, *Rhopalæa*, *Ecteinascidia*, *Clavelina*, *Diazona*, *Chondrostachys*, *Oxycorynia*, *Distoma*. The formation of common cloacal cavities, canals, and apertures cannot be considered as a diagnostic feature of the compound Ascidians. Although Giard has demonstrated their presence in some genera in which they were previously unknown, yet there are some forms considered by all authorities as Synascidiæ, such as *Chondrostachys*, *Diazona*, *Distoma*, and others, in which the atrial apertures of the Ascidiozooids open independently on the surface of the colony, and no common cloaca is formed.

Lastly, we come to characters taken from the condition of the test, but these break down like the others. In the first place, in passing along the series of forms mentioned above as connecting *Ciona* and *Distoma*, we encounter all stages between a distinct test or tunic for each individual and a common mass in which a number of Ascidiozooids are embedded. And, secondly, the remarkable group "Polystyelæ," briefly characterised by Giard in 1874 presents many of the characters of highly differentiated simple Ascidians (the Cynthiidæ), along with the supposed Synascidian feature of a colony composed of many Ascidiozooids completely buried in a common test.

In the *Challenger* collection there is an interesting series of Polystyelæ—all from southern seas—in which it is possible, I believe, to trace a passage from such aggregated Styelinæ as *Polycarpa* to the Botryllidæ. If this passage indicated genetic affinity between these two very distinct groups, which I greatly doubt, it would be impossible to escape from the conclusion that the Ascidiæ Simplices and the Ascidiæ Compositæ have *two* points of connection, almost at the extreme ends of the two series. I think I am justified in believing that probably both groups were derived from a form not unlike *Ecteinascidia* or *Clavelina*. From this common ancestor the simple Ascidians diverged through the Ascidiidæ to the Cynthiidæ (including *Polycarpa*) and the Molgulidæ, while the compound Ascidians diverged through *Diazona* and the Chondrostachyidæ to the Polyclinidæ, Didemnidæ, and Botryllidæ. Hence it seems much more probable that the Polystyelæ have acquired independently certain characters of *Polycarpa* or of *Botryllus* (I have not yet been able to determine to which of the two they are really most closely related) than that there is any direct affinity between such highly differentiated groups as the Cynthiidæ and the Botryllidæ. This, however, does not affect the practical difficulty that the Polystyelæ completely bridge across the gap between simple and compound Ascidians as distinguished by the nature of the test or tunic, and consequently it is extremely difficult to separate them from either of these two great series.

Thus all the diagnostic features usually employed fail utterly, and we find ourselves unable to discover a single character or combination of characters which will serve to distinguish the Ascidiæ Simplices from the Ascidiæ Compositæ.

W. A. HERDMAN

A METEOROLOGICAL LABORATORY

TO the last issue of *Science et Nature* M. L. Mangin contributes an interesting account of the chemical laboratory recently installed on the Pic du Midi, Pyrenees, at an altitude of nearly 9500 feet above the sea. As shown in our first illustration, the laboratory stands between the dwelling-house and the Observatory, of which it forms a dependency, under the direction of MM. Müntz and Aubin. In the second illustration a fuller view is given of the building, which faces southwards, and the slated roof of which is so constructed as to constitute a sort of pluviometer registering the annual rainfall, and retaining sufficient for chemical analysis. This unique establishment, which promises to render great services both to meteorology and to the economic industries, is at present chiefly occupied with the constituent elements of the terrestrial atmosphere, especially in connection with vegetable life. The student of chemistry need scarcely be reminded that, besides oxygen and nitrogen, the air contains in smaller proportions carbonic acid, ammonia, and certain nitric compounds playing an important part in the nutrition of plants, and supplying them with nearly all the nitrogen and carbon that enter into the composition of their tissues. During the summer months of the years 1881-82, MM. Müntz and Aubin were mainly engaged with the quantitative analysis of these substances, under conditions peculiarly favourable for the prosecution of such investigations. The results so far obtained may here be briefly resumed.

Carbonic Acid.—The proportion of this element found in the air at different altitudes is still a subject of discussion amongst analytical chemists. But de Saussure's average of from ·0004 to ·0006 has been shown to be considerably too high by various observations taken of late years at different stations on the globe. These observations are now fully confirmed by the researches on the Pic du Midi, which reduce the average to 2·86 ten-thousandths.

Another important conclusion is that the carbonic acid does not perceptibly vary with the altitude, as had hitherto been supposed. Thus the proportion is found to be much the same at Vincennes near Paris, Luz (740 m.), Pierrefitte (500 m.), and Pic du Midi (2900 m.). On the other hand, the quantity varies slightly in the same locality, being somewhat greater at night and in moist weather than during the day and in dry weather. The subjoined table shows the average quantity of carbonic acid present in the atmosphere during the day and at night at various meteorological stations in different parts of the world :—

	Night	Day
Vincennes	2·98 ...	2·84
Pic du Midi... ...	2·90 ...	2·86
Hayti	2·92 ...	2·70
Florida	2·94 ...	2·89
Martinique	2·85 ...	2·73
Mexico...	2·86 ...	2·66
Patagonia	2·67 ...	2·66
Chili	2·82 ...	2·66

Ammonia.—Although the presence of ammonia in the air has long been known, Schlösing was the first to show that for this substance, as well as for carbonic acid, the sea is the great reservoir whence the atmosphere receives its supplies. But no light had hitherto been thrown upon

FIG. 1.—General View of the Pic du Midi Observatory.

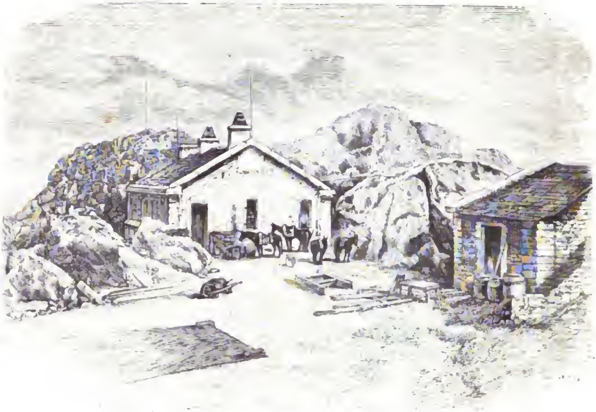


FIG. 2.—The Observatory and Laboratory.

the distribution of ammonia at different altitudes. Examining the atmosphere from this point of view, MM. Müntz and Aubin now find that at an elevation of nearly 3000 m. the quantity does not sensibly differ from that at extremely low levels, which is ascertained to be about 1·35 mgr. to 100 c.m. Hence the diffusion of ammonia in the air is as complete as that of carbonic acid. Consequently it is in the gaseous state that this substance is incessantly transmitted from the marine basins to the atmosphere. The rain and snow collected on the Pic du Midi also revealed the presence of ammonia in solution, as was to be expected.

Atmospheric Nitrification.—The analysis of rain falling during thunderstorms is known invariably to yield certain nitrous compounds in the form of sal ammoniac. From what is known regarding the affinities of nitrogen, it is argued that these compounds are developed under the influence of electric discharges. The nitrous compounds (nitric acid and sub-nitric acid) are converted, in the presence of water and of ammonia, into sal ammoniacs, which are precipitated by the rain. Hence electric disturbances in the air came to be regarded as the chief source of nitrous compounds.

MM. Müntz and Aubin have analysed by the most delicate processes the rain-water collected on the Pic du Midi, but never succeeded in detecting any nitrates in it, although they are always present in rain-water collected on the plains. Their absence corresponds with the absence of thunderstorms taking their rise above the Pic du Midi. Of 184 storms observed during a period of nearly nine years by M. de Nansouty, the director of the Observatory, not more than twenty-three originated at an altitude of over 2300 m.; but in no case were electric phenomena observed at an elevation higher than 3000 m. Hence the electric discharges, which give rise to the nitrates, are limited to the lower atmospheric regions between sea-level and 3000 m. above the sea.

To the general results here resumed MM. Müntz and Aubin have added some details concerning the formation of vegetable soil. They have distinctly determined the presence of nitric ferment in the ground on the highest summits. But owing to the low temperature prevailing at those altitudes, the activity of this ferment is extremely weak.

It may be observed in conclusion that the uniform proportion of carbonic acid and ammonia in the atmosphere, as determined by these remarkable researches, is a fresh confirmation of Schlösing's theory regarding the interchange of gases between the sea and the air. The marine basins are incessantly discharging or absorbing carbonic acid and ammonia in such a way as to maintain the constant proportion of these substances. They thus constitute a vast regulator, restoring to the atmosphere the nitrous or carbonic compounds of which it had been deprived by vegetation.

SCIENCE IN ROME

THE recent changes introduced into the constitution of the Accademia dei Lincei, followed by its removal to new and sumptuous quarters in Trastevere, seem to call for more than a passing notice. There are certainly many other famous societies scattered over the Peninsula, all the large towns of which have long possessed one or more scientific, literary, or artistic corporations. But, with perhaps the single exception of the Florentine Academy, none of them have been so intimately identified with the progress of the physical sciences since the "Renaissance" as this oldest of still existing learned institutions. Founded on August 17, 1603, by the young prince, Federigo Cesi, for the express purpose of cultivating "le scienze matematiche e filosofiche," it began its useful career forty years before the birth of Newton, and six before Galileo had rendered Jansen's telescope a suitable instrument for astronomic observation. The very name of the Lincei, or "Lynx-eyed,"[1] breathes the quaint spirit of the times, when every capital in Italy had its centres of intellectual movement, bearing such eccentric titles as the Accademia dei Sonnacchiosi ("The Drowsy"), dei Sitibondi ("The Thirsty"), dei Svegliati ("The Wide-Awake"), degli Ottusi ("The Dull"), degli Innomati ("The Nameless"), dei Storditi ("The Dazed"), dei Tenebrosi ("The Darklings"), and so forth. But while most of these ephemeral corporations have left little but their names behind them, the Lincei have gone on prospering and continually widening the field of their utility until the Academy now finds itself formally constituted the chief national exponent of the natural sciences in Italy, thus taking rank with the French Institute and the Royal Society of London.

Although such a proud position could scarcely have been anticipated by its founder, the Academy none the less possessed from the outset certain elements of stability, which under favourable circumstances could not fail to insure it a prolonged existence. Its generous patron not only provided it with a home in his ancestral palace, but also placed at its disposal a botanical garden, a rich museum and a choice library soon increased the valuable collection of Virginio Cesarini. Its three first members, the founder, Fabio Colonna, and Francesco Stellati, were all noted for their varied accomplishments, and Colonna especially, at once a mathematician, philosopher, painter, musician, and *savant*, may be regarded as the greatest of botanists previous to Linné.[2]

During the seven first years after its foundation, Gaetano Marini tells us that the Academy "dared to stand up against the tyranny of the Peripatetics, and to introduce a new and more certain method of philosophy, bravely and religiously enduring a long and most unworthy persecution" (*Ist.* i. p. 493). The reference in the last clause, necessarily worded somewhat vaguely, is to the action taken by the Lincei in defence of Galileo, who had joined the Academy, and who had in 1615 received his first summons to Rome to recant his "errors." A feeble attempt seems to have been made to continue the struggle between light and darkness till 1632, when Galileo was finally "suppressed." The "Lynx-eyed" were now shrewd enough to perceive that they had fallen upon times when silence was "golden." Henceforth for many years their records are practically a blank, broken only in 1651 by the publication under their auspices of Francisco Hernandez's great work on the natural history of Mexico.

After the untimely death of Prince Cesi in 1630 the Academicians, now numbering thirty-two members and foreign associates, received a temporary shelter in the house of the Commendator Cassiano del Pozzo. Their first organic constitution had been issued in 1624, and since that period both residence and regulations have been subjected to many changes. After the political unification of Italy and the selection of Rome for its capital, fresh modifications became inevitable, and a new constitution was published in the year 1875. But so rapid has been the progress of the natural sciences, and so great the zeal displayed by the Lincei in the cause for which their predecessors endured "a long and most unworthy persecution," that further alterations in the sense of expansion were soon felt to be imperative. According to the reform introduced in July 1883, better provision is made for the cultivation of all branches of physics by the final and absolute exclusion of the arts and letters. The new

[1] Tiraboschi tells us that this title was adopted "per chè gli accademici presero a lor simbolo un lince, a spiegar l'acutezza con cui si erano prefissi di osservare e di studiar la natura" (viii. p. 72).

[2] "Quicumque," says Boerhaave, "historiam antiquitatis plantarum scire vult, legat opera Fabii Columnæ, qui vix habet similem, sed quidem imitatores" ("Method. discend. Medic.," pars 4. § 8). Colonna, who was born in Naples in 1567, and died an octogenarian in 1647, was also the inventor of the musical instrument by him named the "sambuco linceo," in honour of the Academy.

conditions have of course necessitated this departure from the original scope of the Institute, which, as we are expressly told by Tiraboschi, did not exclude the "humanities."[1] The scheme of the natural sciences itself has also been entirely recast, with a corresponding increase and redistribution of members among the various sections. As regards foreign membership the Lincei take the lead in an important innovation, which will doubtless be adopted in due course by the great scientific institutes of other countries. In a truly "international" spirit, they henceforth practically abolish the distinction between *Associates* (Soci, or home members) and *Correspondents* (Corrispondenti, or foreign members). The clause bearing on this point in the President's Circular of June 26, 1883, deserves to be here quoted in full:—

"Per ciò che concerne gli stranieri fu unanime il pensiero di togliere la distinzione fra i Socî ed i Corrispondenti: distinzione la quale riferendosi a pochi personaggi eminenti nelle scienze a cui attendono e disseminati in tutto il mondo civile, riesce difficilissima e di utilità molto dubbia. Per le scienze fisiche, matematiche, e naturali parve necessario un aumento nel numero degli stranieri aggregabili all' Accademia, non solo per dare una dimostrazione d'onore a personaggi cosi benemeriti, ma anche per agevolare le relazioni scientifiche le quali si fanno ogni giorno più frequenti, più necessarie, e più intime fra i cultori delle stesse scienze ed i direttori di analoghi stabilimenti scientifici, independentemente dai confini politici che li separono."[2]

Amongst the foreign *savants* who thus receive full membership, occur the names of Airy, Adams, Lockyer, and Huggins in Astronomy, Ramsay in Geology, Hooker in Botany, Huxley in Zoology, Cayley and Roberts in Mathematics, Whitney in Philology, Freeman in History and Geography, Gladstone in Social Science.

As reorganised under the new constitution, the Academy consists henceforth of two classes: (1) Physical, Mathematical, and Natural Sciences; (2) Moral Sciences,—distributed into a number of Categories and Sections as under:—

CLASS I.

Categories	Sections	Members
1.	Mathematics	15
	Mechanics	11
	Astronomy	11
	Geography (Physical)	4
2.	Physics	17
	Chemistry	8
	Crystallography and Mineralogy	9
3.	Geology and Palæontology	11
4.	Botany	9
	Zoology and Morphology	8
5.	Agronomy	3
	Physiology	6
	Pathology	3

CLASS II.

Categories	Members
1. Philology	17
2. Archæology	19
3. History and Historical Geography	16
4. Philosophy	15
5. Jurisprudence	10
6. Social Science	21

On May 14, 1881, an Act was passed granting a large sum for the purpose of erecting or purchasing a suitable edifice for the Lincei, henceforth officially recognised as the "Royal Academy of Sciences." After protracted negotiations, an arrangement was made with Prince Tommaso Corsini, in virtue of which for the sum of 95,400*l.* the Academy acquired the perpetual use of the magnificent Palazzo Corsini, situated in the Via della Longara, Trastevere. The purchase, which was effected in May 1883, included the furniture, fittings, gardens, and annexes, but not the Library and Pinakothek, which, being entailed, the prince had no power to alienate. To meet this difficulty a special Act was subsequently passed, which removed the entail, and enabled the prince to make a free gift of the Pinakothek to the nation, and of the Library to the Accademia dei Lincei. The Library, originally collected by Cardinal Neri Corsini, and bequeathed by him in 1774 to his nephew, Duca don Filippo Corsini, comprises the prints, drawings, books, and manuscripts occupying the nine rooms on the first floor of the north side of the building so well known to English visitors in Rome. It passes to the Lincei on the condition of being preserved by them for the public use under the name of the "Biblioteca Corsiniana." It is also to be kept for ever not only in Rome, but in Trastevere, as set forth in the disposition of its chief founder, Cardinal Neri Corsini. Some of our readers may possibly remember the two allegorical busts at the main entrance of the palace. These are now to be replaced by busts of the Cardinal and of Prince Tommaso Corsini, with inscriptions recording their services to the cause of the arts and sciences. The prince also receives from the Academy the gift of a complete copy of its *Atti* or *Proceedings*, of which there are three series: (1) under the Pontifical "dispensation," 23 vols.; (2) 1873–76, 8 vols.; (3) 1876–83, 7 vols. On the yellow wrapper of the present series the tiara gives place to the royal crown of Italy above the lynx, and the Lincei pass from the shadow of the now silent Sant' Uffizio to a right royal residence on the banks of yellow Tiber.

A. H. KEANE

[1] "E benchè il principal loro oggetto fosser le scienze matematiche e filosofiche, non trascuravono però l'amena letteratura e gli studi poetici" (viii. p. 73).

[2] As finally modified in the new articles, the clause affecting foreign members runs thus:—"I soci stranieri sono equiparati ai nazionali allorquando essi sono in Italia."

NIELS HENRIK CORDULUS HOFFMEYER

WE have already (p. 387) briefly referred to the death of Capt. Hoffmeyer; the importance of his work in meteorology deserves more detailed notice.

Capt. Hoffmeyer was born at Copenhagen, June 3, 1836. His father was Col. A. B. Hoffmeyer. He commenced his studies with a view to a professional career, but the idea was soon abandoned, and he was entered as a pupil in the military academy. At the age of eighteen he became an officer, and on completing his studies he received an appointment in the artillery service.

He was engaged in the Schleswig-Holstein war of 1864, but as early as February he was compelled by illness to retire from active service. In early youth he had suffered from rheumatic fever, and the exposure and fatigues of the winter campaign soon laid him prostrate with another severe attack of the same fever. On the reduction of the army at the close of that year, Capt. Hoffmeyer was placed on the retired list.

He spent the early part of the summer of 1865 recruiting his health at Sophienbad, a watering-place near Hamburg, and in August he proceeded to Paris, where and at Nantes he remained a year studying the works carried on at the iron foundries there. On his return to Denmark he took an active part in establishing a similar foundry at Christiansholm, but in 1867 he was appointed to a post in the War Department, and became at the same time a captain of the militia of Copenhagen.

It was while residing in France that Hoffmeyer's attention began to be directed to meteorology. At that time, fortunately, the principles which distinguish modern meteorology were being developed and prosecuted by the genius and energy of Leverrier, in the daily publication in the *Bulletin International* of a weather map for all Europe, which had been begun only two years before. After his appointment to the War Department, he devoted his energies with characteristic ardour to the study of meteorology, and when the Danish Government established the Meteorological Institute in 1872, Capt. Hoffmeyer was appointed director.

He continued to suffer from occasional attacks of rheumatic fever, and during the last year of his life was never quite well; but in spite of the great weakness under which he laboured, his overmastering passion for hard work would not be controlled. His health again gave way at the end of January, and he finally succumbed at one o'clock on the afternoon of February 16.

It was from a singularly clear and firm apprehension of the characteristic principles of modern meteorology, and an unflinching application of them to the facts of observation, that Capt. Hoffmeyer has left his mark on the science,—these principles being the relations of winds, temperature, and rainfall to the distribution of atmospheric pressure. In working out the weather problem of Europe, no country occupies a more splendid position for the observation of the required data than does Denmark with its dependencies of Farö, Iceland, and Greenland. Denmark was slow to occupy the field, nothing being done in this direction by the Danish Government prior to Hoffmeyer's appointment as Director of the Meteorological Institute. In a short time these important regions were represented by stations in Greenland, Iceland, and Farö. The meteorology of Denmark proper was pushed forward with great vigour. In truth, the monthly meteorological *Bulletin* of Denmark is in several respects among the best that reach us. The number for January, 1884, just received, presents the monthly results of pressure for 13 stations, temperature for 109 stations, and rainfall and other forms of precipitation for 159 stations. These results are graphically shown on four maps, accompanied with a full descriptive letter-press—one map giving the isobars for the month, another the isothermals, and on the same map the mean temperature at each of the 109 stations; a third map, the minimum temperature at each of the stations; while the fourth gives isohyetal lines showing the rainfall, and here again the amount at each of the 159 rain stations is entered in plain figures on the map. The educative effect of these instructive monthly sheets on a people whose industries are so largely pastoral and agricultural must be very great.

It was, however, to the department of meteorology which is concerned with the preparation and study of synoptic weather charts that Hoffmeyer chiefly directed his attention. The great services he rendered in this direction may be indicated by a reference to his atlas of daily weather maps of the Atlantic, embracing a period of fully three years, the expense of which was almost wholly borne by himself, and his annual reports giving tri-daily observations for the Denmark, Farö, Iceland, and Greenland stations—a work which no working meteorologist can afford to be without. It was arranged last summer to resume the publication of the synoptic charts in conjunction with Neumayer, and the work was so far advanced that the first sheets were printed off on February 17, the day after his death.

Of the positive additions Hoffmeyer made to science, the most noteworthy are his papers on the Greenland foehn (NATURE, vol. xvi. p. 294), and on the distribution of atmospheric pressure in winter over the North Atlantic, and its influence on the climate of Europe (NATURE, vol. xviii. p. 680). The latter is an original and highly important contribution to science, whether regard be had to the method of investigation or to the results. He showed that the character of the weather, as regards mildness or severity of the winter of the regions surrounding the North Atlantic, is really determined by the position of the region of minimum pressure, according as it is localised to the south-west of Ireland, in Davis Straits, or midway between Jan Mayen and the Lofoden Islands.

It was but fitting that he should have occupied the honourable position of Secretary to the International Polar Commission, one of the principal objects of which was to collect materials for a satisfactory discussion of the different questions raised by the weather maps of the northern hemisphere. For this office the sincerity of his convictions, his honesty of purpose, and his business habits, eminently fitted him. To all who knew him, the memory of his eager readiness to assist fellow-workers, the urbanity of his manner, his joyous nature, and the unusual warmth of his friendship, cannot but awaken the keenest feelings of regret for his early death.

NOTES

As the British Association meets this year—its fifty-fourth—on August 27, in Montreal, preparations for the meeting have had to be made unusually early. Already everything is ready, and we are able to announce the lists of officials. President: the Right Hon. Lord Rayleigh, D.C.L., F.R.S., Professor of Experimental Physics in the University of Cambridge. Vice-Presidents: His Excellency the Governor-General of Canada; the Right Hon. Sir John Alexander Macdonald, K.C.B., D.C.L.; the Right Hon. Sir Lyon Playfair, K.C.B., M.P., F.R.S; the Hon. Sir Alexander Tilloch Galt, G.C.M.G.; the Hon. Sir Charles Tupper, K.C.M.G.; Sir Narcisse Dorion, C.M.G.; the Hon. Dr. Chauveau; Principal J. W. Dawson, C.M.G., F.R.S.; Prof. Edward Frankland, M.D., D.C.L., F.R.S.; W. H. Hingston, M.D.; Thomas Sterry Hunt, LL.D., F.R.S. General Treasurer: Prof. A. W. Williamson, LL.D., F.R.S. General Secretaries: Capt. Douglas Galton, C.B., D.C.L., F.R.S.; A. G. Vernon Harcourt, F.R.S. Secretary: Prof. T. G. Bonney, D.Sc., F.R.S., P.G.S. Local Secretaries for the meeting at Montreal: L. E. Dawson, R. A. Ramsay, S. Rivard, S. C. Stevenson, Thomas White, M.P. Local Treasurer for the meeting at Montreal, F. Wolferstan Thomas. The Sections are the following:—A.—Mathematical and Physical Science.—President: Prof. Sir William Thomson, M.A., LL.D., D.C.L., F.R.SS.L. and E., F.R.A.S. Vice-Presidents: Prof. J. B. Cherriman, M.A.; J. W. L. Glaisher, M.A., F.R.S., F.R.A.S. Secretaries: Charles H. Carpmael, M.A.; Prof. A. Johnson, M.A., LL.D.; Prof. O. J. Lodge, D.Sc.; D. MacAlister, M.A., M.B., B.Sc. (Recorder). B.—Chemical Science.—President: Prof. H. E. Roscoe, Ph.D., LL.D., F.R.S., F.C.S. Vice-Presidents: Prof. Dewar, M.A., F.R.S., F.C.S.; Prof. B. J. Harrington, B.A., Ph.D. Secretaries: Prof. P. Phillips Bedson, D.Sc., F.C.S. (Recorder); H. B. Dixon, M.A., F.C.S.; T. McFarlane, Prof. W. W. Pike. C.—Geology.—President: W. T. Blanford, F.R.S., F.G.S., F.R.G.S. Vice-Presidents: Prof. Rupert Jones, F.R.S., F.G S.; A. R. C. Selwyn, LL.D., F.R.S., F.G.S. Secretaries: F. Adams, B.Ap.Sc.; G. M. Dawson, D.Sc., F.G.S.; W. Topley, F.G.S. (Recorder); W. Whitaker, B.A., F.G.S. D.—Biology.—President: Prof. H. N. Moseley, M.A., F.R.S., F.L.S., F.R.G.S., F.Z.S. Vice-Presidents: W. B. Carpenter, C.B., M.D., LL.D., F.R.S., F.L.S., F.G.S.; Prof. R. G. Lawson, Ph.D., LL.D. Secretaries: Prof. W. Osler, M.D.; Howard Saunders, F.L.S., F.Z.S. (Recorder); A. Sedgwick, B.A.; Prof. R. Ramsay Wright, M.A., B.Sc. E.—Geography.—Vice-Presidents: Col. Rhodes; P. L. Sclater, M.A., Ph.D., F.R.S., F.L.S., F.G.S., F.R.G.S. Secretaries: R. Bell, M.D., LL.D., F.G.S.; Rev. Abbé Laflamme; E. G. Ravenstein, F.R.G.S.; E. C. Rye, F.Z.S. (Recorder). F.—Economic Science and Statistics.—President: Sir R. Temple, G.C.S.I., C.I.E., D.C.L., F.R.G.S. Vice-Presidents, J. B. Martin, F.S.S.; Prof. J. Clark Murray, LL.D. Secretaries: Prof. H. S. Foxwell, M.A., F.S.S.; J. S. McLennan, B.A.; Constantine Molloy (Recorder); Prof. J. Watson, M.A., LL.D. G.—Mechanical Science.—President: Sir F. J. Bramwell, F.R.S., M.Inst.C.E. Vice-Presidents: Prof. H. T. Bovey, M.A.; P.G. B. Westmacott, M.Inst.C.E. Secretaries: A. T. Atchison, M.A., C.E.; J. Kennedy, C.E.; L. Lesage, C.E.; H. T. Wood, B.A. (Recorder). H.—Anthropology.—President: E. B. Tylor, D.C.L., LL.D., F.R.S. Vice-Presidents: Prof. W. Boyd Dawkins, M.A., F.R.S., F.S.A., F.G.S.; Prof. Daniel Wilson, LL.D., F.R.S.E. Secretaries: G. W. Bloxam, M.A., F.L.S. (Recorder); Rev. J. Campbell, M.A.; Walter Hurst, B.Sc.; J. M. P. Lemoine. It is expected that the public lectures will be by Mr. Crookes, Dr. Dallinger, and Prof. Ball. Liberal reductions of fares will be made by the steamship companies and the American railways; the Canadian Pacific Railway, indeed, gives free travelling to all members from August 1 to the time for the excursion to the Rocky Mountains, which it offers free to 150 members. Many other excursions have been arranged for, and the American Association invites the members to join its meetings and excursions at Philadelphia on September 3. We are glad to see that Section A is following the good example set by Prof. Lankester in Biology last year. A circular signed by Sir William Thomson has been issued by the Committee of Section A, inviting the co-operation of mathematicians and physicists, and requesting those willing to read papers and take part in the discussions to send their names to the Secretaries of Section A, British Association, Albemarle Street. The following subjects have been selected for special discussion by the Committee:—On Friday, August 29, The Seat of the Electromotive Forces in the Voltaic Cell. On Monday, September 1, The Connection of Sunspots with Terrestrial Phenomena.

THE death is announced on March 1 of Dr Isaac Todhunter, F.R.S., the well-known mathematician, at his residence, Brookside, Cambridge. Dr. Todhunter was born in 1820, and having passed some years of his life as usher in a school, proceeded to University College, London, and when twenty-four years of age, entered as an undergratuate of St. John's. He graduated in the Mathematical Tripos of 1848, obtaining the distinction of Senior Wrangler and first Smith's Prizeman in a year which produced some remarkably able men. Dr. Todhunter was in due course elected to a Fellowship at St. John's, and subsequently filled the offices of assistant tutor and principal lecturer in mathematics. Dr. Todhunter is well known as the author of numerous mathematical treatises, which have obtained a wide circulation, and are recognised as standard works of education in the universities and public schools. His treatises on the "Differential Calculus," "Analytical Statics," "Plane Coordinate Geometry," "Plane Trigonometry," and "Spherical Trigonometry," greatly enhanced his reputation. He also published various elementary works, all of which enjoyed a large circulation. In 1871 he obtained the Adams Prize for an essay, "Researches on the Calculus of Variations." He published, in 1873, "A History of the Mathematical Theories of Attraction and the Figure of the Earth from the time of Newton to that of Laplace." In 1876 there also appeared from his pen, "An Account of the Writings of William Whewell, D.D., Master of Trinity College, with selections from his literary and scientific correspondence." By the new University statutes the University was authorised to confer the degrees of Doctor in Science and Doctor in Letters. Dr. Todhunter was among the first upon whom the distinction of Doctor in Science was conferred, and last year proceeded to that degree. A few years previously he had been elected an honorary Fellow of his College as a mark of recognition of his great mathematical attainments. It may be mentioned that Dr. Todhunter took an active part in University affairs, was a member of several Syndicates and Boards of Studies, and an elector to the Plumian Professorship of Astronomy. He had been in failing health for some time, and a few weeks ago was attacked with paralysis, which precluded all hope of recovery.

NATURAL HISTORY, and especially Palæontology, in Sicily, have sustained a great loss in the decease of the septuagenarian Abbé Brugnone, who died at Palermo on the 3rd of last month. He published several excellent papers on the recent and Pliocene shells of his native island, which were illustrated by his own pencil. His real name appears from the obituary card to have been Rugnone. We understand that his valuable collections are for sale.

M. FAYE read at the last meeting of the Academy of Sciences the draft of a resolution which will be presented by the Special Commission appointed to report on the removal of the Observatory, and which will be discussed by the Academy at one of its next private sittings. It approves the removal of the Observatory to a site in close proximity to Paris, and the sale of the grounds, on condition that the existing building will remain intact, and so much land as is necessary for executing astronomical observations in the establishment.

THE Academy of Sciences has nominated M. Darboux a member in the Section of Geometry. Mr. Darboux is the editor of a mathematical paper published in Paris, and the author of numerous memoirs on analysis and geometry printed in the *Transactions* of the Academy.

M. BERTRAND has issued the first number of a monthly astronomical journal published by the Observatory of Paris under the title of the *Bulletin*. It is edited by M. Tisserand, with the co-operation of a number of astronomers of the Paris Observatory.

UNDER the auspices of the Paris Geographical Society a course of lectures is being delivered by some of the most eminent French men of science. These lectures, eight in number, are held every Monday, at 8.30 p.m.; they began on February 11, and end on March 31, in the Hall of the Geographical Society. The following are the subjects of these lectures:—M. Faye, of the Institute, the connection of astronomy and geography in the principal periods of history; M. de Lapparent, M.E., reliefs of the globe; M. E. Fuchs, M.E., distribution of minerals; M. Mascart, director of the Meteorological Bureau, climate; M. Vélain, lecturer at the Sorbonne, glaciers and their action on the reliefs of the globe; M. Bureau, professor at the Museum of Natural History, geographical distribution of plants; M. Ed. Perrier, professor at the Museum of Natural History, the depths of the sea and their inhabitants; M. Alphonse Milne-Edwards, of the Institute, geographical distribution of animals. The course will be continued next year. Information respecting the above lectures, to which the public is admitted, may be had at the rooms of the Geographical Society, 184, Boulevard St. Germain.

THE Rev. Marc Dechevrens, S.J., of Zi-ka-wei Observatory, writes to us under date January 22, that the sky there continues to exhibit remarkable colours; during this winter the zodiacal light appeared to M. Dechevrens to be more feeble than in preceding years. He incloses a letter from Dr. D. J. Macgowan of Hankow to the *North China Daily News*:—"A phenomenon similar to the 'green sun in India' (observed at Ceylon from September 9 to 11 inclusive; from various portions of the Indian Ocean on the 10th and 13th; and at Trichinopoly, for some three weeks preceding October 2) has been witnessed several times at Hankow; on November 17 by the Rev. A. W. Nightingale, and on another occasion about the same time (date unrecorded), and again so recently as December 29 by the Rev. G. John and Rev. A. Foster. On these occasions the sun shortly before setting was of a pale green tint, the colour deepening as the orb declined; then followed an exhibition of the glowing redness of the western and southern horizon, which since the early part of December last has been observed from the sea-board far into the interior. Information from other parts of China respecting the 'green sun' is a desideratum."

THE latest official report on the condition of the districts overwhelmed by the Krakatoa eruption states that the surviving inhabitants of the various villages have reassembled under their headmen, and are erecting their huts. The volcanic ashes did little harm to the soil, the growing crops all presenting a luxuriant appearance. The trees, however, have suffered greatly, as had some of the coffee plantations. Two bays, Lampong and Semengka, which were blocked up by the fields of pumice, were free by the middle of December.

ON a summer night of 1882 a woman in Högsby parish, in Sweden, saw a shining object fall from the sky, disappearing behind a stable. Search was made for the meteorite, according to the statements of the woman, but without success. Last autumn it was, however, accidentally discovered near the spot indicated, and has now been forwarded to proper quarters in the town of Oskarshamn. The surface of the meteorite appears as if it had been welded from various substances; it is about the size of a billycock hat, very thick, and weighs a little over 14 lbs.

M. W. DE FONVIELLE writes:—"I took the liberty of suggesting in one of the last issues of the *Ville de Paris* a scheme for discovering clock-work in parcels deposited in luggage-rooms. All the luggage should be laid flat on wooden tables supported by iron feet, and not nailed to them; the least noise within the parcels would be made audible if a microphone of proper construction were placed on each table. The charge for keeping should be made heavier to diminish the number of parcels, and the right of opening optional with the railway companies."

THE Commission for Montsouris Observatory held its annual sitting at the end of February. It was resolved to ask from the Municipal Council an increase of the annual allocation, which is somewhat less than 1200*l*., exclusive of some extra charges. But it is not supposed the request will be granted, and a diminution is rather expected. It must be remembered that meteorological observations are now conducted at Montsouris, at Parc Saint Maur, and at the Paris Observatory, almost on the same principles and with analogous instruments. It is curious to see this triple working by almost independent administrations.

THE long isolated kingdom of Corea having now been definitely opened by treaties to European trade and residence, we may soon expect English scholars to take their part in exploring its language, literature, and history. For the benefit of those about to study in the new field, it may be well to recall the fact that, so far, we are entirely dependent on French priests for the meagre knowledge we possess of the country. There is a paper in the *Transactions of the Royal Asiatic Society*, by Mr. Aston of Japan, on the Corean language, but the two works to which for some years to come European students must first resort are the Grammar and Dictionary edited by Msgr. Ridel, and published by Lévy of Yokohama. The latter appeared in 1879, and is a large volume of some 700 pages, containing about 30,000 words. The native words are accompanied not only by a French transliteration, but also by the Chinese characters representing them, so that the work can be used by a Chinese as well as a European, and, to those who already know Chinese or Japanese, an additional explanation is thus supplied. All that is known respecting the country to the priests—its fauna, flora, arts, manners, and customs—finds a place in the volume. An appendix gives a brief sketch of the grammar, while another contains the geography, the names, and position of the provinces, mountains, rivers, and chief towns. The Grammar was published last year, and contains an introduction on the character of the Corean language, and a comparison of it with Chinese, as well as appendices on the divisions of time, weights, measures, the mariner's compass, &c. Throughout the East the Catholic missionaries have been the advanced guard of European science and methods of study. The volumes which they produced nearly a hundred years ago on China are still as necessary to thorough study of that country as they were then. The student who cannot refer to the original authorities, as, for instance, Chinese history, had, until the recent publication of Mr. Boulger's work, to go to the long series of volumes published towards the close of the last century by the Société des Missions Étrangères under the editorship of de Mailla, Amyot, and other missionaries.

WE learn from *Science* that at 7.24 p.m. on January 25 earthquake waves were indicated by the delicate levels of the astronomical instruments of the San Francisco Observatory. The amplitude of each vibration was three seconds of arc in three seconds of time, and they continued for twenty minutes.

AT the last meeting of the Sociological (Spencerian) Section of the Birmingham Natural History Society it was decided to commence making an index to the study of Sociology. Letters were read from Mr. Spencer approving of the system about to be adopted, and stating that time and health had alone prevented him commencing such an undertaking previously.

THE Westphalian Provinzial Verein for Science and Art is about to publish a large work entitled "Westphalen's Thierleben in Wort und Bild." The Society also intends establishing a Provinzial Museum.

AT Berlin a branch of the German Meteorological Society was founded on January 29 last.

WE are pleased to learn that a complete catalogue of the Reference Department of the Nottingham Free Library is in course of preparation, but as that will be the work of some time, class lists have been issued for public use in the meantime. The publication noticed in these columns on January 31 was one of these, already supplemented considerably.

AT the suggestion of the Austrian Crown Prince, a work on the ethnography of the Empire is about to be written. Maurus Jokaj, the well-known Hungarian, has been intrusted with the task of editing it.

A SEVERE shock of earthquake, lasting two seconds, was felt at 4 a.m. on February 25 at Chios, Tchesme, and Vourla. So far as is known at present no damage has been done. An earthquake-wave, lasting about fifteen minutes, and inundating part of the town, was noticed at Montevideo on January 14, at 7.30 a.m. The weather was fine; the direction of the wave was from the Patagonian coast. Several people were drowned on the south side of the town.

THE death is announced of Prof. Heinrich Karl Berghaus, the well-known geographer and historian. Born at Kleve on May 3, 1797, he died at Stettin on February 17 last.

AN Engineering Exhibition will be held at Breslau from June 9 to 11 next.

THE additions to the Zoological Society's Gardens during the past week include a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. J. B. Drew; an Arabian Gazelle (*Gazella arabica* ♀) from Arabia, presented by Lieut. Brown, R.N.; two Herring Gulls (*Larus argentatus*), European, presented by Mr. G. D. Macgregor; a Ring-necked Parrakeet (*Palaeornis torquatus*) from India, presented by Mr. J. Biehl; a Black-headed Gull (*Larus ridibundus*), European, presented by Miss Elise Cooper; eight Hoary Snakes (*Coronella cana*) from South Africa, presented by Mr. C. B. Pillans; a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by Mr. R. A. Robertson; a Common Heron (*Ardea cinerea*), a Cirl Bunting (*Emberiza cirlus*), British, a Banded Parrakeet (*Palaeornis fasciatus*) from India, purchased; three Mute Swans (*Cygnus olor*), European, received in exchange; eight Brown-tailed Gerbilles (*Gerbillus erythyrurus*), born in the Gardens.

THE SIX GATEWAYS OF KNOWLEDGE[1]

I THANK you most warmly for the honour you have done me in electing me to be your president. I value the honour very highly; but when I look at the list of distinguished men who have preceded me in the office, I feel alarmed at the responsibility I have undertaken. A very pleasing duty, however, has been already performed in the interesting and not onerous function we have now gone through. I would gladly speak on the several subjects, for merit in the study of which these prizes have been awarded; but I am afraid that if I were to do so, it would be more for my own gratification than for your pleasure and profit, and I feel that I shall best consult your wishes in passing on at once to the subject of the address which it becomes my duty to give.

The title of the subject upon which I am going to speak this evening might be—if I were asked to give it a title—"The Six Gateways of Knowledge." I feel that the subject I am about to bring before you is closely connected with the studies for which the several prizes have been given. The question I am going to ask you to think of is: What are the means by which the human mind acquires knowledge of external matter?

John Bunyan likens the human soul to a citadel on a hill, self-contained, having no means of communication with the outer world, except by five gates—Eye Gate, Ear Gate, Mouth Gate, Nose Gate, and Feel Gate. Bunyan clearly was in want of a word here. He uses "feel" in the sense of "touch," a designation which to this day is so commonly used that I can scarcely accuse it of being incorrect. At the same time, the more correct and distinct designation undoubtedly is, the sense of touch. The late Dr. George Wilson, first Professor of Technology in the University of Edinburgh, gave, some time before his death, a beautiful little book under the title of "The Five Gateways of Knowledge," in which he quotes John Bunyan in the manner I have indicated to you. But I have said *six* gateways of knowledge, and I must endeavour to justify this saying. I am going to try to prove to you that we have six senses—that if we are to number the senses at all we must make them six.

The only census of the senses, so far as I am aware, that ever made them more than five before was the Irishman's reckoning of seven senses. I presume the Irishman's seventh sense was common sense; and I believe that the large possession of that virtue by my countrymen—I speak as an Irishman—I say the large possession of the seventh sense, which I believe Irishmen have, and the exercise of it, will do more to alleviate the woes of Ireland than even the removal of the melancholy ocean which surrounds its shores. Still I cannot scientifically see how we can make more than six senses. I shall, however, should time permit, return to this question of a seventh sense, and I shall endeavour to throw out suggestions towards answering the question—Is there, or is there not, a magnetic sense? It is possible that there is, but facts and observations so far give us no evidence that there is a magnetic sense.

The six senses that I intend to explain, so far as I can, this evening, are according to the ordinary enumeration, the sense of sight, the sense of hearing, the sense of smell, the sense of taste, and the sense of touch, divided into two departments. A hundred years ago Dr. Thomas Reid, Professor of Moral Philosophy in the University of Glasgow, pointed out that there was a broad distinction between the sense of roughness or of resistance, which was possessed by the hand, and the sense of heat. Reid's idea has not I think been carried out so much as it deserves. We do not, I believe, find in any of the elementary treatises on natural philosophy, or in the physiologists' writings upon the senses, a distinct reckoning of six senses. We have a great deal of explanation about the muscular sense, and the tactile sense; but we have not a clear and broad distinction of the sense of touch into two departments, which seems to me to follow from Dr. Thomas Reid's way of explaining the sense of touch, although he does not himself distinctly formulate the distinction I am now going to explain.

The sense of touch, of which the organ commonly considered is the hand, but which is possessed by the whole sensitive surface of the body, is very distinctly a double quality. If I touch any object, I perceive a complication of sensations. I perceive a certain sense of roughness, but I also perceive a very distinct sensation, which is not of roughness, or of smoothness. There are two sensations here, let us try to analyse them. Let me dip my hand into this bowl of hot water. The moment I touch the water, I perceive a very distinct sensation, a sensation of heat. Is that a sensation of roughness, or of smoothness? No. Again, I dip my hand into this basin of iced water. I perceive a very distinct sensation. Is this a sensation of roughness, or of smoothness? No. Is this comparable with that former sensation of heat? I say yes. Although it is opposite, it is comparable with the sensation of heat. I am not going to say that we have two sensations in this department—a sensation of heat, and a sensation of cold. I shall endeavour to explain that the perceptions of heat and of cold are perceptions of different degrees of one and the same quality, but that that quality is markedly different from the sense of roughness. Well now, what is this sense of roughness? It will take me some time to explain it fully. I shall therefore say in advance that it is a sense of force; and I shall tell you in advance, before I justify completely what I have to say, that the six senses, regarding which I wish to give some explanation, are: the sense of sight, the sense of hearing, the sense of taste, the sense of smell, the sense of heat, and the sense of force. The sense of force is the sixth sense; or the senses of heat and of force are the sense of touch divided into two, to complete the census of six that I am endeavouring to demonstrate.

Now I have hinted at a possible seventh sense—a magnetic sense—and though out of the line I propose to follow, and although time is precious, and does not permit much of digression, I wish just to remove the idea that I am in any way suggesting anything towards that wretched superstition of animal magnetism, and table-turning, and spiritualism, and mesmerism, and clairvoyance, and spirit-wrapping, of which we have heard so much. There is no seventh sense of the mystic kind. Clairvoyance, and the like, are the result of bad observation chiefly, somewhat mixed up, however, with the effects of wilful imposture, acting on an innocent, trusting mind. But if there is not a distinct magnetic sense, I say it is a very great wonder that there is not.

Many present know all about magnetism. A very large number of pupils have gained an immense amount of valuable knowledge in various subjects, from the classes carried on nightly within the walls of the Birmingham and Midland Institute; and I can see from the prizes that have been awarded, and that I have just now had the pleasure of distributing for excellence and proficiency in this department, that many have learned of magnetism. I had the pleasure of seeing the class-rooms this morning, and I wished I could be in them in the evening to see the studies as carried on in them every evening. Well now, the study of magnetism is the study of a very recondite subject. We all know a little about the mariner's compass, the needle pointing to the north, and so on; but not many of us have gone far into the subject, and not many of us understand all the recent discoveries in electromagnetism. I could wish, had I the apparatus here, and if you would allow me, to show you an experiment in magnetism. If we had before us a powerful magnet, or say the machine that is giving us this beautiful electric light by which the hall is illuminated, it, serving to excite an electro-magnet, would be one part of our apparatus; the other part would be a piece of copper. Suppose then we had this apparatus, I would show you a very wonderful discovery made by Faraday and worked out admirably by Foucault, an excellent French experimenter. I have said that one part of this apparatus would be a piece of copper, but silver would answer as well. Probably no other metal than copper or silver—certainly no other one, of all the metals that are well known, and obtainable for ordinary experiments—possesses, and no other metal or substance, whether metallic or not, is known to possess, in anything like the same degree as copper and silver, the quality I am now going to call attention to.

The quality I refer to is "electric conductivity," and the result of that quality in the experiment I am now going to describe is, that a piece of copper or a piece of silver, let fall between the poles of a magnet, will fall down slowly as if it were falling through mud. I take this body and let it fall. Many of you here will be able to calculate what fraction of a second it takes to fall one foot. If I took this piece of copper, placed it just above the space between the poles of a powerful electromagnet and let it go, you would see it fall slowly down before you; it would perhaps take a quarter of a minute to fall a few inches.

This experiment was carried out in a most powerful manner by Lord Lindsay (now Lord Crawford), assisted by Mr. Crom-

[1] An Address at the Midland Institute, Birmingham, October 3, 1883, by Prof. Sir William Thomson, LL.D., F.R.S., president.

well F. Varley. Both of those eminent men desired to investigate the phenomena of mesmerism, which had been called animal magnetism; and they very earnestly set to work to make a real physical experiment. They asked themselves, Is it conceivable that, if a piece of copper can scarcely move through the air between the poles of an electromagnet, a human being or other living creature placed there would experience no effect? Lord Lindsay got an enormous electromagnet made, so large that the head of any person wishing to try the experiment could get well between the poles, in a region of excessively powerful magnetic force. What was the result of the experiment? If I were to say *nothing!* I should do it scant justice. The result was marvellous, and the marvel is that nothing was perceived. Your head, in a space through which a piece of copper falls as if through mud, perceives nothing. I say this is a very great wonder; but I do not admit, I do not feel, that the investigation of the subject is completed. I cannot think that the quality of matter in space which produces such a prodigious effect upon a piece of metal can be absolutely without any—it is certainly not without any—effect whatever on the matter of a living body; and that it can be absolutely without any *perceptible* effect whatever on the matter of a living body placed there seems to me not proved even yet, although nothing has been found. It is so marvellous that there should be no effect at all, that I do believe and feel that the experiment is worth repeating; and that it is worth examining, whether or not an exceedingly powerful magnetic force has any perceptible effect upon a living vegetable or animal body. I spoke then of a seventh sense. I think it just possible that there may be a magnetic sense. I think it possible that an exceeding powerful magnetic effect may produce a sensation that we cannot compare with heat or force or any other sensation.

Another question that often occurs is, "Is there an electric sense?" Has any human being a perception of electricity in the air? Well, somewhat similar proposals for experiment might, perhaps, be made with reference to electricity; but there are certain reasons, that would take too long for me to explain, that prevent me from placing the electric force at all in the same category with magnetic force. There would be a surface action that would annul practically the force in the interior, there would be a definite sensation which we could distinctly trace to the sense of touch. Any one putting his hand, or his face, or his hair, in the neighbourhood of an electric machine perceives a sensation, and on examining it he finds that there is a current of air blowing, and his hair is attracted; and if he puts his hand too near he finds that there are sparks passing between his hand or face and the machine; so that, before we come to any subtle question of a possible sense of electric force, we have distinct mechanical agencies which give rise to senses of temperature and force; but that this mysterious, wonderful, magnetic force, due, as we know, to rotations of the molecules, could be absolutely without effect—without perceptible effect—on animal economy, seems a very wonderful result, and at all events it is a subject deserving careful investigation. I hope no one will think I am favouring the superstition of mesmerism in what I have said.

I intend to explain a little more fully our perceptions in connection with the double sense of touch—the sense of temperature and the sense of force—should time permit before I conclude. But I must first say something of the other senses, because if I speak too much about the senses of force and heat no time will be left for any of the others. Well, now, let us think what it is we perceive in the sense of hearing. Acoustics is one of the studies of the Birmingham and Midland Institute, of which we have heard many times this evening. Acoustics is the science of hearing. And what is hearing? Hearing is perceiving something with the ear. What is it we perceive with the ear? It is something we can also perceive without the ear; something that the greatest master of sound, in the poetic and artistic sense of the word at all events, that ever lived—Beethoven—for a great part of his life could not perceive with his ear at all. He was deaf for a great part of his life, and during that period were composed some of his grandest musical compositions, and without the possibility of his ever hearing them by ear himself; for his hearing by ear was gone from him for ever. But he used to stand with a stick pressed against the piano and touching his teeth, and thus he could hear the sounds that he called forth from the instrument. Hence, besides the Ear Gate of John Bunyan, there is another gate or access for the sense of hearing.

What is it that you perceive ordinarily by the ear—that a healthy person, without the loss of any of his natural organs of sense, perceives with his ear, but which can otherwise be perceived, although not so satisfactorily or completely? It is distinctly a sense of varying pressure. When the barometer rises, the pressure on the ear increases; when the barometer falls, that is an indication that the pressure on the ear is diminishing. Well, if the pressure of air were suddenly to increase and diminish, say in the course of a quarter of a minute—suppose in a quarter of a minute the barometer rose one-tenth of an inch and fell again, would you perceive anything? I doubt it; I do not think you would. If the barometer were to rise two inches, or three inches, or four inches, in the course of half a minute, most people would perceive it. I say this as a result of observation, because people going down in a diving bell have exactly the same sensation as they would experience if from some unknown cause the barometer quickly, in the course of half a minute, were to rise five or six inches—far above the greatest height it ever stands at in the open air. Well, now, we have a sense of barometric pressure, but we have not a continued indication that allows us to perceive the difference between the high and low barometer. People living at great altitudes—up several thousand feet above the level of the sea, where the barometer stands several inches lower than at sea-level—feel very much as they would do at the surface of the sea, so far as any sensation of pressure is concerned. Keen mountain air feels different from air in lower places, partly because it is colder and drier, but also because it is less dense, and you must breathe more of it to get the same quantity of oxygen into your lungs to perform those functions, which the students of the Institute who study animal physiology—and I understand there are a large number—will perfectly understand. The effect of the air in the lungs—the function it performs—depends chiefly on the oxygen taken in. If the air has only three-quarters of the density it has in our ordinary atmosphere here, then one and one-third times as much must be inhaled, to produce the same oxidising effect on the blood, and the same general effect in the animal economy; and in that way undoubtedly mountain air has a very different effect on living creatures from the air of the plains. This effect is distinctly perceptible in its relation to health.

But I am wandering from my subject, which is the consideration of the changes of pressure comparable with those that produce sound. A diving bell allows us to perceive a sudden increase of pressure, but not by the ordinary sense of touch. The hand does not perceive the difference between 15 lbs. per square inch pressing it all around, and 17 lbs., or 18 lbs., or 20 lbs., or even 30 lbs. per square inch, as is experienced when you go down in a diving bell. If you go down five and a half fathoms in a diving bell, your hand is pressed all round with a force of 30 lbs. to the square inch; but yet you do not perceive any difference in the sense of force, any perception of pressure. What you do perceive is this: behind the tympanum, is a certain cavity filled with air, and a greater pressure on one side of the tympanum than on the other gives rise to a painful sensation, and sometimes produces rupture of it in a person going down in a diving bell suddenly. The remedy for the painful sensation thus experienced, or rather I should say its prevention, is to keep chewing a piece of hard biscuit, or making believe to do so. If you are chewing a hard biscuit, the operation keeps open a certain passage, by which the air pressure gets access to the inside of the tympanum, and balances the outside pressure and thus prevents the painful effect. This painful effect on the ear experienced by going down in a diving bell is simply because a certain piece of tissue is being pressed more on one side than on the other; and when we get such a tremendous force on a delicate thing like the tympanum, we may experience a great deal of pain, and it may be dangerous; indeed it is dangerous, and produces rupture or damage to the tympanum unless means be adopted for obviating the difference in the pressures; but the simple means I have indicated are, I believe, with all ordinary healthy persons, perfectly successful.

I am afraid we are no nearer, however, to understanding what it is we perceive when we hear. To be short it is simply this: it is exceedingly sudden changes of pressure acting on the tympanum of the ear, through such a short time and with such moderate force as not to hurt it; but to give rise to a very distinct sensation, which is communicated through a train of bones to the auditory nerve. I must merely pass over this; the details are full of interest, but they would occupy us far more than an hour if I entered upon them at all. As soon as we get to the nerves and the bones, we have gone beyond the subject I proposed to speak upon. My subject belongs to physical science;—what is called in Scotland, Natural Philosophy. Physical science refers to dead matter, and I have gone beyond the range whenever I speak of a living body; but we must speak of a living body in dealing with the senses as the means of perceiving—as the means by which, in John Bunyan's language, the soul in its citadel acquires a knowledge of external matter. The physicist has to think of the organs of sense, merely as he thinks of the microscope; he has nothing to do with physiology. He has a great deal to do with his own eyes and hands, however, and must think of them, if he would understand what he is doing, and wishes to get a reasonable view of the subject, whatever it may be, which is before him in his own department.

Now what is the external object of this internal action of hearing and perceiving sound? The external object is a change of pressure of air. Well, how are we to define a sound simply? It looks a little like a vicious circle, but indeed it is not so, to say it is sound if we call it a sound—if we perceive it as sound, it *is* sound. Any change of pressure, which is so sudden as to let us perceive it as sound is a sound. There [giving a sudden clap of the hands]—that is a sound. There is no question about it—nobody will ever ask, Is it a sound or not? It is sound if you hear it. If you do not hear it, it is not to you a sound. That is all I can say to define sound. To explain what it is, I can say, it is change of pressure, and it differs from a gradual change of pressure as seen on the barometer only in being more rapid, so rapid that we perceive it as a sound. If you could perceive by the ear, that the barometer has fallen two-tenths of an inch to day, that would be sound. But nobody hears by his ear that the barometer has fallen, and so he does not perceive the fall as a sound. But the same difference of pressure coming on us suddenly—a fall of the barometer, if by any means it could happen, amounting to a tenth of an inch, and taking place in a thousandth of a second, —would affect us quite like sound. A sudden rise of the barometer would produce a sound analogous to what happened when I clapped my hands. What is the difference between a noise and a musical sound? Musical sound is a regular and periodic change of pressure. It is an alternate augmentation and diminution of air pressure, occurring rapidly enough to be perceived as a sound, and taking place with perfect regularity, period after period. Noises and musical sounds merge into one another. Musical sounds have a possibility at least of sometimes ending in a noise, or tending too much to a noise, to altogether please a fastidious musical ear. All roughness, irregularity, want of regular, smooth periodicity, has the effect of playing out of tune, or of music that is so complicated that it is impossible to say whether it is in tune or not.

But now, with reference to this sense of sound, there is something I should like to say as to the practical lesson to be drawn from the great mathematical treatises which were placed before the British Association, in the addresses of its president, Prof. Cayley, and of the president of the mathematical and physical section, Prof. Henrici. Both of these professors dwelt on the importance of graphical illustration, and one graphical illustration of Prof. Cayley's address may be adduced in respect of this very quality of sound. In the language of mathematics we have just "one independent variable" to deal with in sound, and that is air pressure. We have not a complication of motions in various directions. We have not the complication that we shall have to think of presently, in connection with the sense of force; complication as to the place of application, and the direction, of the force. We have not the infinite complications we have in some of the other senses, notably smell and taste. We have distinctly only one thing to consider, and that is air pressure or the variation of air pressure. Now when we have one thing that varies, that, in the language of mathematics, is "one independent variable." Do not imagine that mathematics is harsh, and crabbed, and repulsive to common sense. It is merely the etherealisation of common sense. The function of one independent variable that you have here to deal with is the pressure of air on the tympanum. Well now in a thousand counting houses and business offices in Birmingham and London, and Glasgow, and Manchester, a curve, as Prof. Cayley pointed out, is regularly used to show to the eye a function of one independent variable. The function of one independent variable most important in Liverpool perhaps may be the price of cotton. A curve showing the price of cotton, rising when the price of cotton is high, and sinking when the price of cotton is low, shows all the complicated changes of that independent variable to the eye. And so in the Registrar-General's tables of mortality, we have curves showing the number of deaths from day to day—the painful history of an epidemic, shown in a rising branch, and the long gradual talus in a falling branch of the curve, when the epidemic is overcome, and the normal state of health is again approached. All that is shown to the eye; and one of the most beautiful results of mathematics is the means of showing to the eye the law of variation, however complicated, of one independendent variable. But now for what really to me seems a marvel of marvels: think what a complicated thing is the result of an orchestra playing—a hundred instruments and two hundred voices singing in chorus accompanied by the orchestra. Think of the condition of the air, how it is lacerated sometimes in a complicated effect. Think of the smooth gradual increase and diminution of pressure—smooth and gradual, though taking place several hundred times in a second—when a piece of beautiful harmony is heard! Whether, however, it be the single note of the most delicate sound of a flute, or the purest piece of harmony of two voices singing perfectly in tune; or whether it be the crash of an orchestra, and the high notes, sometimes even screechings and tearings of the air, which you may hear fluttering above the sound of the chorus—think of all that, and yet that is not too complicated to be represented by Prof. Cayley, with a piece of chalk in his hand, drawing on the blackboard a single line. A single curve, drawn in the manner of the curve of prices of cotton, describes all that the ear can possibly hear, as the result of the most complicated musical performance. How is one sound more complicated than another? It is simply that in the complicated sound the variations of our one independent variable, pressure of air, are more abrupt, more sudden, less smooth, and less distinctly periodic, than they are in the softer, and purer, and simpler sound. But the superposition of the different effects is really a marvel of marvels; and to think that all the different effects of all the different instruments can be so represented! Think of it in this way. I suppose everybody present knows what a musical score is—you know, at all events, what the notes of a hymn tune look like, and can understand the like for a chorus of voices, and accompanying orchestra—a "score" of a whole page with a line for each instrument, and with perhaps four different lines for four voice parts. Think of how much you have to put down on a page of manuscript or print, to show what the different performers are to do. Think, too, how much more there is to be done than anything the composer can put on the page. Think of the expression which each player is able to give, and of the difference between a great player on the violin and a person who simply grinds successfully through his part; think, too, of the difference in singing, and of all the expression put into a note or a sequence of notes in singing that cannot be written down. There is, on the written or printed page, a little wedge showing a diminuendo, and a wedge turned the other way showing a crescendo, and that is all that the musician can put on paper to mark the difference of expression which is to be given. Well now, all that can be represented by a whole page or two pages of orchestral score, as the specification of the sound to be produced in say ten seconds of time, is shown to the eye with perfect clearness by a single curve on a riband of paper a hundred inches long. That to my mind is a wonderful proof of the potency of mathematics. Do not let any student in this Institute be deterred for a moment from the pursuit of mathematical studies by thinking that the great mathematicians get into the realm of four dimensions, where you cannot follow them. Take what Prof. Cayley himself, in his admirable address, which I have already referred to, told us of the beautiful and splendid power of mathematics for etherealising and illustrating common sense, and you need not be disheartened in your study of mathematics, but may rather be reinvigorated when you think of the power which mathematicians, devoting their whole lives to the study of mathematics, have succeeded in giving to that marvellous science.

(To be continued.)

THE GEOLOGICAL POSITION OF THE HUMAN SKELETON FOUND AT TILBURY

IN a paper on this subject read by Mr. T. V. Holmes, F.G.S., at the meeting of the Essex Field Club on Saturday, February 23, at Buckhurst Hill, the author pointed out that the Tilbury skeleton was found in recent alluvium. The section at

Tilbury, consisting of blue clay with peaty bands, above sand and gravel, strongly resembles those given by Prof. Sollas of the alluvial deposits of the estuary of the Severn; the amount of subsidence, as shown by the present position of the lower peaty band, being also nearly the same. Mr. Holmes considered the notions promulgated in the brief newspaper reports regarding the antiquity of the remains to be entirely misleading. If any strata were entitled to be styled "recent," those at Tilbury must be so; for their deposition would now be going on but for the embankment of the Thames during the Roman occupation of Britain. Yet the newspaper reports described these beds by the extremely vague term "Pleistocene," while the skeleton was styled "Palæolithic." The remains of man, however, have been found in alluvial deposits fifty feet above the present level of the Thames, and remains found in such beds must be immensely more ancient than any discovered in recent alluvium. Geological position furnishes the only absolute test of relative age. The test of association with extinct mammalia is largely dependent on negative evidence. A hint on this point was given by the results of the drainage of Haarlem Lake thirty years ago. Excellent sections were made in all directions across its bed, and carefully examined by skilled geologists. Hundreds of men were known to have perished in its waters three centuries before, and it had always been the centre of a considerable population. Yet no human bones were found, though works of art were. Thus hundreds or even thousands of mammalia, incapable of producing works of art, might be interred in particular strata, and yet leave no signs whatever of their former existence two or three centuries afterwards. And, on the other hand, were extinct mammalia present in the Tilbury Dock beds no additional antiquity would thereby be conferred on the beds themselves, but the period at which the animals became extinct would be shown to be later than had been supposed. Similarly as regards the rude implements known as Palæolithic; their presence could confer no antiquity on recent beds. Still, as the skeleton was found thirty-two feet below the surface, in alluvium that has received no additions since Roman times, it is unquestionably prehistoric. And the extreme rarity of prehistoric human skeletons gives to this discovery an interest greater than could have been claimed for that of a bushel of flint implements. The age of the Tilbury skeleton may possibly be not far removed from that of the Neanderthal man, to which it is said to have a strong resemblance: a resemblance which, if as great as it is stated to be, goes far to show that we have in each a normal type of prehistoric man.

At the same meeting a communication from Mr. Worthington G. Smith was read. Mr. Smith stated that he had seen the skeleton, and specimens of the sand in which it was found. Palæolithic sands with fossil bones and stone implements occur about a mile to the north of Tilbury, and with these Mr. Smith was well acquainted. The Palæolithic sand is quite different in colour from the Tilbury sand, and the former swarms with fossil shells of land and freshwater mollusks. As far as could be seen no such shells were present in the Tilbury sand sent to the British Museum. Mr. Smith's specimens of fossil bones from the Palæolithic sand were in an entirely different mineral condition from the bones of the Tilbury skeleton, and he could trace no resemblance whatever either in sand or bones. Mr. Smith made this statement with great deference to the opinion of Sir Richard Owen, and confessed that a Palæolithic skeleton might have been washed from the high ground to the low, and got into the mineral state of the Tilbury skeleton, although at present there was no evidence of anything of the sort having taken place. His opinion was that there was no proof of the Palæolithic age of the Tilbury relic.

NOTES ON THE VOLCANIC ERUPTION OF MOUNT ST. AUGUSTIN, ALASKA, OCTOBER 6, 1883[1]

ON the western side of the entrance to Cook's Inlet (forty-five miles wide) lies Cape Douglas; and to the northward of the cape the shore recedes over twenty miles, forming the Bay of Kamishak. In the northern part of this bay lies the Island of Chernaboura ("black-brown"), otherwise called Augustin Island. It is eight or nine miles in diameter, and near its north-eastern part rises to a peak, called by Cook Mount St. Augustin. As laid down by Tebenkoff, the island is nearly round.

[1] From *Science*.

The northern shores are high, rocky, and forbidding, and are bordered by vast numbers of rocks and hidden dangers. The southern shore is comparatively low.

Mount St. Augustin was discovered and named by Capt. Cook, May 26, 1778; and he describes it as having "a conical figure, and of very considerable height." In 1794 Puget describes it as—

"A very remarkable mountain, rising with a uniform ascent from the shores to its lofty summit, which is nearly perpendicular to the centre of the island, inclining somewhat to its eastern side. . . . Towards the seaside it is very low, from whence it rises, though regular, with a rather steep ascent, and forms a lofty, uniform, and conical mountain, presenting nearly the same appearance from every point of view, and clothed with snow and ice, through which neither tree nor shrub were seen to protrude; so that, if it did produce any, they must either have been very small, or the snow must have been sufficiently deep to have concealed them."

At that time there were native hunters, under the direction of two Russians, hunting or living in the vicinity of the north-eastern point of the island.

Vancouver placed the peak of this mountain in latitude 59° 22′; Tebenkoff places it in latitude 59° 24′.

The peak of St. Augustin is distant forty-nine miles nearly due west (true) from the settlement on the southern point of Port Graham, or, as it is sometimes called, English Harbour. This harbour is situated on the eastern side of Cook's Inlet, near Cape Elizabeth.

In connection with the fall of pumice-dust at Iliuliuk on October 16, 1883, it may be of interest to observe that the peak of Augustin is over 700 miles to the north-eastward of Bogosloff Island off Unalashka.

About eight o'clock on the morning of October 6, 1883, the weather being beautifully clear, the wind light from the southwestward (compass), and the tide at dead low water, the settlers and fishing parties at English Harbour heard a heavy report to windward (Augustin bearing south-west by west three-fourths west by compass). So clear was the atmosphere that the opposite or north-western coast of the inlet was in clear view at a distance of more than sixty miles.

When the heavy explosion was heard, vast and dense volumes of smoke were seen rolling out of the summit of St. Augustin, and moving to the north-eastward (or up the inlet) under the influence of the lower stratum of wind; and, at the same time (according to the statements of a hunting-party of natives in Kamishak Bay), a column of white vapour arose from the sea near the island, slowly ascending, and gradually blending with the clouds. The sea was also greatly agitated and boiling, making it impossible for boats to land upon or to leave the island.

From English Harbour (Port Graham) it was noticed that the columns of smoke, as they gradually rose, spread over the visible heavens, and obscured the sky, doubtless under the influence of a higher current (probably north or north-east). Fine pumice-dust soon began to fall, but gently, some of it being very fine, and some very soft, without grit.

At about 8.25 a.m., or twenty-five minutes after the great eruption, a great "earthquake-wave," estimated as from twenty-five to thirty feet high, came upon Port Graham like a wall of water. It carried off all the fishing-boats from the point, and deluged the houses. This was followed at intervals of about five minutes, by two other large waves, estimated at eighteen and fifteen feet; and during the day several large and irregular waves came into the harbour. The first wave took all the boats into the harbour, the receding wave swept them back again to the inlet, and they were finally stranded. Fortunately it was low water, or all of the people at the settlement must inevitably have been lost. The tides rise and fall about fourteen feet.

These earthquake-waves were felt at Kadiak, and are doubtless recorded on the register of the Coast Survey tide-gauge at that place. Also the pumice-ashes fell to the depth of four or five inches, and a specimen of the deposit was given to the tidal observer at St. Paul. It will be interesting to compare these ashes with those collected at Iliuliuk on October 16, and which, from a confusion of dates, were supposed to have come from the new Bogosloff volcanic island. I am of the opinion that they came from St. Augustin.

The condition of the Island of Augustin or Chernaboura, according to the latest accounts, is this:—

At night, from a distance of fifty or sixty miles, flames can be seen issuing from the summit of the volcano; and in the daytime vast volumes of smoke roll from it. Upon nearer approach from English Harbour it was found that the mountain had been split in two from peak to base by a great rupture extending across it from east to west, and that the northern slope of the mountain had sunk away to the level of the northern cliff.[1] This is corroborated by the statement of the hunting-party in Kamishak Bay. Smoke issued from the peak at a very short distance to the southward of the rupture.

The party of natives on Kamishak did not approach the islet, though they gave clear and distinct accounts of its eruption and subsequent appearance; but Capt. C. T. Sands, who was at English Harbour, gave the Alaska Company a full description; and Capt Cullie, of the *Kodiak*, states that, if there were plenty of water in the line of rupture, it would be possible for a vessel to sail through. At the time of Capt. Sands' observations the low ground of the island was visible, and seemed to be a vast crater, from which smoke and flames were issuing.

But beyond all these phenomena, apart from the volcanic eruption and the rupture of the island, we have the report of Capt. Cullie, of the schooner *Kodiak* (from whom we also obtain a statement in regard to the rupture), who approached the island from English Harbour on November 10, and found that a new island about a mile and a half long and seventy-five feet high, had been upheaved in the ten-fathom passage between Augustin and the mainland to the westward. This passage is from six to eight miles wide, and was sailed through by Puget in Vancouver's voyages of discovery.

This new island (also reported by the hunting-party in Kamishak) would appear to have arisen during the late volcanic activity. It lies to the north-westward of Chernaboura Island (Augustin), and was distinctly seen from the *Kodiak*, as that vessel lay ten miles to the north-eastward, and had clear weather.

To show the violence of the volcanic convulsions at this time, two extinct volcanoes on the Alaska peninsula, which are reported to be about west (true) from the active volcano Iliamna (twelve thousand feet high), had burst into activity; and during the day volumes of smoke were distinctly seen, and columns of flame at night. Usually, at that season, Augustin and the peak are covered with deep snow. On November 10, however, when Capt. Cullie approached the island, while there was a depth of four feet of snow at Port Graham (English Harbour), Mount St. Augustin was bare and black.

George Davidson,
Assistant U.S. Coast and Geodetic Survey

THE ORIGIN OF THE SCENERY OF THE BRITISH ISLANDS[2]

The Plains of Britain, like those elsewhere, must be regarded as local base-levels of denudation, that is, areas where, on the whole, denudation has ceased, or at least has become much less than deposit. Probably in all cases the areas they occupy have been levelled by denudation. Usually a greater or less depth of detrital material has been spread over them, and it is the level surface of these superficial accumulations that forms the plain. But in some instances, such as the flats of the Weald Clay and the Chalk of Salisbury Plain, there is hardly any such cover of detritus, the denuded surface of underlying rock forming the actual surface of the plain. Our plains, if classed according to the circumstances of their origin, may be conveniently regarded as (1) river plains—strips of meadow-land bordering the streams, and not infrequently rising in a succession of terraces to a considerable height above the present level of the water; (2) lake plains—tracts of arable ground occupying the sites of former lakes, and of which the number is ever on the increase; (3) marine plains—mostly flat selvages of alluvial ground, formed of materials originally laid down as a littoral marine deposit when the land lay below its present level: in the northern estuaries these up-raised sea-beds spread out as broad carse-lands, such as those of the Tay, Forth, and Clyde; (4) glacial drift plains—tracts over which the clays, sands, and gravels of the Ice Age form the existing surface; (5) submarine plains—the present floor of the North Sea and of the Irish Sea, which must be regarded as essentially part of the terrestrial area of Europe.

When plains remain stationary in level, they may continue for an indefinite period with no material change of surface. But, should they be upraised, the elevation, by increasing the slope of the streams, augments their erosive power, and enables them once more to deepen their channels. Hence, plains like that of the New Forest, which have been deeply trenched by the water-courses that traverse them, may with probability be assigned to a time when the land stood at a lower level than it occupies at present. In this connection the successive river-terraces of the country deserve attention. They may be due not to the mere unaided work of the rivers, but to the cooperation of successive uplifts. It would be an interesting inquiry to correlate the various river-terraces throughout the country, for the purpose of discovering whether they throw any light on the conditions under which the most recent uprise of the country took place. That the elevation proceeded intermittently, with long pauses between the movements, is shown by the succession of raised beaches. It may be possible to establish a somewhat similar proof among our river-terraces.

The submarine plains are by far the most extensive within the British area. In the case of the North Sea the tendency of tidal scour and deposit must modify the form of the bottom. This great basin of water is obviously being slowly filled up by the deposit of sediment over its floor. A vast amount of mud and silt is borne into it by the rivers of Western Europe, as well as by those that drain the eastern and larger part of Britain, and the sea itself is cutting away the land on both sides and swallowing up the waste. We have only to contrast the colour of the Atlantic on the west of Ireland or Scotland with that of the North Sea to be assured of the wide diffusion of fine mud in the water of the latter. There is practically no outlet for the detritus that is thus poured into the basin of the North Sea. From the north a vast body of tidal water enters between Scotland and Norway, and travelling southward, aided by the strong northerly winds, sweeps the detritus in the same direction. On the other hand, another narrower and shallower tidal stream enters from the Strait of Dover, and, aided by the south-west winds, drives the sediment northward. Yet, making every allowance for the banks and shoals which this accumulating deposit has already formed, we can still, without much difficulty, recognise the broader features of the old land-surface that now lies submerged beneath the North Sea. It presents two plains, of which the southern has an average level of perhaps a little more than 100 feet below the surface of the water. This upper plain ends northward in a shelving bank, probably the prolongation of the Jurassic escarpment of Yorkshire, and is succeeded by the far wider northern plain, which lies from 100 to 150 feet lower, and gradually slopes northward. As mentioned in a previous lecture, the drainage-lines of the united Rhine, Thames, &c, on the one side, and the Elbe, Weser, &c., on the other, can still be partially traced on the sea-floor. The Irish Sea was probably, in its later history, a plain dotted with lakes. It appears to have been submerged before the whole of the present fauna and flora had reached Ireland.

Some of the most characteristic and charming scenery of the British Islands is to be found along their varied sea-board. Coast-scenery appears to depend for its distinctive features upon (1) the form of the ground at the time when by emergence or submergence the present level was established; (2) the composition and structure of the shore-rocks; (3) the direction of the prevalent winds, and the relative potency of subaërial and marine denudation. The British coast-line presents three distinct phases: in many places it is retreating; in others it is advancing; while in a few it may be regarded as practically stationary. As examples of retreat, the shores of a large part of the east of England may be cited. In Holderness, for instance, a strip of land more than a mile broad has been carried away during the last eight centuries. Even since the Ordnance Survey maps were published, thirty-three years ago, somewhere about 500 feet have in some places been removed, the rate of demolition being here and there as much as five yards in a year. The advance of the coast takes place chiefly in sheltered bays, or behind or in front of projecting headlands and piers, and is due in large measure to the deposit of material which has been removed by the sea from adjoining shores. The amount of land thus added does not compensate for the quantity carried away, so that the total result is a perceptible annual loss. The best examples of a stationary coast-line where there is no appre-

[1] Capt. Cullie's account.
[2] Abstract of fifth and concluding lecture by Archibald Geikie, F.R.S., Director-General of the Geological Survey, given at the Royal Institution, March 3. Continued from p. 420.

ciable erosion by the waves and no visible accumulation of detritus, are to be found among the land-locked fjords or inlets of the west coast of Scotland. In these sheltered recesses the smoothed striated rocks of the Ice Age slip under the sea, with their characteristic glaciated surfaces still so fresh that it is hard to believe that a long lapse of ages has passed away since the glaciers left them.

The remarkable contrast between the scenery of the eastern and western coast-line of the British Islands arises partly from the preponderance of harder rocks on the west than on the east side, but probably in large measure upon the greater extent of the submergence of the western sea-board, whereby the sea has been allowed to penetrate far inland by fjords which were formerly glens and open valleys. The details of coast-scenery vary with the rock in which they are developed. Nowhere can the effects of each leading type of rock upon landscape be more instructively studied than along the sea-margin. As distinct types of coast-scenery, reference may be made to sea-cliffs and rocky shores of granite, gneiss, basalt, massive sandstone and flagstone, limestone, alternations of sandstone shale or other strata, and boulder-clay, and to the forms assumed by detrital accumulations such as sand-dunes, shingle-banks, and flats of sand or mud.

The concluding portion of the lecture was devoted to an indication of the connection between the scenery of a country and the history and temperament of the people. This subject was considered from four points of view, the influence of landscape and geological structure being traced in the distribution of races, in national history, in industrial and commercial progress, and in national temperament and literature.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The proposal to allow women to enter for the same honour examinations as men met with less opposition in Congregation than was generally anticipated. By 100 votes to 46 the statute was passed by Congregation permitting women to enter for both Classical and Mathematical Moderations, and for the final Schools of History, Mathematics, and Natural Science. On March 11 the statute will come before Convocation, and will in all probability be passed.

In a Convocation held on March 4 a decree was passed authorising the Professors of Anatomy and Physiology to engage a table for the use of students of the University at the Zoological Station at Villefranche. The anti-vivisectionists were demonstrative, but did not divide the House.

The Professor of Medicine gives notice that the Testamurs for Chemistry and Physics in the Preliminary Honour Examination excuse candidates from the Chemistry and Physics Examination in the First M.B., but that the Testamurs for Chemistry and Physics in the Pass School are not recognised. Candidates may take up Chemistry and Physics separately from Anatomy and Physiology.

An examination will be held at Keble College on March 18 to elect a Scholar in Natural Science. Candidates may offer Chemistry and Biology.

CAMBRIDGE.—Plans have been obtained for the building of a new foundry and a temporary lecture-room and museum for the Department of Mechanism, suitable eventually for additional workshops. The cost is to be 450*l*. The number of pupils in this department has now increased to fifty-seven.

Plans have also been prepared for the new botanical class-rooms for microscopic work, the estimated cost being 1065*l*.

Messrs. E. C. Ames, B.A., B. H. Bent, and J. H Nicholl, B.A., have been appointed Demonstrators of Mechanism and Applied Mechanics.

The following Colleges hold Examinations for Open Scholarships in Natural Sciences on the respective dates mentioned:—Clare, March 18; Jesus, March 13; Downing, June 10; Cavendish, August 6. For particulars, application should be made to the tutors of the Colleges. A Clothworkers' Exhibition in Physical Science, tenable either at Oxford or at Cambridge, will be awarded in July. Information may be obtained from the Censor of Non-Collegiate Students, Cambridge.

SCIENTIFIC SERIALS

Journal of Botany.—The number for February commences with the first part of an important paper by Mr. Thomas Hick on protoplasmic continuity in the Florideæ. The connection of protoplasm from cell to cell has now been established in a number of instances in the vegetable kingdom. It may be seen with very great ease, as described and drawn by Mr. Hick, in the frond of some of the red seaweeds, as *Polysiphonia* and *Callithamnion*, without any chemical reagent, except one that causes a slight contraction.—Mr. Carruthers contributes a useful paper on the mode of distinguishing the seed of the sweet vernal grass, *Anthoxanthum odoratum*, from that of *A. Puelii*, an annual species with which it is often adulterated by seed-growers.

THE last part (vol. iii. heft 3) of Cohn's *Beiträge zur Biologie der Pflanzen* contains two important cryptogamic papers: one by E. Eidam, on the development of the Ascomycetes, in which two new forms are described; the other, by M. Franke, describing an interesting new genus of parasitic algæ, *Endoclonium*, dimorphic, and growing on decaying fronds of *Lemna gibba*.

Journal of the Russian Chemical and Physical Society, vol. xv. fasc. 9.—On the action of the hydrocarbons of the acetylene series upon oxide of mercury and its salts, by M. Kutscheroff.—Thermic data of pyrosulphuryl, by D. Konovaloff. The heat of formation of a molecule of $S_2O_5Cl_2$ from its elements in a gaseous state is equal to 180·6 calories.—On a hydrate of silicium obtained from cast iron, by G. Zabudsky.—On the characters of the infra-molecular force, by M. Bardsky (second article).—On electrolytic light, by N. Sloughinoff, being an experimental and mathematical inquiry into the light disengaged during the electrolysis of liquids at one of the electrodes: historical sketch of the subject; instruments employed; the laws of the extra-currents of Edlund; light disengaged in a water solution of sulphuric acid, and dependence of it upon the number of elements in the battery; oscillations of the force of the current; experiments with a rotating glass; wearing of the electrodes; spectrum; light in the acid solutions of salts; on the resistance, the electro-spheroidal state, and the heat disengaged; the oscillating currents.—On the theory of the curved nets, by A. Sokoloff.

Atti della R. Accademia dei Lincei, Rome, October 18 and 19, 1883.—On the alterations undergone by the red globules of the blood in malarious infections, by Prof. Ettore Marchiafava.—Meteorological observations made at the Royal Observatory of the Campidoglio during the months of August, September, and October, 1883.

December 2.—Remarks on Dr. F. Mercanti's memoir on the cilian muscle in reptiles, by Signor Moriggia.—On the alterations in the red globules of the blood in malarious infections, by S. Todaro.—Report on Prof. E. Millosevich's memoir on the diameter of Uranus, by S. Respighi.—On the molecular velocities of gaseous bodies, by A. Violi.—Note on fluorbenzine and fluorotoluine, by P. Emanuele and O. Vincenzo.—A new series of compounds of titanium, by A. Piccini.—On the transformation of the fluorbenzoic acids in the animal organism, by F. Coppola.—A study of the resins of *Thapsia garganica*, by Fr. Canzoneri.—On a new species of Salpa (*S. dolicosoma*), by Fr. Todaro).—Observations on the Pons-Brooks comet, by Pietro Tacchini.—On the unipolar induced electric current and nervous excitement, by G. Magini.—Archæological discoveries at Angera, Peschiera, Viterbo, Rome, Sulmona, and in other parts of Italy, from June to October, 1883.—S. Sella and S. Mamiani were elected president and vice-president for the ensuing four years, 1884-7.

Rivista Scientifico-Industriale, Florence, November 15-30, 1883.—Further applications of the nephoscope invented by Filippo Cecchi (four illustrations).—Description of a new electro-magnet recently exhibited before the Society of Natural and Economical Sciences at Palermo, by Prof. A. Riccò.—An account of some of the important results already obtained in the Acclimatisation Garden established ten years ago by General Vincenzo Ricasoli at Portercole, by G. Arcangeli. Amongst the exotics here successfully reared are *Cocos flexuosa*, *Calorica borbonica*, *Phœnix reclinata*, *Boldea fragrans*, *Citharexylon reticulatum*, *Casuarina quadrivalvis*, *Edwardsia grandiflora*, *Eugenia australis*, *Ficus elastica*, *Picconia fragrans*, besides numerous species of *Bignonia*, *Agave*, *Acacia*, and *Eucalyptus*, and other Australian plants.

Rendiconti del R. Istituto Lombardo, Milan, December 13, 1883.—On the distinctions observed in criminal law between the authors and accomplices in a felony, by Prof. A. Buccellati.—Inquiry into the nature of the underground disturbances that occurred at Ischia on July 28, 1883, by Prof. A. Serpieri.—On numbers irreducible by complex numbers, by Prof. C. Formenti.—On some forms of right lines produced by two reciprocal stars, by Prof. F. Aschieri.—Meteorological observations made at the Brera Observatory, Milan, during the months of October and November, 1883.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 14.—"On a New Reflecting Galvanometer of Great Sensibility, and on New Forms of Astatic Galvanometers." By Thomas Gray, B.Sc., F.R.S.E., and Andrew Gray, M.A., F.R.S.E. Communicated by Sir William Thomson, F.R.S.

The paper describes first a very sensitive galvanometer, of novel construction, which the authors have had made, with aid from the Government Research Fund, for their experiments on the electric resistance of glass and allied substances. It consists of two pairs of coils with hollow cores, arranged so that the axes of each pair are parallel and in a vertical plane, which act on a needle-system, consisting of two horse-shoe magnets of thin steel wire connected by a very light frame of aluminium, and hung with their planes vertical, so that a horse-shoe corresponds to each pair of coils and has its poles within the hollow cores. In the instrument constructed each pair of coils is carried by a vertical brass plate, and these two plates are set so as to make an angle with one another of about 106°. A line drawn from the suspension thread (a single fibre of silk) to a point near a pole of either of the needles, when the needles are at the same distance within both pairs of coils, is nearly at right angles to the axis of the coil, and the motion of the needle for small deflections is nearly along the axis. The needles enter the coils from the same side, and the current is usually sent through the coils, so that one pair cause their horse-shoe to move outwards and the other pair their horse-shoe to move inwards, thus turning the needle-system round the suspension fibre. A mirror fixed to the aluminium connecting-bar gives a measure of the deflection in the ordinary manner. This system of needles, when rightly adjusted, is practically astatic in a magnetic field of uniform intensity.

A magnet (or system of magnets) is generally arranged to give a differential field at the upper and lower ends of the needles, which are usually placed with unlike poles turned in similar directions; but any magnetic system may be employed to give directive force in the proper manner and degree for a particular purpose or arrangement.

Another form of the instrument is described in which the coils are all in one plane, and the connecting aluminium bar carrying the horse-shoe needles passes through the plate in which the coils are set from one side to the other, so that one horse-shoe enters its pair of coils from one side, and the other horse-shoe from the other side. When the needle-system is deflected thus, both needles are pushed out of the coils or both pulled in.

By the method of arranging the needles and coils adopted in these instruments the current is made, when the hollow cores are made small, to act very advantageously on the needles, and hence in great measure their high sensibility. By attaching to the suspended system a small needle to give directive force in a uniform field, the great magnetic moment and leverage of the horse-shoes may be taken advantage of.

The paper then describes a new and very compact form of distributing plate, by means of which a multiple coil galvanometer, or one in which the coil is wound in sections, may be connected in any desired manner to vary its resistance or its sensibility.

Finally, two forms of instrument are described, in which two perfectly vertical and straight needles connected together rigidly by bars of aluminium are used to give a perfectly astatic system, not disturbed by the magnetising or demagnetising action of neighbouring magnets, a result the authors think practically unattainable in any arrangement of horizontal needles. Two vertical needles, with their upper ends in the position occupied by the upper needle of a so-called astatic galvanometer, and their lower ends in the position of the lower needle, experience, if their like poles are turned in dissimilar directions, a similar electromagnetic action to that in the horizontal needles; and the authors propose when convenient to use such an arrangement instead of the ordinary needle system.

Also a pair of vertical needles may be used instead of the horse-shoe needles described above, the coils being so placed as to act advantageously, and give a convenient arrangement of the parts of the instrument.

Geological Society, February 15.—Annual General Meeting.—J. W. Hulke, F.R.S., president, in the chair.—The Secretaries read the Reports of the Council and of the Library and Museum Committee for the year 1883. In the former the Council congratulated the Fellows upon an improvement in the state of the Society's affairs since the date of their last Report, the income of the Society having been greater, and its expenditure less, in 1883 than in 1882, while, although the removal from the list of the names of twelve Fellows whose addresses were unknown, and whose election dated back before the incorporation of the Society in 1826, had produced an apparent loss of three Fellows during the year, the Society might really be regarded as having received an increase of nine Fellows. The increase in the number of contributing Fellows was twenty-two. The Council's Report further announced the awards of the various Medals and of the proceeds of the Donation Funds in the gift of the Society.

In presenting the Wollaston Gold Medal to Prof. A. Gaudry, F.M.G.S., the President addressed him as follows:—"Prof. A. Gaudry,—The Council of the Geological Society has awarded you the Wollaston Medal in recognition of the value of your palæontological researches and the important scientific generalisations you have deduced from long and laborious observations. The numerous papers on topographical geology and on palæontology you have contributed during the past thirty years, your important 'Recherches Scientifiques en Orient entreprises par les ordres du Gouvernement pendant les années 1853–1854,' your 'Animaux fossiles et géologie de l'Attique,' and, lastly, your work 'Les Enchaînements du monde animal dans les temps géologiques,' have made your name so familiar, wherever our branch of natural science is cultivated, that in receiving you we feel we are not receiving a stranger, but a scientific brother, and one who, by his labours and singleness of aim, has achieved a position as a palæontologist such as few can hope to attain. Personally it affords me great and sincere pleasure that it has fallen to my lot to hand you this medal, which, by the consent of all, has never been more worthily bestowed."

The President then presented the balance of the proceeds of the Wollaston Donation Fund to Mr. E. Tulley Newton, F.G.S., and addressed him as follows:—"Mr. Newton,—The Council has voted you the balance of the proceeds of the Wollaston Donation Fund, in recognition of the value of your researches amongst the Pleistocene Mammalia of Great Britain, and to assist you in the prosecution of further investigations. Your memoirs published by the Geological Survey of England and Wales, 'On the Vertebrata of the Forest-bed Series of Norfolk and Suffolk,' and on 'The Chimæroid Fishes of the Cretaceous Rocks,' and your papers published in our *Journal* are considered by the Council to evince great merit; they regard them as a bright earnest of future work which they hope may be promoted by this award."

In presenting the Murchison Medal to Dr. Henry Woodward, F.R.S., the President said: "Dr. Henry Woodward,—The Council has awarded you the Murchison Medal and a grant of ten guineas in recognition of your valuable researches into the structure and classification of the fossil Crustacea, especially of the Merostomata and Trilobita, and your services to the progress of geology in Great Britain by your conduct of the *Geological Magazine* for nearly twenty years. Your monograph on the 'Merostomata,' published by the Palæontographical Society, and your 'Catalogue of British Fossil Crustacea, with their synonyms and the range in time of each genus and order,' will long continue to be works of reference indispensable to every student of these interesting life-forms. But valuable as are these written records, they discover but a small part of the services you have rendered in the advancement of our science. How much more you have done by the assistance you have so freely given to all who have sought your help at the Museum in deciphering some difficult matters in palæontology will never be fully known."

The President then handed the balance of the proceeds of the Murchison Geological Fund to Mr. R. Etheridge, F.R.S., for transmission to Mr. Martin Simpson, of Whitby, and addressed him as follows: "Mr. Etheridge,—The balance of the proceeds of the Murchison Donation Fund has been awarded by the Council to Mr. M. Simpson, Curator of the Whitby Museum. He has devoted much attention to the fossils of that district, and he is the author of two books descriptive of them. The Council hopes that this cheque may be of assistance to him in continuing the useful extra-official work he has long been carrying on in that locality."

The President next handed the Lyell Medal to Prof. W. H. Flower, F.R.S., for transmission to Dr. Joseph Leidy, F.M.G.S., and addressed him as follows :—"Prof. Flower,—The Council has bestowed on Dr. J. Leidy the Lyell Medal, with a sum of 25*l*., in recognition of his valuable contributions to palæontology, especially as regards his investigations on the Fossil Mammalia of Nebraska and the Sauria of the United States of America. These vast and, in comparison with our own country, but little explored territories have for some years past yielded a harvest of fossil vertebrate remains of exceeding richness, of which we have no example here. How well this harvest is being garnered by our Transatlantic *confrères* the flood of memoirs published by them during the last quarter of a century bears witness. Amongst these scientific labourers in the palæontological harvest-field, Dr. J. Leidy has held a foremost place. Careful in observing, accurate in recording, cautious in inferring, his work has the high merit which trustworthiness always imparts. The well-nigh astounding number of papers written by him between 1845 and 1873, amounting to 187, his Reports on the 'Extinct Vertebrate Fauna of the Western Territories,' his 'Synopsis of the Extinct Mammalia of North America,' and his 'Cretaceous Reptiles of the United States,' testify to the fertility of his pen."

In presenting to Prof. C. Lapworth, F.G.S., the balance of the Lyell Geological Fund, the President said: "Prof. Lapworth,—The Council has awarded to you the balance of the proceeds of the Lyell Donation Fund in recognition of the value of your researches into the palæontology and physical structure of the older rocks of Great Britain, carried on frequently under unfavourable circumstances and to the injury of your health, and to aid you in similar investigations. Your papers on 'The Girvan Succession,' 'The Moffat Series,' published in our *Journal*, and 'The Graptolites,' and 'The Secret of the Highlands,' contributed to the *Geological Magazine*, were the outcome of an extremely laborious and detailed exploration of the districts to which they refer—an exploration in conducting which you spared no pains and shrank from no hardships. No one who desires to know the structure of these districts can safely omit a careful study of these very instructive papers."

The President then handed to Prof. Bonney, F.R.S., for transmission to Dr. J. Croll, a portion of the proceeds of the Barlow-Jameson Fund, and said: "Prof. Bonney,—The Council, in recognition of the value of Dr. James Croll's researches into the 'Later Physical History of the Earth,' and to aid him in further researches of a like kind, has awarded to him the sum of 20*l*. from the proceeds of the Barlow-Jameson Fund. Mr. Croll's work on 'Climate and Time in their Geological Relations,' and his numerous separate papers on various cognate subjects, including the 'Eccentricity of the Earth's Orbit,' 'Date of the Glacial Period,' the 'Influence of the Gulf Stream,' the 'Motion of Glaciers,' 'Ocean Currents,' and the 'Transport of Boulders,' by their suggestiveness have deservedly attracted much attention. In forwarding to Dr. Croll this award, the Council desires you to express the hope that it may assist him in continuing these lines of research."

In handing to Prof. Seeley, F.R.S., a second portion of the proceeds of the Barlow-Jameson Fund for transmission to Prof. Leo Lesquereux, F.C.G.S., the President spoke as follows: "Prof. Seeley,—The Council has awarded to Prof. Leo Lesquereux the sum of 20*l*. from the proceeds of the Barlow-Jameson Fund, in recognition of the value of his researches into the palæobotany of North America, and to aid him in further investigations of a similar kind. Prof. Lesquereux's 'Contributions to the Fossil Cretaceous and Tertiary Flora of the Western Territories,' published in the 'Reports of the United States Geological Survey,' are works which, for their matter, typography, and illustrations, leave nothing to desire. In transmitting this award to Prof. Lesquereux, you will convey to him the hopes of the Council that it may assist him in prosecuting further investigations in the difficult branch of research in which he has already accomplished so much."

The President then read his Anniversary Address, in which, after giving obituary notices of some of the Members lost by the Society in 1883, he passed in review the principal work done by the Society since the last Anniversary Meeting, and finally referred more in detail to some important results obtained elsewhere in connection with the comparative osteology of the Vertebrata, dwelling particularly upon the question of the existence in the lower jaw of an unpaired bone occupying, or anterior to, the symphysis—the "os présymphysien" of M. Dollo, the "mento-Meckelian" of Cope, the "inferior intermaxillary element" of W. K. Parker,—and upon certain cranial and pelvic characters of the Dinosauria.

The ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President: Prof. T. G. Bonney, F.R.S. Vice-Presidents: W. Carruthers, F.R.S., John Evans, F.R.S., J. A. Phillips, F.R.S., Prof. J. Prestwich, F.R.S. Secretaries: W. T. Blanford, F.R.S., Prof. J. W. Judd, F.R.S. Foreign Secretary: Warington W. Smyth, F.R.S. Treasurer: Prof. T. Wiltshire, F.L.S. Council: H. Bauerman, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., W. Carruthers, F.R.S., John Evans, F.R.S., Col. H. H. Godwin-Austen, F.R.S., Henry Hicks, Rev. Edwin Hill, M.A., G. J. Hinde, Ph.D., J. Hopkinson, Prof. T. M'Kenny Hughes, M.A., J. W. Hulke, F.R.S., J. Gwyn Jeffreys, F.R.S., Prof. T. Rupert Jones, F.R.S., Prof. J. W. Judd, F.R.S., J. A. Phillips, F.R.S., Prof. J. Prestwich, F.R.S., F. W. Rudler, Warington W. Smyth, F.R.S., J. J. H. Teall, M.A., W. Topley, Prof. T. Wiltshire, F.L.S., Henry Woodward, F.R.S.

Chemical Society, February 21.—Dr. W. H. Perkin, president, in the chair.—The following gentlemen were elected Fellows of the Society:—L. Archbutt, J. H. Burland, D. Bain, W. H. Barr, R. A. Bush, P. S. Chantrell, A. F. Damon, H. C. Draper, T. R. Duggan, V. Edwards, W. T. H. Elsley, G. W. Gibson, F. W. Harris, T. Hilditch, R. E. Moyle, P. Morton, W. J. Orsman, F. R. Power, A. E. Simpson, C. W. Sutton, H. G. Shaw, E. F. Smith, F. W. Tompson, A. Tarn, and E. W. Voelcker.—The following papers were read:—On the composition of the ash of wheat grain and straw grown at Rothamsted in different seasons and by different manures, by Sir J. B. Lawes and Dr. J. H. Gilbert. This is an extremely lengthy paper giving the details of 253 analyses of ashes from produce whose history as to growth, soil, season, and manuring is known. The experiments are given in three series. The first gives the results obtained during sixteen consecutive seasons under three characteristically different conditions as to manuring, and thus illustrates the influence of the fluctuation of season from year to year. The second represents nine different conditions as to manuring obtained in four seasons—two favourable, two unfavourable—and so shows the influence of characteristic seasons under a great variety of manuring conditions. The third series represents the proportionally mixed produce for the ten years 1852-61, and again for the succeeding ten years, 1862-71, from ten differently manured plots, and thus brings out the influence of continuous exhaustion or supply of certain constituents. The general results are that the influence of the season on the composition of the ash is very much more marked than the influence of the manure, and that the composition of normally-ripened grain is very uniform and in fact only varies in any marked degree according to manure, when there is a very abnormal deficiency of one or more constituents; the amounts of mineral constituents in the straw have a very obvious connection with the supply or exhaustion of these constituents in the soil.—On the analysis of Shotley Bridge Spa water, by H. Peile. This is a chalybeate water containing 0·0155 grm. Fe_2O_3 per litre as ferrous bicarbonate, 1·73 grm. sodium chloride, calcium salts, some lithium chloride, magnesium bromide and iodide, &c.

Zoological Society, February 19.—Mr. Osbert Salvin, F.R.S., president, in the chair.—Mr. Sclater laid on the table and made some remarks on a copy of the lately issued "Guide to the Calcutta Zoological Gardens."—Mr. W. T. Blanford, F.R.S., made some observations on the collection of drawings of Himalayan birds lately presented to the Society's library by Brian H. Hodgson, F.Z.S.—Prof. F. Jeffrey Bell read the second part of his contribution to the systematic arrangement of the Asteroidea. In the present communication the author treated of the species of the genus *Oreaster*.—A communication was read from M. Fernand Lataste, C.M.Z.S., containing the description of a new species of Gerbille from Arabia. This new species was founded on specimens living in the Society's Gardens, which had been hitherto referred to *Gerbillus erythrurus*, Gray. M. Lataste considered the species to be undescribed, and proposed to call it *Meriones longifrons*.—A communication was read from Mr. J. Wood-Mason, F.Z.S., in which he gave a description of a new species of the Neuropterous genus *Corydalis*. The first example of this insect (a female) was captured by Lieut.-Col. H. H. Godwin-Austen, F.R.S., on the Naga Hills, north-east frontier of India; but male specimens had since been obtained. The author proposed to call this species *Corydalis asiatica*.—A communication was read from Dr. J. Gwyn Jeffreys, F.R.S., on the Mollusca procured during the *Lightning* and *Porcupine* Expeditions 1868-70, forming the seventh part of his series of papers on this subject. The present part comprised the genera from *Rissoa* to *Acirsa*, with seventy-four sp cies, of which fourteen were new to science, as was also one new genus.

Physical Society, February 23.—Prof. F. Guthrie, president, in the chair.—New Members:—Mr. E. F. J. Love, Mr. James Grandy, Rev. F. J. Smith, Mr. F. R. Bawley.—Prof. Silvanus P. Thompson read a paper on a new method of making resistance coils. This consisted in cutting off a piece of the wire of which the coil is to be made, long enough to give a resistance some 2 per cent. higher. From the formula—

$$\text{Shunt} = \frac{R\,r}{R - r}$$

(where R is the rough resistauce, and r the final resistance), the value of a wire wherewith to shunt the first piece in order to give the resistance required is found. A length of wire giving this resistance (or, rather, about 2 per cent. more) is then cut off and soldered as a shunt to the first piece. Practice shows that this method is very quick and accurate. It is useful for shunts under 10 ohms. Prof. Thompson also described a new form of "meter bridge" devised by him. The wire is 2 m. long, and there are two wires, one of a resistance about ¼ ohm, the other 8·21 ohms. Contact is made by one or other by a sliding contact with vernier attached. This arrangement is more convenient than the single wire meter bridge, and allows of higher resistances being measured. A special switch board with an arrangement of mercury cups avoids the necessity of transposing the coils in Foster's method, this being effected by shifting the contact links in the mercury cups.—Mr. R. T. Glazebrook, F.R.S., explained a cam or axle key devised by Mr. Shaw to effect the contacts necessary to transpose the coils by a single movement. He pointed out that a certain pressure was necessary to make good contact with mercury. The ordinary way of making coils was to double the wire, cut the bight, bare the ends there, and solder a piece of copper across them, which could be shifted until the resistance was got. Prof. G. C. Foster said that the copper links in mercury cups should rest on the copper.—Prof. Foster read a paper by himself and Mr. Pryson on the difference of potential required to give sparks in air. Let V = this difference of potential, l = length of spark in centimetres, their experiments gave (approximately) $V = 102\,l + 7·07$. Tables and curves of the sparking distances, potentials, and electric forces in the experiments were given. The results were got with brass balls 1·35 centimetres in diameter, a frictional machine, and a Foster absolute electrometer. When l = ·142, the electric force giving a spark was 154·76; l = ·284, the electric force was 133·35, or less than at a shorter distance; l = 497, the electric force was 131·66; l = ·9, the electric force was 138·57; that is, it began to rise again.—Prof. G. Forbes made a communication on a magnetised chronometer watch. The watch slowed several minutes a day. He found the rate to vary with the position of the watch with respect to the cardinal points and also in a vertical plane. The bar of the balance was magnetised and some screw nails. He traced the variation of rate to magnetisation of the spring, the bar, and screws. The fact that it varied with position suggested that a magnetised ship's chronometer might be made which would integrate the course and give a mean course. Messrs. E. Dent and Co. had fitted a gold spring and a platinum iridium balance to the chronometer, and rendered it non-magnetisable.

Royal Meteorological Society, February 20.—Mr. R. H. Scott, M.A., F.R.S., president, in the chair.—T. G. Benn, Capt. C. F. Cooke, Francis Galton, M.A., F.R.S., Prof. S. A. Hill, B.Sc., Capt. A. W. Jeffery, G. Paul, F.G.S., F.R.H.S., R. Veevers, H. T. Wakelam, and E. Wells were elected Fellows of the Society.—The following papers were read:—The great storm of January 26, 1884, by William Marriott, F.R.Met.Soc. This storm was remarkable for its violence and large area, as well as for the unprecedentedly low barometer reading at its centre. The author has prepared isobaric charts for each hour from noon on the 26th to 3 a.m. on the 27th, and by this means has tracked the storm across the British Isles. The centre of the depression appears to have first reached the north-west coast of Ireland at noon, and passed in a north-easterly direction over the north of Ireland and across the middle of Scotland, reaching Aberdeen about midnight. Its rate of progress was therefore about thirty miles an hour. A violent gale was experienced all over the British Isles, the greatest hourly velocity of the wind being 68 miles at Valencia at 11 a.m., 70 miles at Holyhead at 2 p.m., 63 miles at Falmouth at 3 p.m., 69 miles at Armagh and 59 miles at Aberdeen at 5 p.m., 58 miles at Greenwich from 5 to 7 p.m., and 76 miles at Alnwiek at midnight. Thunderstorms occurred on the south-eastern side of the depression, and travelled across the south of Ireland and England at the rate of about thirty miles an hour. The lowest readings of the barometer (reduced to sea-level) yet reported were 27·32 inches at Kilcreggan at 8.30 p.m., and 27·332 inches at Ochtertyre, near Crieff, at 9.45 p.m. In the southern part of England, directly after the minimum had occurred, there was a very sudden rise in the reading of the barometer, in some cases amounting to ·08 inch in five minutes. From an examination of previous records, it appears that there has never before been so low a barometer reading as 27·32 inches, so that this storm may be considered as one of the most remarkable that has occurred in the British Islands.—The height of the neutral plane of pressure and depth of monsoon currents in India, by Prof. E. D. Archibald, M.A, F.R.Met.Soc.—The sunrises and sunsets of November and December, 1883, and January, 1884, by the Hon. F. A. Rollo Russell, M.A., F.R.Met.Soc. The author gives a very interesting account of all the special features of the remarkable sunrises and sunsets which have been observed from November 8 to February 2. The following are stated to be the marks distinguishing the peculiar sky-haze from cirrus:—1. It is commonly much more evenly spread over the sky than cirrus. 2. It is visible (except when very dense or in the neighbourhood of the sun) only about the time of sunrise and sunset. During the day not the faintest trace obscures the clear azure, whereas cirrus becomes more distinct with more daylight. 3. When actually glowing with bright colour, it loses its wavy appearance. 4. It has no perceptible motion, unless perhaps when watched through a long period. 5. It does not interfere with the clear definition of the moon or brilliancy of the stars. 6. It lies, almost without exception, in long streaks, stretching from between south-south-west and west-south-west to between north-north-east and east-north-east. 7. Its radiant point lies, not on the horizon, but far below it. 8. If both cirrus and sky-haze be present, the sky-haze begins to shine with a red light soon after the cirrus has ceased to glow above the western horizon. When cirrus is present, however, there is in general a reaction of effects. 9. The sky-haze is destitute of the fibrous twists and angular branches of cirrus, and, since the sunlight leaves it in regular progression, it must be stratified at the same uniform level. 10. It has always been visible on every clear day for more than two months, and has been quite independent of wind and weather.

Entomological Society, February 6.—Mr. J. W. Dunning, president, in the chair.—The President nominated Sir S. S. Saunders and Messrs. F. P. Pascoe and R. Meldola as vice-presidents for the ensuing year. Two new members were elected.—Mr. P. Crowley exhibited specimens of *Castnia eudesmia*, with eggs, larval galleries, and pupæ.—Mr. W. F. Kirby exhibited a coloured photograph of an abnormal specimen of the genus *Samia*, which had been bred by M. Alfred Wailly.—Mr. H. T. Stainton remarked on the food of the larva of *Aglossa pinguinalis*.—The Secretary exhibited photographs of the female of *Hypocephalus armatus*, and read some notes on the subject by Dr. Sharp.—Mr. F. P. Pascoe exhibited a collection of *Curculionidæ* from New Guinea.—The President made some remarks on the attempt to introduce humble-bees into New Zealand. He also called attention to the disappearance of many common butterflies and moths from the neighbourhood of Huddersfield, upon which a discussion ensued, the opinion of most of the speakers being that butterflies were rapidly becoming much scarcer in England than they used to be.—The Secretary read a report from the Committee appointed to inquire into the alleged occurrence of *Phylloxera* in Victoria, confirming its presence in that colony.—Mr. J. W. Douglas communicated a description of a new species of *Orthezia* from Monte Cristo.—Sir S. S. Saunders communicated further notes on the caprification of domestic figs.

Anthropological Institute, February 12.—Mr. John Evans, F.R.S., vice-president, in the chair.—The election of Mr. Joseph

Fothergill, F.R.G.S., was announced.—Mr. Park Harrison exhibited some remains found last year in Castlefield, Wheatley, by Mr. E. Gale, the occupier of the land. The skulls were of two types, and belonged to subjects who have been interred for the most part in a flexed or contracted position, but some at full length. The objects associated with the skulls were also diverse. Amongst those lent by Mr. Gale were an unusually long and narrow spear-head and the boss of a target with rivets ornamented with tinned studs, such as have been found elsewhere in Oxfordshire. Other objects excavated at the expense of the late eminent archæologist, Mr. J. H. Parker, and given by him to the Ashmolean Museum, which he had intended to send, were not exhibited, owing to his lamented death. Mr. Harrison thought the remains at Wheatley dated from the time of the extension of the kingdom of Mercia to the Thames. Dr. Garson is preparing a description of the cranial peculiarities of the skulls.—Mr. Worthington G. Smith exhibited two skulls of the Bronze Age from a tumulus at Whitby.—Mr. Henry Prigg exhibited two Palæolithic implements and a fragment of a human skull from Bury St. Edmund's.—Mr. R. Morton Middleton exhibited some human bones from Morton, near Stockton.—Mr. John T. Young read a paper on some Palæolithic fishing implements from the Stoke Newington and Clapton gravels. Mr. Young exhibited a large collection of flints of various sizes, which he considered had been manufactured for use as fish-hooks, gorges, and sinkers; some of them showed evident traces of human workmanship; and the paper gave rise to an animated discussion.—Miss A. W. Buckland read a paper on traces of commerce in prehistoric times, in which she urged that the similarity of three cups of gold discovered, one in Cornwall, another at Mycenæ, and the third in the Necropolis of old Tarquinii, might be taken as evidence of the existence of commercial relations between Etruria and Ancient Britain.—A paper was read on a human skull found near Southport, by Dr. G. B. Barron.

Institution of Civil Engineers, February 26.—Sir J. W. Bazalgette, C.B., president, in the chair.—The paper read was on hydraulic propulsion, by Mr. Sydney Walker Barnaby, Assoc.M.Inst.C.E.

Edinburgh

Royal Physical Society, February 20.—Ramsay H. Traquair, M.D., F.R.S., president, in the chair.—The following communications were read:—On the geological structure and age of the Harz Mountains, by H. M. Cadell, B.Sc., of H.M. Geological Survey of Scotland, a continuation of his former paper. The rocks of the Palæozoic core of the region had been deposited in an area subject to occasional volcanic outbursts. There were many patches of diabase on the Lower Harz which were usually associated with rocks of Hercynian age, and were regarded by German geologists as portions of interbedded sheets. Mr. Cadell believed they were intrusive sheets and bosses of later date, and gave as his reasons that (1) the adjacent strata were metamorphosed by heat on all sides; (2) the diabase sometimes cut obliquely through the sedimentary strata; (3) there was no tuff associated with these diabases as there was with the true interbedded lavas of the Harz; (4) these diabases did not, like the contemporaneous volcanic rocks, occur as continuous sheets, but were found in isolated patches like the intrusive diabases of the Scottish Midlands. The Whintill of Northumberland was cited as an example of an intrusive sheet which, like some of those on the Harz, kept on nearly the same horizon for considerable distances, but was not on that account alone to be regarded as interbedded. The first great break in the deposition of the Harz rocks took place in the middle of the Carboniferous period at the time of the irruption of the Brocken granite. The metalliferous veins of Clausthal and St. Andreasberg were all in faults traversing the culm strata and the granite, but were truncated by the Zechstein, which rested unconformably on the flanks of the Harz, and were therefore of Permian age. The Harz was bare during the Coal-measure and Permian periods, as conglomerates of Harz fragments were found in these strata. During the Secondary period the whole region appeared to have remained submerged, but the huge fault which bounded the north side of the Harz and inverted the whole of the Secondary rocks showed that the final upheaval had begun at the close of the Cretaceous period.—Remarks on the genus *Megalichthys* (Ag.), with description of a new species, by R. H. Traquair, M.D., F.R.S. This specimen was found at Burdiehouse, and was believed to be a different species from the *Megalichthys* of the Coal-measures.—On the principles of classification, by Prof. J. Cossar Ewart, M.D.—On the occurrence of an adult specimen of Sabine's gull (*Larus sabinii*) in Scotland, with exhibition of specimen, by Mr. E. Bidwell. This was a male bird shot last autumn on a loch in Mull, and is said to be only the second specimen of the bird in a mature state known to have been found in Europe. Immature specimens of this rare bird have occasionally been met with on the west coast of Ireland, but its home is on the borders of the Arctic region. In connection with this, Mr. Harvie-Brown, F.Z.S., made some interesting remarks on the migration of birds.

Paris

Academy of Sciences, February 25.—M. Rolland in the chair.—Notice of the scientific labours of the late M. Th. du Moncel, by M. Edm. Becquerel.—A second communication on hydrophobia, by MM. Pasteur, Chamberland, and Roux. The results are reported of further experiments on dogs, rabbits, poultry, sheep, monkeys, and other animals who were inoculated with the virus, chiefly by trepanning. The object of the operation was to ascertain how far immunity could thus be secured against rabies communicated by mad dogs. As many as twenty-three dogs have by the process been rendered absolutely safe from the effects of the virus in whatever way and in whatever quantity administered. To make the whole species in this way free from the disorder would afford a practical solution of the question in a prophylactic sense, for human beings are never affected by rabies except from virus proceeding directly or indirectly from dogs.—On the equilibriums established between chlorhydric and fluorhydric acids, by MM. Berthelot and Guntz.—General considerations on the distribution of plants in Tunis, and on their chief botanical affinities, by M. E. Cosson.—On the quantities forming a group of nonions analogous to the quaternions of Hamilton, by M. Sylvester.—Note on the chief inventions of the Genevese watchmaker, G. A. Leschot, who died on Feb. 4, by M. D. Colladon. Leschot was the first to suggest the use of carbonado (fragments of Brazilian black diamonds) for piercing rocks and tunnelling.—Memoir on atmospheric movements above barometric depressions and risings; schemas deduced from the results of the work of Hildebrand-Hildebrandsson, entitled "On the distribution of the meteorological elements about the barometric minima and maxima," by M. A. Poincaré.—*Résumé* of the observations made at Cape Horn on atmospheric electricity, by M. Lephay.—Determination of the proportion of carbonic acid present in the air effected by the mission to Cape Horn, by MM. A. Müntz and E. Aubin. From these observations it appears that the quantity of carbonic acid present in the atmosphere at Cape Horn is only about 2·56 in 10,000 volumes of air, as compared with 2·84, the average in Europe.—Observations of the Pons-Brooks comet made at the Observatory of Marseilles, by M. Borrelly.—On the appendices to the nucleus of the Pons-Brooks comet, by M. P. Lamey.—On the red glows observed at sunset and sunrise during the mild winter of 1876–77, by M. P. Lamey.—On the rosy, crepuscular after-glows recently observed at Buenos Ayres, by M. Beuf.—On a sudden earthquake-wave observed on January 14, at Montevideo, by M. Beuf. At 7.30 a.m. the water suddenly fell several feet, and then rose in two successive waves about 1·5 m. above the ordinary sea-level. The disturbance seems to have been quite local, and was not felt at Buenos Ayres on the opposite side of the estuary.—On the calculation of the diurnal rotation of the solar spots, by M. Pansiot.—On the hyperfuchsian groups (mathematical analysis), by M. H. Poincaré.—On the propagation of a uniform shock communicated to a gas inclosed in a cylindrical tube, by MM. Sebert and Hugoniot.—On the lowering of the freezing-point of solutions of alkaline salts, by M. F. Raoult.—Heat of formation of the chloride and oxychlorides of antimony, by M. Guntz.—On the heat of formation of the oxybromides of mercury, by M. G. André.—Synthesis of the pyridic and piperidic bases, by M. A. Ladenburg.—On the addition of the chloride of iodine ICl to monochloruretted ethylene, $CH_2 = CHCl$, by M. L. Henry.—New reduction of the carbamate of ethyl, by M. G. Arth.—On ethyl and the methylacetylcyanacetate of ethyl, by M. A. Held.—On the action of bromuretted ethylene on benzine in the presence of chlorine of aluminium, by MM. Hanriot and Guilbert.—On the action of rennet on milk, by M. E. Duclaux.—Researches on the fermentation of farmyard manure, by M. U. Gayon.—Experimental researches on rabies, showing (1) that birds are liable to be attacked; (2) that they recover spontaneously, by M. P. Gibier.—Note on the electric reaction of the sensory nerves of the skin in ataxic animals, by M. M. Mendelssohn.—On the treatment by electricity of the elephantiasis prevalent amongst the Arabs, by MM. Moncorvo and Silva Araujo.—On the poison of the toad and other batrachians, by M. G. Calmels.—On the sexual differences of the *Corbæus bifasciatus*, and on the pretended eggs of this coleopterous insect injurious to the evergreen oak, by M. A. Laboulbène.—On the coincidences observed between the solar phenomena witnessed in 1831 and 1883, by M. A. Witz.

BERLIN

Physiological Society, February 1.—Dr. W. Wolff had had occasion to make an intimate study of the electrical plates of the torpedo, in the course of which he came upon a series of facts which served to explain the still very diverse views of authors on the structure of the electrical organ, and so confirmed his conception of the subject. The electrical organ of the fish in question consists, as is well known, mostly of hexagonal columns extending from the dorsal usually to the ventral side, though occasionally not so far. They were embedded in sheaths of ligamentous texture, in which were found the nerves and vessels of the organ, and consisted of single plates of 0·012 millimetres thickness piled one above the other, without any intermediary substance; detached cells of connective tissue, each with two or three fine offshoots, were now and again found between the plates, which themselves, in the main consisting of elastic fibres, were easily capable of being coiled in at the edges. In the plates, between the fibres were found detached round granules of a diameter equal to the thickness of the plates. These granules were for the most part enveloped each in a transparent sheath. On the lower side of the plate were seen punctiform organs consisting of small, powerfully refracting granules of a semi-liquid gelatinous consistence. Hitherto they had been for the most part regarded as the terminal organs of the nerves, and in the descriptions given of them by different authors the most diverse structures were imputed to them. According to Dr. Wolff, however, these were all accidental productions. The granules had no relation whatever to the nerves, their only function being probably that of making the plates cohere. The nerves ran in the sheaths of connective tissue belonging to the columns, and there split up into bundles of primitive fibers bending each to a single plate, in order to spread out on its lower side, dividing, as they constantly did, in a dichotomous manner. Soon the medullary sheath terminated either at a dividing spot or in the course of a twig, and all that remained was but the axial cylinder with the Schwann sheath. The dichotomous partition having been pushed forward to the most delicate filaments capable of being recognised, the Schwann sheath passed over into the membrane of the plate, while the axial cylinder in all probability came suddenly to an end.—Prof. Kronecker handed in a treatise for the *Proceedings*, in which he rebutted as unjustifiable the claims of priority advanced by M. Arloing in Paris against Herren Kronecker and Meltzer in the matter of the stoppage of the movements of swallowing.—Dr. Mœli gave a report on changes occurring in the cortex of the cerebrum of guinea-pigs, which he had observed after cutting through the capsula interna of the thalamus. Conjectures he had made on the course of the fibres in the cerebrum led him to cut through the fibrous courses of the corona (*Stabkranz*) radiating from the thalamus and running to the cerebrum at a point as far as possible from the cerebral cortex, and after a considerable time to examine the changes that had been produced in the cortical tissue in consequence of this cutting. By this examination he found that a large part of the fine filaments of the cortical substance had degenerated and faded away. A part of the ganglia, on the other hand, had continued unchanged, while another part had been essentially altered. Altogether Dr. Mœli distinguished in the cortex four species of ganglia: (1) round, (2) fusiform, (3) pyramidal, and (4) small and round, with short appendages. The first two, slightly tinged with colouring matter, remained unchanged on the side operated on, and like those on the sound side. The pyramidal and caudated cells, on the other hand, which were strongly tinged with colouring matter, had shrunk on the side operated on, and were greatly altered from those on the sound side. From this Dr. Mœli concluded that there was a centripetal propagation of the degeneration from the cut fibres to their central ganglia.—Dr. J. Munk took a survey of the various views held on the resorption of fat, and called to mind that in former experiments he had demonstrated how sebacic acids might, in the process of nourishment, take the place of neutral fat, but that even in the chyle neutral fats were alone to be found. By many physiologists the absorption of neutral fats from the food was disputed, and it was sought to derive the whole deposition of fat from decomposed albumen. Dr. Munk considered the arguments adduced in support of this view as not pertinent, and had repeated the fundamental experiment, which consisted in the absorption of a heterogeneous, and therefore easily demonstrable, neutral fat. He gave a dog, which through a long course of starvation had lost almost all the fat of its body, a large quantity of rape seed, and only so much albumen as was just necessary for the preservation of its life. After having been kept on this artificial food for a length of time, the dog was killed, and the fat of the skin, together with that of the ventral cavity, was melted in one lot, and compared with the fat of a dog that had been normally fed. The very appearance of the two kinds of fat under the temperature of the sitting-room was greatly different. The fat of the dog fed on rape seed was clear and fluid, and had but a little sediment of a firmer fat, while the fat of the normally fed dog formed a soft opaque mass. Chemically analysed, the first yielded some 80 per cent. of sebacic acid, while the normal fat contained but 68 per cent. of sebacic acid. Finally, Dr. Munk was able to demonstrate the presence of erucic acid in the fat of the rape-seed fed dog, though in a somewhat impure state, a fact which conclusively proved the absorption of rape seed, and therefore of alimental fat. Dr. Munk stated that at the next meeting of the Society he would communicate further experiments regarding the formation and deposition of the fat in the animal body.—After their addresses Dr. Wolff and Dr. Mœli gave demonstrations in the demonstrating hall of the Physiological Institute.

CONTENTS

THURSDAY, MARCH 13, 1884

POLISH BONE CAVES

The Bone Caves of Ojcow in Poland. By Prof. Dr. Ferd. Römer. Translated by John Edward Lee, F.G.S., F.S.A., Author of "Isca Silurum," &c., Translator of Keller's "Lake Dwellings," Merk's "Kesslerloch," &c. (London: Longmans, Green, and Co., 1884.)

A RANGE of Oolitic hills, extending, in a north-westerly direction, from Cracow in Galicia to Czenstochau in Russian Poland, a distance of about fifteen German miles, contains the caverns termed, as we learn from the title of the work placed at the head of this article, "The Bone Caves of Ojcow," from a town of that name within the Russian frontier, and about three German miles north of Cracow. These caverns first attracted scientific attention from the fact that their deposits, worked for manure, were found to be rich in bones. Prof. Römer visited them first in 1874, and, having obtained funds from the Royal Prussian Ministry of Instruction, and subsequently from the Royal Academy of Sciences at Berlin, the work of investigation was begun in 1878, and carried on, at intervals, to the summer of 1882.

The facts disclosed, with speculations respecting them, were embodied in a work apparently published early in 1883; and there can be no doubt that, by preparing and publishing the translation now before us, Mr. Lee has added to the obligation under which his previous labours, both as author and translator, have laid English readers. The volume is enriched with twelve admirable plates; a charming Woodburytype frontispiece, exhibiting a magnificent skull of *Ursus spelæus;* and a useful sketch-map of the situation of the bone caves.

The caverns investigated were nine in number; and it must be stated here that, from 1873 to 1879, Count Johann Zawisza of Warsaw had with great care carried on researches in two of them—the Lower and the Upper Caves of Wierszchow, to the former of which he gave the name of *Mammoth Cave.*

The following brief statements respecting the caves themselves must suffice :—

The Cave of Jerzmanowice, about 1 German mile west-south-west from Ojcow, and the largest of the series, is about 230 metres long, tortuous, made up of a series of small grottoes connected by narrow passages, and famous as the richest of the caves in its palæontological and archæological relics.

The Cave of Kozarnia, about ·6 of a German mile west-north-west from Ojcow, measured about 59 metres long, had a large entrance, and was rich in remains of mammals and of human industry, of which the greater part had been found, and unfortunately dispersed beyond recovery, before Prof. Römer's researches began.

Near Wierszchow, almost on the frontier of Russian Poland and Galicia, rather more than 1 German mile due south from Ojcow, there are two caverns known as the "Lower" and the "Upper," the former being Count Zawisza's *Mammoth Cave,* as already stated. The Lower Cave is about 19 metres long, 13 metres wide, has two narrow lateral ramifications, and is about 577 metres from the Upper Cave.

The Cave of Zbójecka, about ·2 of a German mile south-west from Ojcow, is very low at the entrance, but expands at once into a tolerably high arched space, whence two branches are sent off; that on the right being 129 metres long and 4 wide, while that on the left is but short.

The Cave of Czajowice, a short distance south of that just mentioned, is about 165 metres long. Its stalagmites are more considerable than those of any of the other caverns, attaining in some places a foot in thickness.

Sadlana Cave, about ·5 of a German mile north-north-west from Ojcow, and the most northerly of the series, has four entrances, and throws off two lateral branches, which, being blocked up with stones, have not been examined.

Bembel Cave, about 1 German mile south-west from Ojcow, is of but small extent.

Górenice Cave, about 3 German miles west-south-west from Ojcow, the most westerly of the series, and on the frontier of Russian Poland and Galicia, is so very low that a man can rarely stand erect in it, and has two entrances about 40 metres apart.

An oolitic floor appears to be very seldom reached in any of them. They generally contain a deposit of angular pieces of oolite, from an inch in diameter to the size of the fist, mixed with dark brown calcareous clay, and attaining in some cases a thickness of 6 or 8 feet. A few blocks of oolite, some of them containing several cubic feet, are occasionally met with in the deposit, and it is believed that the entire mass was derived from the walls and roof. In most of the caves there are horizontal layers of coarsely crystalline stalagmite, varying from a few inches to upwards of a foot in thickness.

All the caverns have yielded bones, occurring sometimes under the stalagmite and not unfrequently embedded within it, and most of them have entirely lost their gelatinous matter. An entire infra-human skeleton has never been found, nor does there appear to have been anything like even a distant approach to it; indeed, except in one solitary case, the two rami of every lower jaw were separated.

Few, probably none, of the caves have received an exhaustive scientific exploration, and it is stated of most of them that they have only been very partially examined. Unfortunately, as we learn from Prof. Römer, it cannot be always positively stated from which bed the specimens were taken; "but," he adds, "the case is the same with most of the caves which have been excavated in Germany." We agree with him that this could only have been avoided by carrying the work on quite slowly and with great precaution under the continued superintendence of a scientific manager, and we venture to add that such a price would have been well worth paying. It must be stated, however, that Count Zawisza, having mainly devoted himself to one of the caves, in which the daylight was available for the whole work, and on which he appears to have spent at least portions of seven years, was able to note the exact situation of each specimen.

The caverns yielded remains of fifty species of mammals, twelve of birds, and two of reptiles. All the birds belong to species still inhabiting the British Isles as well as continental Europe, with the possible exception of very scanty relics of the genera *Emberiza* and *Hirundo,* and may be dismissed with the remark that they are to the nerves and the bones, we have gone beyond the subject I proposed to speak upon. My subject belongs to physical science;—what is called in Scotland, Natural Philosophy. Physical science refers to dead matter, and I have gone beyond the range whenever I speak of a living body; but we must speak of a living body in dealing with the senses as the means of perceiving—as the means by which, in John Bunyan's language, the soul in its citadel acquires a knowledge of external matter. The physicist has to think of the organs of sense, merely as he thinks of the microscope; he has nothing to do with physiology. He has a great deal to do with his own eyes and hands, however, and must think of them, if he would understand what he is doing, and wishes to get a reasonable view of the subject, whatever it may be, which is before him in his own department.

Now what is the external object of this internal action of hearing and perceiving sound? The external object is a change of pressure of air. Well, how are we to define a sound simply? It looks a little like a vicious circle, but indeed it is not so, to say it is sound if we call it a sound—if we perceive it as sound, it *is* sound. Any change of pressure, which is so sudden as to let us perceive it as sound is a sound. There [giving a sudden clap of the hands]—that is a sound. There is no question about it—nobody will ever ask, Is it a sound or not? It is sound if you hear it. If you do not hear it, it is not to you a sound. That is all I can say to define sound. To explain what it is, I can say, it is change of pressure, and it differs from a gradual change of pressure as seen on the barometer only in being more rapid, so rapid that we perceive it as a sound. If you could perceive by the ear, that the barometer has fallen two-tenths of an inch to day, that would be sound. But nobody hears by his ear that the barometer has fallen, and so he does not perceive the fall as a sound. But the same difference of pressure coming on us suddenly—a fall of the barometer, if by any means it could happen, amounting to a tenth of an inch, and taking place in a thousandth of a second, —would affect us quite like sound. A sudden rise of the barometer would produce a sound analogous to what happened when I clapped my hands. What is the difference between a noise and a musical sound? Musical sound is a regular and periodic change of pressure. It is an alternate augmentation and diminution of air pressure, occurring rapidly enough to be perceived as a sound, and taking place with perfect regularity, period after period. Noises and musical sounds merge into one another. Musical sounds have a possibility at least of sometimes ending in a noise, or tending too much to a noise, to altogether please a fastidious musical ear. All roughness, irregularity, want of regular, smooth periodicity, has the effect of playing out of tune, or of music that is so complicated that it is impossible to say whether it is in tune or not.

But now, with reference to this sense of sound, there is something I should like to say as to the practical lesson to be drawn from the great mathematical treatises which were placed before the British Association, in the addresses of its president, Prof. Cayley, and of the president of the mathematical and physical section, Prof. Henrici. Both of these professors dwelt on the importance of graphical illustration, and one graphical illustration of Prof. Cayley's address may be adduced in respect of this very quality of sound. In the language of mathematics we have just "one independent variable" to deal with in sound, and that is air pressure. We have not a complication of motions in various directions. We have not the complication that we shall have to think of presently, in connection with the sense of force; complication as to the place of application, and the direction, of the force. We have not the infinite complications we have in some of the other senses, notably smell and taste. We have distinctly only one thing to consider, and that is air pressure or the variation of air pressure. Now when we have one thing that varies, that, in the language of mathematics, is "one independent variable." Do not imagine that mathematics is harsh, and crabbed, and repulsive to common sense. It is merely the etherealisation of common sense. The function of one independent variable that you have here to deal with is the pressure of air on the tympanum. Well now in a thousand counting houses and business offices in Birmingham and London, and Glasgow, and Manchester, a curve, as Prof. Cayley pointed out, is regularly used to show to the eye a function of one independent variable. The function of one independent variable most important in Liverpool perhaps may be the price of cotton. A curve showing the price of cotton, rising when the price of cotton is high, and sinking when the price of cotton is low, shows all the complicated changes of that independent variable to the eye. And so in the Registrar-General's tables of mortality, we have curves showing the number of deaths from day to day—the painful history of an epidemic, shown in a rising branch, and the long gradual talus in a falling branch of the curve, when the epidemic is overcome, and the normal state of health is again approached. All that is shown to the eye; and one of the most beautiful results of mathematics is the means of showing to the eye the law of variation, however complicated, of one independent variable. But now for what really to me seems a marvel of marvels: think what a complicated thing is the result of an orchestra playing—a hundred instruments and two hundred voices singing in chorus accompanied by the orchestra. Think of the condition of the air, how it is lacerated sometimes in a complicated effect. Think of the smooth gradual increase and diminution of pressure—smooth and gradual, though taking place several hundred times in a second—when a piece of beautiful harmony is heard! Whether, however, it be the single note of the most delicate sound of a flute, or the purest piece of harmony of two voices singing perfectly in tune; or whether it be the crash of an orchestra, and the high notes, sometimes even screechings and tearings of the air, which you may hear fluttering above the sound of the chorus—think of all that, and yet that is not too complicated to be represented by Prof. Cayley, with a piece of chalk in his hand, drawing on the blackboard a single line. A single curve, drawn in the manner of the curve of prices of cotton, describes all that the ear can possibly hear, as the result of the most complicated musical performance. How is one sound more complicated than another? It is simply that in the complicated sound the variations of our one independent variable, pressure of air, are more abrupt, more sudden, less smooth, and less distinctly periodic, than they are in the softer, and purer, and simpler sound. But the superposition of the different effects is really a marvel of marvels; and to think that all the different effects of all the different instruments can be so represented! Think of it in this way. I suppose everybody present knows what a musical score is—you know, at all events, what the notes of a hymn tune look like, and can understand the like for a chorus of voices, and accompanying orchestra—a "score" of a whole page with a line for each instrument, and with perhaps four different lines for four voice parts. Think of how much you have to put down on a page of manuscript or print, to show what the different performers are to do. Think, too, how much more there is to be done than anything the composer can put on the page. Think of the expression which each player is able to give, and of the difference between a great player on the violin and a person who simply grinds successfully through his part; think, too, of the difference in singing, and of all the expression put into a note or a sequence of notes in singing that cannot be written down. There is, on the written or printed page, a little wedge showing a diminuendo, and a wedge turned the other way showing a crescendo, and that is all that the musician can put on paper to mark the difference of expression which is to be given. Well now, all that can be represented by a whole page or two pages of orchestral score, as the specification of the sound to be produced in say ten seconds of time, is shown to the eye with perfect clearness by a single curve on a riband of paper a hundred inches long. That to my mind is a wonderful proof of the potency of mathematics. Do not let any student in this Institute be deterred for a moment from the pursuit of mathematical studies by thinking that the great mathematicians get into the realm of four dimensions, where you cannot follow them. Take what Prof. Cayley himself, in his admirable address, which I have already referred to, told us of the beautiful and splendid power of mathematics for etherealising and illustrating common sense, and you need not be disheartened in your study of mathematics, but may rather be reinvigorated when you think of the power which mathematicians, devoting their whole lives to the study of mathematics, have succeeded in giving to that marvellous science.

(*To be continued.*)

THE GEOLOGICAL POSITION OF THE HUMAN SKELETON FOUND AT TILBURY

In a paper on this subject read by Mr. T. V. Holmes, F.G.S., at the meeting of the Essex Field Club on Saturday, February 23, at Buckhurst Hill, the author pointed out that the Tilbury skeleton was found in recent alluvium. The section at better, though still rough, workmanship, was a small pipkin-like vessel, with its handle perfect. Some of these pieces were roughly and simply ornamented. Specimens from the uppermost level were clearly more modern.

Three of the caves yielded dark gray or black spindle-whorls of burnt clay, of fairly good workmanship.

The metal objects included a bronze fibula and ring, a silver coin supposed to be about the year 140, and iron arrow- and lance-heads of mediæval form.

We are grateful for this contribution to the palæontology and anthropology of Europe, and are encouraged by it to entertain the hope that Prof. Römer may be enabled to make arrangements for the *complete and systematic* exploration of at least one of the Ojcow caves at present untouched; and that sufficient means may be at his disposal to place the work under continued scientific superintendence.

OUR BOOK SHELF

Poisons: their Effects and Detection. By Alex. Wynter Blyth, M.R.C.S. (London: Charles Griffin and Co., 1884.)

THIS elaborate volume forms a part of the second edition of the author's treatise on "Practical Chemistry," which has been wisely split up into two volumes, one on "Foods," the other on "Poisons." Mr. Blyth's experience as a health-officer and public analyst guarantees that his conclusions are largely based on actual practice as a toxicologist; and the book will be found to abound in records of his own experiences.

But Mr. Blyth is also an accomplished linguist, and his book bears ample evidence of extensive reading, and a wide acquaintance with the European literature of toxicology. Almost every page teems with references to original memoirs in the French, German, and Italian languages; and this circumstance alone would render it an indispensable work of reference to be placed in the library of every toxicologist. But "Poisons" has other and distinguishing merits.

The general reader will find the introductory chapter on the old poison-lore of great interest, and replete with many but little known facts and fables relative to the history of poisons and their secret administration. Following on this we find a succinct account of the growth and development of the modern methods of chemically detecting poisons, at the end of which nearly three pages are devoted to a bibliography of the chief works on toxicology of the present century, in which we miss any reference to one of the most complete treatises on poisons extant—that forming the bulk of the seventeenth volume of Ziemssen's "Cyclopædia of Medicine."

In giving a scientific definition of a poison, Mr. Blyth somewhat enigmatically remarks that "The definition of a poison, in a scientific sense, should be broad enough to comprehend not only the human race, but the dual world of life, both animal and vegetable." He finally defines a poison thus:—"A substance of definite chemical composition, whether mineral or organic, may be called a poison, if it is capable of being taken into any living organisms, and causes, by its own inherent chemical nature, impairment or destruction of function." He excludes the bacteroid bodies met with in certain diseases, but apparently ignores the views of those observers who are of opinion that these organisms form or excrete true poisons of definite chemical constitutions.

A novelty in the work is the devotion of a section to what are termed "life-tests," *i.e.* the identification of poisons by their effects on living animals. This, and the elaborate instructions given on the authority of various writers, as to the methods to be adopted for separating and identifying the various poisons, will be found invaluable to the analyst; and his only difficulty will be the choice of one out of the almost innumerable methods given for the separation of a single poison, say arsenic or opium.

THOMAS STEVENSON

Informe Official de la Comision cientifica agregada al estado mayor general de la Expedicion al Rio Negro (Patagonia) realizada en los meses de Abril, Mayo, y Junio de 1879, bajo las órdenes del General D. Julio A. Roca. Entrega I. Zoologia (con 4 laminas). Part I. 4to, 168 pp. (Buenos Ayres, 1881.)

IN 1879 the Government of the Argentine Republic despatched an expedition to the southern confines of their territory for the suppression of the hordes of Indians that had for many years previously rendered the district of the Rio Negro unsafe to travellers and to settlers. Under the command of General Roca these marauding savages were successfully driven off to the south of the Rio Negro, and a new frontier, which they are not allowed to cross northwards, was established. General Roca (whose excellent example on this occasion it would be well if some of the Governments of Europe would follow) having invited a commission of scientific men to accompany his expedition, Dr. P. G. Lorentz and Mr. G. Niederlein were sent with him as botanical collectors, and Herr Schulz, Inspector of the Zoological Museum of Cordoba, as zoologist. The results of the last-mentioned naturalist's labours are contained in the volume now before us, which has been prepared by Dr. A. Doering, with the assistance of Dr. Berg, Dr. Holmberg, and D. Enrique Lynch Arribálzaga, and is highly creditable to the youthful Academy of Natural Sciences of Cordoba, to whom, it would appear, the task of working out the scientific collections was intrusted.

Dr. Doering commences his labours by a chapter of general observations upon the fauna of the newly occupied territory, which he divides into four "zoogeographic zones"—(1) the region of the Southern Pampas; (2) the river-region of Northern Patagonia; (3) the central mountain-region; and (4) the eastern slopes of the Cordillera. The two last regions being very little known and not having been traversed by the expedition, are not discussed in the present essay, but the two former are subdivided into minor districts, and the principal zoological characters of each of their subdivisions are pointed out. Lists are also given of the principal mammals, birds, amphibians, and land-mollusks that are chiefly peculiar to the different districts.

Dr. Doering's instructive "zoogeographical" essay is followed by the systematic portion of the volume, in which the vertebrates and land-shells are treated of by the same naturalist, while his colleagues, Dr. Berg and Dr. Lynch Arribálzaga, have worked out the insects, and Dr. Holmberg the arachnidans. We have thus before us an excellent basis for a fauna of this hitherto little-known portion of the great Neotropical Region, which does credit alike to the Government of the Republic which instituted the investigation, and to the Academy of Natural Sciences of Cordoba, under whose auspices the work has been elaborated.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Instinct

IN his letter under this heading in last week's NATURE (p. 428), Mr. Romanes says that I *now* admit that the actions of animals testify to some corresponding mental states. If he will kindly refer to my original paper he will find that my views have not undergone the change he implies, for I *then* wrote: "We have therefore grounds for believing that, running parallel to the neuroses of animals, there are certain psychoses"; and again: "Animal minds are also ejective; they are more or less distorted images of our own minds"; and, in my "Conclusion," "While fully admitting the great interest that attaches to the study of the inferred mental faculties of the higher brutes," &c.

Were I to take his concluding remark seriously, and say that, if I were the only individual to hold the view that the mental life of animals cannot be the subject-matter of a science, this would not prove my view untrue, Mr. Romanes would smile at my want of appreciation of his powers of sarcasm. I content myself with drawing Mr. Romanes' attention, and that of your readers, to the following quotations from Prof. Huxley's volume on the Crayfish:—"Under these circumstances it is really quite an open question whether a crayfish has a mind or not; moreover, the problem is *an absolutely insoluble one*, inasmuch as nothing short of being a crayfish would give us positive assurance that such an animal possesses consciousness. . . . So we may as well leave this question of the crayfish's mind on one side for the present, and turn to *a more profitable investigation*," &c. (p. 89). And again: "At the most, one may be justified in supposing the existence of something approaching dull feeling in ourselves, and so far as such obscure consciousness accompanies the molecular changes of its nervous substance, it will be right to speak of the mind of a crayfish" (p. 126).

The question now seems to turn on what we mean by a science. Animal minds, as ejects, are distorted images of our own minds. Can we frame a *science* which deals with these distorted ejects? Could we frame a *science* of astronomy if the only method of procedure were to observe the stars and planets in mirrors *of varying and unknown curvature?* If we can give an affirmative answer to the latter question, I am ready to admit that, in the same degree, we can give an affirmative answer to the former. C. LLOYD MORGAN

Circular Rainbow seen from a Hill-top

READING Mr. Fleming's letter in your issue of January 31 (p. 310), I am moved to put on record an observation of my own involving shadows and rainbows upon a cloud. On August 19, 1878, I was encamped upon a plateau known as Table Cliff, in the southern part of Utah Territory. The plateau has its longer dimension north and south, and ends southward in an acute promontory, precipitous toward the south, west, and east. The altitude is about 10,000 feet. On that day the air was moist, and scattering clouds were to be seen both in the valley beneath and in the sky above. A strong wind blew from the west. On that side of the promontory the air was clear; but at the crest a cloud was formed, so that the view eastward was completely cut off. This phenomenon is not unusual on mountain summits, and has been plausibly explained as due to the sudden rarefaction of the air on the lee-side of an obstacle. Standing on the verge of the cliff just before sunset, I saw my own shadow and that of the cliff distinctly outlined on the cloud. The figure appeared to be about fifty feet distant, and was not colossal. About the head was a bright halo with a diameter several times greater than the head. Its colours included only a portion of the rainbow series, but I neglected to record them, and do not venture to recite from memory. At the usual angle outside there appeared two rainbows of great brilliancy, likewise concentric with the head. They did not describe complete circles, but terminated at the left and beneath, where they met the shadow of the cliff. I estimated that 225° of arc were displayed. The phenomenon was continuous for some hours, the cloud-mass being persistent in position, notwithstanding the fact that its particles had a velocity of twenty-five or thirty miles an hour.

The observation has more than a scientific interest, because, in the popular imagination, the heads of scientific observers are not usually adorned with halos. G. K. GILBERT

Washington, U.S.A., February 25

Right-sidedness

IN all the letters thus far published in NATURE on the subject of the tendency to deflection in walking, I find two things confounded which are quite distinct. There are two distinct senses in which we may use the term *right-leggedness:* the one refers to *strength*, the other to *dexterity* or accurate co-ordination of muscular action. In the arm these two always go together; for dexterity gives greater use (dexterity, I believe, is largely inherited), and use gives greater strength. But in the leg these may be and often are dissociated. As Prof. Darwin truly says, the left leg is often the stronger, but I believe the right is nearly always the more dexterous. My own case is a typical one. I hop on my left leg, and rise from it in jumping. But I do so not only because the left is stronger, but also, and I think mainly, because I use the right more dexterously as a swinging weight. The dexterous management of the free leg is certainly no less important than the strength of the jumping leg. In kicking or performing any other movement requiring dexterity, I stand on the left leg and use the right.

In my own case the whole body is *right-sided*, as far as dexterity is concerned. Impressions on my left eye are as vivid, perhaps even more vivid, than on my right, yet I see more intelligently (as, for example, in using a microscope) with my right. In the case of double images of near objects when looking at a more distant one, it is the left-eye image (the right in position) which I neglect. In pointing with the finger, whether of the right or left hand, with both eyes open, it is the right-eye image of the finger (the left in position) that I range with the object. In the case of two or three left-handed persons on whom I have made observations, I have found, on the contrary, that it is the right-eye image that they neglect, and the left-eye image that they use in pointing. JOSEPH LE CONTE

Berkeley, California, February 19

"Suicide" of Black Snakes

WHILE encamped near Mount Wynne, Kimberley district, for a few days from June 13, 1883, our survey party saw and killed several black snakes averaging about five feet in length. In three days I saw seven of these unpleasant visitors in our camp. As is well known, the black snake is one of the most venomous of the Australian serpents, and whenever met with is if possible destroyed. I have seen many killed, but usually they die hard; and even when the back is broken in several places will linger for more than an hour, still capable of revenging themselves on an incautious assailant.

On this occasion our men had disabled one, and as I was anxious to obtain the skin I induced them to let it alone (they usually cut off the head so as to insure death). While we were looking at it some large black ants attacked the wounded part—about three feet from its head—when it instantly turned short round and bit itself twice in the neck, with seeming determination. In less than one minute it was dead. There can be no doubt, therefore, that it was poisoned by its own venom.

I do not know if such a custom on the part of snakes has been recorded. However, my men assured me that they had often witnessed similar occurrences, especially in the case of the "death" or "deaf" adder, a very venomous Australian snake. One man informed me that he had often insured the death of this reptile by simply pinning him to the ground by means of a forked stick. In all cases the reptile would turn round, bite himself, and die instantly.

EDWARD F. HARDMAN,
Government Geologist

Perth, Western Australia, January 28

Sea Fish in Freshwater Rivers

DURING my journey up the Fitzroy River with the surveying party from King's Sound to the Leopold Ranges (between lat. 17° 4' and 18° 20' S.), I observed many specimens of sword- and saw-fish. They appeared at intervals the whole way up the river, but none observed were more than three feet or three feet six inches long. About 300 miles up on the Margaret River I procured the saw of a small one. It measures about nine inches long and two inches wide. A few days after this, a little higher up the river, some of our men found a shark five feet long, and recently killed, probably by natives. I could not visit the place, as we were then about to break up camp for our return, but the men showed us some of the teeth, which were unmistakably those of a shark. They were, besides, well acquainted with the appearance of that fish.

Some time after this, when returning down a branch of the Fitzroy, and camped in the sand of the river bed, I found the body of a small young shark. It was about eighteen inches long. I secured this as evidence. This locality is about 170 miles from the mouth of the river.

During the six months we were in the country, the bed of the river, which varies from 50 to 800 yards in width, was almost dry, with the exception of deep pools at intervals connected with each other by a narrow stream, often very shallow, running under the high banks. In the summer time the river is deeply flooded, the water rising ten to twenty feet (as shown by drift wood in trees) above the banks, in many places from forty to fifty feet high. The force of the flood might at its height prevent fish going up, but they could easily ascend in the intermediate season. In some cases the fish must have lived months in the upper waters, for portions of the Margaret, at least, are absolutely dry in the winter season, May to November usually.

I am not aware that such a circumstance has ever been noted before. If not, the fact is sufficiently interesting in itself. It is also important from a geological point of view, as showing that some caution must be observed in the classification of strata as freshwater or marine on the evidence of fish alone. No doubt many of these remains are embedded in the river detritus, and if discovered at some future time when the physical geology of the country has altered, might lead to the conclusion that these deposits were of marine origin.

EDWARD F. HARDMAN,
H.M. Geological Survey, Government Geologist
Perth, Western Australia, January 28

The Zodiacal Light

ONE of the members of the staff of this establishment, Mr. E. G. Constable, observed a brilliant appearance of the zodiacal light at about 7 p.m. on the evening of Wednesday the 5th inst., the cone of light being exceedingly well defined. The phenomenon was not visible long, having completely disappeared by 7.20 p.m. G. M. WHIPPLE

Kew Observatory, Richmond, Surrey, March 7

THE AXIOMS OF GEOMETRY

SINCE the time when Riemann and Helmholtz began their investigations on the axioms of geometry so much has been written on this subject in learned papers and in a more or less popular form that it might have appeared superfluous again to call the attention of writers on, and teachers of, elementary geometry to it, had it not been for the publication a year or two ago of a new edition of the first six books of Euclid's "Elements," with annotations and notes, by Prof. Casey. I hope the eminent author of this in many respects excellent book will excuse me for criticising some points in it, and making them the opportunity for again returning to the question about the axioms in geometry.

The points I object to besides his treatment of Book V., of which I may possibly say a few words on another occasion, is contained in Note B at the end of the book. Here Prof. Casey gives Legendre's and Hamilton's proofs of I. 32, that the sum of the interior angles of any triangle is equal to two right angles, implying, of course, that he considers these proofs valid, proofs which are independent of the theory of parallels. The theorem in question depends in Euclid upon Axiom XII., and all depends upon the question whether this axiom is necessary. For the two propositions in this axiom and in Theorem I. 32 stand in such a relation that either is a consequence of the other. Hence if I. 32 can be proved independently, the Axiom XII. changes into a theorem. But the investigations above referred to show that it is this axiom which tells us what kind of a surface the plane really is, and that until this axiom is introduced all propositions apply equally well to the spherical and to the plane surface.

I select for discussion the "quaternion proof" given by Sir William Hamilton, this being the easiest of the two. But that by Legendre can be treated in exactly the same way.

Hamilton's proof consists in the following:—

One side A B of the triangle A B C is turned about the point B till it lies in the continuation of B C; next, the line B C is made to slide along B C till B comes to C, and is then turned about C till it comes to lie in the continuation of A C. It is now again made to slide along C A till the point B comes to A, and is turned about A till it lies in the line A B. Hence it follows, *since rotation is independent of translation*, that the line has performed a whole revolution, that is, it has been turned through four right angles. But it has also described in succession the three exterior angles of the triangle, hence these are together equal to four right angles, and from this follows at once that the interior angles are equal to two right angles.

To show how erroneous this reasoning is—in spite of Sir William Hamilton and in spite of quaternions—I need only point out that it holds exactly in the same manner for a triangle on the surface of the sphere, from which it would follow that the sum of the angles in a spherical triangle equals two right angles, whilst this sum is known to be always greater than two right angles. The proof depends only on the fact, that any line can be made to coincide with any other line, that two lines do so coincide when they have two points in common, and further, that a line may be turned about any point in it without leaving the surface. But if instead of the plane we take a spherical surface, and instead of a line a great circle on the sphere, all these conditions are again satisfied.

The reasoning employed must therefore be fallacious, and the error lies in the words printed in italics; for these words contain an assumption which has not been proved. In fact they contain an axiom which completely replaces Euclid's Axiom XII., viz. it expresses that property of a plane which differentiates it from the sphere.

On the sphere it is, of course, not true that rotation is independent of translation, simply because every translation—sliding along a great circle—is a rotation about the poles of the great circle.

From this it might be said to follow that the calculus of quaternions must be wrong. But this again is not correct. The fact is that the celebrated author of this calculus had built it up with the full knowledge of the fundamental space properties in his mind, and making full use of them. Afterwards, on reasoning backwards, he got these space properties out of his formulæ, forgetting that they were exactly the facts with which he started. The process is, as far as logic is concerned, not very different from that practised by some alchemists, who pretended to make gold, and actually did produce gold out of their crucibles, but only as much as they had themselves put in.

The following considerations may help to clear up this point still further:—

Prof. Sylvester once conceived, in illustration of some points connected with our subject, an infinitely thin bookworm living in a surface, and consequently limited in its space conceptions to the geometry on such surface. In a similar manner we may imagine an intelligent being consisting merely of an eye occupying a fixed point in space, but capable of perceiving rays of light in every direction. For such a being space would have two dimensions only, but in this space it could conceive figures for which most of Euclid's definitions and all axioms with the exception of the twelfth, and therefore all propositions up to the twenty-sixth in the first book, would hold. Only the names *point*, *line*, *angle*, &c., would stand for objects different to those which they represent to our mind. Nothing can put the vagueness of Euclid's definitions and the real nature of his axioms, viz. that they contain the real logical definitions of the geometrical entities, in a clearer light than the fact that it is possible to use these so-called definitions for objects quite different from those to which Euclid applied them.

To return to our imaginary being: let us suppose it capable of studying Euclid. A ray of light, that is, a line, would appear to it as having no extension but only position, and would answer Euclid's definition of a point. Two such rays determine a plane, but to the eye this would have one dimension only, and it would *lie evenly between its boundaries;* calling the latter "points" it answers the description of lying evenly between its extreme points, and may be called a straight line, whilst the angle between the two rays would be the *distance* between the points. If two of these lines be drawn from the same point, we get as the inclination between them a *rectilineal angle;* this being to our mind the dihedral angle between two planes. If a line A B were made to revolve about its fixed end A, the other point B would describe a *circle;* in our space a cone of revolution.

The following is a list of those definitions and axioms from Euclid with which we have here to deal. It will be seen that they hold, every word of them, for the figures above described as conceived by our eye-being. Only it must be remembered that a point for the eye-being is to our mind a line through the eye, and so for the line, &c. The words in square brackets indicate what the figures are to our mind.

DEFINITIONS

I. A point [line through the eye] is that which has no parts or which has no magnitude.

II. A line [conical surface with vertex in the eye] is length without breadth.

IV. A straight line [plane through the eye] is that which lies evenly between its extreme points [lines through the eye].

IX. A rectilineal angle [dihedral angle] is the inclination of two straight lines [planes through the eye] to one another which meet together but are not in the same straight line [plane].

X. When a straight line [plane] standing on another straight line [plane] makes the adjacent angles equal to one another, each of the angles is called a right angle [right dihedral angle].

XV. A circle [cone of revolution with vertex at the eye] is a figure contained by one line [surface] which is called the circumference, and is such that all straight lines [angles] drawn from a certain point within the figure to the circumference are equal to one another.

XVI. And this point [line] is called the centre of the circle [axis of the cone].

AXIOMS CALLED POSTULATES IN EUCLID

I. Let it be granted that a straight line [plane through the eye] may be drawn from any one point [line through the eye] to any other point [plane determined by two lines through the eye].

II. That a terminated straight line may be produced to any length in a straight line [plane through intersecting lines may be produced beyond these lines].

III. And that a circle may be described from any centre at any distance from that centre [a cone about any axis with any angle at the vertex].

AXIOMS

X. Two straight lines cannot inclose a space [two planes through a point cannot inclose a space].

XI. All right [dihedral] angles are equal to one another.

Starting with the above definitions and axioms, the eye-being would have no difficulty in mastering the constructions and theorems contained in the first propositions of the "Elements." Only in Proposition IV. a difficulty might occur. For it may perhaps prove to be impossible to make the two triangles coincident. In Euclid's triangles, namely, it may be necessary to take of one of the triangles the side opposite to the one originally given by taking it out of the plane and turning it over before it can be made to coincide with the other triangle. So perhaps our being would find out, if the two triangles [trihedral angles] were right- and left-handed, that it has to take of one of the triangles the opposite side, viz. that on the other side of itself [formed by the continuations of the rays], which then will answer the purpose. After this every other proposition would follow without difficulties till parallel lines were introduced, which might sorely puzzle our eye-being, and finally be dismissed as downright nonsense, parallel lines being absolutely inconceivable. And if Sir William Hamilton's proof of the proposition that the sum of the angles in a triangle equalled two right angles were given to it, it would grant the construction and every step as possible and correct, but it would "shake its head" about the conclusion included in the words printed above in italics. It might even consider Euclid a fit subject for a "Budget of Paradoxes." For it is difficult to imagine that this being *without moving in space* should be able to generalise and invent a geometry in a space of zero curvature.

If in any one of the first twenty-six propositions of Euclid the changes above indicated are made from our conceptions to those of the eye-being, we get a series of well-known fundamental propositions in solid geometry which when obtained in this manner do not require any further proof.

O. HENRICI

THE SCIENTIFIC WORK OF THE "VEGA" EXPEDITION[1]

THE second volume of this work is as rich an addition to our knowledge of the far north as the previous one. It contains also not only the bare results of the observations of the scientific staff of the *Vega*, but also a series of elaborate papers connected with the various topics which were within the circle of the researches of the expedition.

F. R. Kjellman contributes two more papers on the Arctic flora. In the first of these he deals with the phanerogamous flora of the island of St. Lawrence, situated under the 63rd parallel in the Behring Straits. This island has been represented in Middendorff's work as quite devoid of trees and shrubs, although Chamisso had seen on it large spaces covered with a *Salix*. M. Kjellman found, during his very short stay at the island, no less than 96 species of phanerogams, of which 53 are new for the island, the whole of the phanerogamous species known reaching thus 113 (22 Monocotyledons, and 91 Dicotyledons). They are chiefly Gramineæ (11 species), Compositæ, and Ranunculaceæ (9 species each), Saxifragaceæ, Cruciferæ, and Caryophyllaceæ (8 species each; the Scrophulariaceæ, Salicineæ, and Cyperaceæ are represented by 7 species each. The flora is purely Arctic; 105 species being East Siberian, 79 West Siberian, and 101 West American. The island proves to have thus taken in species indifferently from the eastern and from the western continent. Having, however, a few genera more in common with Siberia than with America, and these genera having also a wider extension in Siberia, it would seem that the island stands in a somewhat closer connection with Asia than with America. It is worthy of notice that M. Kjellman found no endemic species; only the variety *tomentosa* of the *Cineraria frigida*, and *Saxifraga neglecta*, var. *stolonifera*, which show such variations from the typical forms as might lead them to be considered perhaps as separate species. Both are figured on plates that accompany the paper, as well as *Saxifraga neglecta* var. *congesta*, from the land of the Chukches.—Another paper, by the same author, deals with the phanerogams of the "Western Esquimaux Land," that is of the north-western extremity of North America, between Norton

[1] "*Vega*-Expeditionens Vetenskapliga Saktlagelser, bearbetade af deltagare i resan och andra forskare, utgifna af A. E. Nordenskjöld." Andra bandet, med 32 taflor.

Sound and Point Barrow. The *Vega* stopped at Port Clarence, and M. Kjellman added to the 242 formerly known species about 45 new ones for this locality, one of which—*Draba palanderiana*—is a new species.

M. Oscar Nordquist contributes, under the title of "Remarks and Studies on the Mammifers of the Coasts of the Siberian Polar Sea," an elaborate paper, the result of the observations made during the cruise, as well as of his studies at the museums of St. Petersburg, Stockholm, and Copenhagen. The North Siberian coast is very poor in mammals, only twenty-nine species altogether being known from the whole of the region; moreover, seven of them inhabit the sea, to which number six or seven species of whales ought to be added. Of the twenty species of mammals inhabiting the northern coast region, only seventeen or eighteen belong exclusively to the coast region, and do not penetrate into the forest region. No distinct zoological regions can be established on this wide space; it can only be said that the fauna of the Behring region has some marked differences (especially with regard to its birds) from that of the western parts of the littoral, and especially of the coasts of the Karian Sea. The most characteristic mammal from Behring Sound is *Phoca fasciata*, and *Odobænus rosmarus*, var. *obesus*, from the seas north of Behring Strait. The variety *largha* of *Phoca vitulina* does not penetrate north of the Strait. The Chukche peninsula has a few mammals and many birds characteristic of it, namely, *Spermophilus parryi*, *Lagomys hyperboræus*, *Lepus timidus*, var. *chukchorum*, and *Arvicola kamchatika*. The other parts of the littoral have no special characteristic mammals of their own, and *Phoca fœtida*, *Phoca barbata*, and the ice bear, extend from the Ugrian Strait to the utmost eastern extremity of Asia. The most common mammals throughout the Siberian sea coast are *Canis lagopus*, *C. vulpes*, and *C. lupus*, *Rangifer tarandus*, *Myodes obensis*, *Caniculus torquatus*, two species of Arvicola described by M. Polakoff under the names of *A. middendorffii* and *A. nordenskjöldii*, and the hare (probably its Kamchatka variety). The author mentions also the interesting periodical migrations, not only of the reindeer (well known from Wrangel's descriptions), but also of *Myodes obensis* and *Cuniculus torquatus*, and reproduces a little-known Russian paper, by M. Argentoff, dealing with the migrations of mammals in North-Eastern Siberia. This general sketch is followed by the descriptions of the North Siberian mammals, with plates figuring the skulls of *Lepus chukchorum*, *Odobænus obesus*, and *Phoca fasciata*.

The same volume contains a most valuable contribution to the fossil flora of Japan, by M. Nathorst, the well-known Swedish palæontologist, to whom we are already indebted for so many researches into the Quaternary flora of Europe. It is known from Nordenskjöld's general report that the *Vega* Expedition discovered—embedded in volcanic ashes at Mogi, close by Nagasaki—a very rich collection of plants belonging to the most recent Tertiary or to the earlier Quaternary period. This find was the more precious, as our knowledge of the fossil flora of Japan was exceedingly meagre. We knew from Japan only Jurassic plants, quite like those of Eastern Siberia, with but very few exceptions, like the *Podozamites reinii*. Besides, Reiss, to whom we were indebted for these plants, had brought also from "Nikawa, Niphon," one fossil Tertiary plant identified with the *Carpinus grandis* of Unger; and Mr. Godfrey has mentioned that the coal beds at Kiousiou contain fossil plants, probably belonging to the Chalk. If we add a collection of fossil leaves at the Berlin Museum—much like those of Mogi—and another collection brought in by Mr. Lyman, and determined by Prof. Lesquereux at Columbus, Ohio (the plants appear, according to his communication to the author, much like the Miocene flora of Sakhalin), we have enumerated all we formerly knew about the younger fossil flora of Japan. No wonder that with such scant material the climate of Japan during the Tertiary and Quaternary periods remained so little known, and that Engler in his "Entwickelungsgeschichte der Pflanzenwelt" arrived at the conclusion that "no such changes of climate as those undergone by Europe and Northern America have taken place in the Japanese region since the Tertiary period." This opinion of the great German botanist does not seem to be supported by the discoveries of the *Vega*. The fossil flora at Mogi shows that this southern island of Japan experienced about the end of the Tertiary epoch a colder climate than now; it was covered at the sea-level with a vegetation much like that of the forests which cover now only the mountains of Kiousiou; the description of these forests by Rein (at Fuji-no-yama) shows that they contain a great number of species identical with, or nearly akin to, those which are found as fossils at Mogi. These last originate from a forest which contained a great variety of trees and bushes; the most common of them was the beech, akin to an American species, but as nearly akin too to the present Fuji-no-yama beech. There are, of course, at Mogi, a few plants that are not met with now in Japan, such as *Celtis nordenskjöldii*, *Rhus griffithsii*, *Liquidambar formosana*, and perhaps *Magnolia dicksoniana*; but they are few, and have but a secondary meaning; only the *Magnolia* and the beech are American, whilst the others have their nearest relations in the Caucasus and Afghanistan (as the *Celtis*), or on the Himalaya (as the *Rhus griffithsii*), where we find also several other Japanese species. Several species of the Mogi flora have disappeared since; however they have still near relations in the flora of the Japanese highlands. Such are the *Juglans kjellmani*, *Carpinus subcordata* and *stenophylla*, *Quercus stuxbergii*, *Aphananthe viburnifolia*, *Diospyros nordquisti*, *Clethra maximowiczi*, *Fripetaleja almquisti*, *Sorbus lesquereuxi*, *Rhus engleri*, *Acer nordenskjöldii*, and *Ilex heeri* (all new species of M. Nathorst), which have very closely allied representatives in the forest vegetation of the Japanese highlands and northern parts of the Japanese archipelago. At the same time the more southern forms which make a constituent part of the present flora of Japan are absolutely missing in the fossil flora of Mogi. M. Nathorst concludes, therefore, that this last shows undoubtedly a colder climate than that enjoyed now by Japan. As to its age it might be either younger Pliocene or Glacial, or post-Glacial; but its characters would exclude both the latter, and thus we must admit that it belongs to the younger Pliocene; but it would be impossible, until further researches are made, to determine its age with more precision.

M. Nathorst points out also that the Miocene flora of Sakhalin, situated 18° of latitude to the north of Mogi, testifies to a much warmer climate, whilst that of Alaska, of the same period, situated, however, 9° more to the north, scarcely corresponds to a colder climate. The Miocene flora of Japan ought to have been therefore still more different from that of Mogi, and M. Nathorst concludes that the fossil flora of Mogi is a sure testimony of the extension of a colder climate, before and during the Ice period, throughout the whole of the northern hemisphere, and that this colder climate could not depend on those local conditions which were resorted to for Europe and Northern America. We may add to this conclusion that a considerable lowering of temperature throughout Northern Asia is proved also by the unmistakable traces of glaciation found, not only in the deep valleys of the Olekma highlands, but also on the southern slope of the Sayan Mountains, close by Lake Kossogol. Though received at first with some distrust, the glaciation at least of the highlands of the Thian-Shan, the Sayan, and Stanovoy Mountains has since been confirmed by so many testimonies that there can be no more doubt about it. We can only mention here the very interesting sketch given by M. Nathorst of the relations of the Japanese flora to those of different parts of the Pacific basin; the paper ought to be translated in full in some language more familiar to the geologists of Western Europe. The memoir contains the description of seventy species of plants from Mogi, seven species from the coal-measures of Takasima, and seven species from the plants in the Berlin Museum. The descriptions are accompanied by sixteen plates.

Two other important papers, both in English, are contributed to the same volume by M. Otto Petterson. One of them embodies a general discussion, an account of which appeared in NATURE, vol. xxviii. p. 417, on the properties of water and ice between $-20°$ to $+15°$ Cels., on the ground of the author's own measurements. The second paper, "Contributions to the hydrography of the Siberian Sea," not only contains valuable information gathered from the very numerous measurements of depth, saltness, and temperature of water during Nordenskjöld's expeditions on the Kara Sea and along the Siberian coast, but also gives a most valuable sketch of the hydrography of the Kara Sea. It seemed that nothing new could be written on this northern Mediterranean Sea after the beautiful researches by Dr. Pettermann based upon the recent researches of the Norwegian seal-hunters. Still Mr. Petterson introduces a new element into the discussion, namely, the influence of the warm water poured into its basin by the Siberian rivers. During the summer the Kara Sea north of the Obi and Yenisei is covered with a layer of almost fresh water which has a depth of nearly twenty metres in the south, and a temperature of 6° to 9° Celsius in the summer. This layer thins out and becomes cooler as it advances towards the north, but still it reaches the north-eastern extremity of Novaya Zemlya, where it meets with the salt oceanic current brought along the western coast of the island. On the other hand, the middle parts of the Kara Sea are invaded by the Arctic current bringing cold and much salter water from the north-east. It passes underneath the fresh-water current and reaches the surface about the middle of the Kara Sea, where a saltness of 3·03 has been observed. This cold current, which has in the deepest parts of the Kara Sea (100 to 222 metres) a temperature slightly oscillating between $-1°.4$ to $-2°.0$, and a saltness of 3·19 to 3·49, is heated more or less on its surface, which reaches in the summer from 2° to 4° above zero in the south-western and north-eastern parts of the Kara Sea: whilst in the middle, even on the surface, the temperature is generally about zero, or even $-0°.8$. This distribution of currents explains the very slow melting of ice in the middle parts of the Kara Sea, which Dr. Pettermann compared to an ice-shoal floating in the middle on the surface of our ponds after a free channel has been opened along its coasts. Two maps on a large scale, showing the distribution of temperature and saltness in the Siberian Sea from Novaya Zemlya to Behring Strait, and embodying the results of Nordenskjöld's determinations of latitudes and longitudes on the Siberian coast, accompany the papers of M. Petterson.

We find in the same volume an elaborate paper, by A. Wirén, on the Chætopods of the Siberian and Behring Seas. Six tables accompany this paper, which contains the description of seventy-three species of Chætopods. The chief features of this fauna already being known from Nordenskjöld's preliminary report, we only notice that the richest part of the Siberian Sea is the Kara Sea, where the *Vega* Expedition and those of 1875 and 1876 discovered no less than sixty-nine species, whilst in the remainder of the Siberian Sea only fifty-three species were found until now.

Finally, we notice in the same volume M. Aug. Wijkander's paper on the magnetic observations made during the expedition (in French), and an appendix to the paper on the geographical determinations, by A. Lindhagen. It appears from the former that the magnetic declination on the coast of North-Eastern Asia presents several anomalies. The position of the isodynams is quite different from those given on the map of the German Admiralty ("Isodynamen und Werthe des magnetischen Potentials für 1880"). As to the inclination, it is but slightly different from the values which would result from Sabine's work; but the declination differs notably from the values given on the maps both of the German and English Admiralties. For the Behring Strait region this last, however, is decidedly the best, the average corrections for the English map being $-2°.1$, and $-3°.7$ for the German Admiralty map. The errors result from the secular variation having been only calculated, and not yet measured directly.

The interest awakened by the expedition of the *Vega* towards the North Siberian Sea will be perpetuated by this work. The serious scientific spirit in which the different departments of natural history are dealt with in the records of the cruise of the *Vega* will contribute more towards the increase of our knowledge of the Arctic regions than many costlier expeditions.

The third volume, just published, is mostly occupied by F. Kjellmann's "Algæ of the Arctic Ocean" (430 pages, with 31 plates). This work—the result of the author's ten years' Arctic experience—not only contains a complete botanical description of all the Algæ of the Arctic Ocean which came under notice; the author gives also a general sketch of the Arctic marine flora, with its sub-regions; he discusses the causes which gave it its present character: structure of the coast-line, tides, characters of the bottom, temperature, and so on; and he endeavours to draw also the chief lines of its evolution, giving thus rich material for solid generalisations.

Mr. W. Leche contributes to the same volume a note on the forty-two species of Lamellibranchiata brought in by the *Vega*; Mr. P. T. Cleve describes (in English) the Diatoms collected in the Arctic Ocean and on the return journey of the expedition, his paper being illustrated by five plates, which figure eighty-four species, mostly new; and Prof. P. Kramer and Dr. C. J. Neuman describe (in German) thirteen new species of Acarids. P. K.

EARTH TREMORS

Of the various movements to which the crust of the earth is subject, the minute motions called earth tremors attract our attention by their universality. Between them and the other motions which affect the soil the difference is chiefly in degree.

Earthquakes are the sudden and violent movements of the ground. Earth pulsations, which may be observed as terminal phenomena of large earthquakes, are movements of considerable amplitude, but so slow in period that without the aid of instruments they may be passed by unnoticed. Earth oscillations are the secular movements of upheaval and depression evidenced to us by raised beaches, sunken forests, and other geological phenomena. Lastly, we have earth tremors, or movements quick in period, but which escape our attention on account of the smallness in their amplitude. As these latter are phenomena which are probably observable in all portions of the globe, and have as yet attracted but little attention excepting perhaps where they have proved themselves troublesome intruders affecting astronomical and other observations of a delicate nature, I purpose giving an epitome of the more important results which their observation has yielded.

Earth tremors produced by artificial disturbances, such as the passing of carriages or trains, the movements of machinery or bodies of people, are at our disposal for daily observation. At Greenwich Observatory the tremulous motion in the soil, especially noticeable on bank holidays and at times when Greenwich Park was unusually crowded, resulted in the construction of an apparatus in which the dish of mercury used in the determination of the collimation error of the transit circle was suspended by flaccid springs. By means of this contrivance the tremulous motions of the ground were absorbed before they reached the mercury, and the difficulty of observation was overcome. French engineers, working with delicate surveying instruments in crowded cities, have similarly been compelled to suspend a portion of their apparatus, so that a steady image could be obtained. Prof. H. M. Paul, seeking for a site for the Naval Observatory at Washington, found that the image of a star reflected from a tray of mercury was disturbed by a train passing at the distance of a mile. Lieut.-Col. Palmer, when engaged in observing the transit of Venus in New Zealand, discovered that a ditch a few feet in depth was sufficient to intrench his instruments against the disturbance created by trains passing at a distance of 700 yards. Capt. Denman found the effect of a goods train to be transmitted 1100 feet over marshy ground, but vertically above the train, passing through a tunnel in sandstone, the disturbance extended only 100 feet. One result obtained from these and numerous other observations upon artificially produced tremors indicates that these disturbances are superficial, and although they may creep up the surface of a gently sloping hill, their spread is checked by a steep cutting.

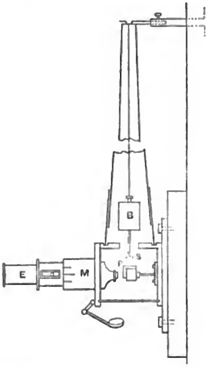
Naturally produced tremors differ from those just spoken of by the fact that their distribution is not so superficial, and not only are they to be observed in the most substantial structures which engineers can design, but they are to be equally well seen in cellars and in the walls of rocky caves. Some knowledge of the depth to which they extend might be obtained by a few microseismic observations in the deep mines of Lancashire and other parts of the United Kingdom. As the observations are so simple, and the instrument required so easily constructed—in fact, it may be home made—it is earnestly desired that some of our mine managers will spontaneously undertake this work.

I make this suggestion, not only on account of the scientific value of the work, but because there are reasons to believe that such observations may lead to results of a practical value by relations they may hold to the escape of gas, the circulation of subterranean waters, and other underground phenomena. The instrument I should recommend for this purpose is the tromometer of Bertelli and Rossi. This is shown in the accompanying figure. B is the bob of a pendulum about 100 grammes in weight, suspended by a very fine wire about 1½ metres in length. The whole is inclosed in a tube. The style S of this pendulum is seen reflected by the prism P by means of the microscope M. The eye-piece E of this microscope contains a micrometer scale, by which to measure the amplitude of the motion of the style.

The direction of motion may be obtained by turning the eye-piece until the scale is parallel with the direction of motion, and this direction then read off from the position of an index moving over compass divisions marked on the fixed tube of the microscope. To commence with, the style of a pendulum might be looked at directly with a microscope, or two microscopes placed at right angles, having magnifications of forty or fifty diameters; and if it was found that movements existed, the prism and micrometer scale might be added subsequently. The pendulums may be hung from spikes driven in the solid rock or from an iron stand.

The chief results which have been obtained with instruments of this type are those which have been arrived at in Italy. The father of the science of microseismology is Father Bertelli of Florence, who, since 1870, has made many thousands of observations under a variety of circumstances. Another ardent worker at this subject is Prof. M. S. de Rossi at Rome, by whose exertions numerous observatories have been established throughout the whole of Italy where these observations are systematically carried on. In making these observations every precaution appears to have been taken to avoid accidental disturbances, and the experiments have been repeated in a variety of forms. The results which from time to time have been announced are of the greatest interest to those who study the "physics of the earth's crust," and appear to be leading not only to the establishment of laws of scientific value, but also to the elucidation of phenomena which have an intimate connection with our every-day existence.

It would seem that the soil of Italy is in incessant movement, there being periods of excessive activity usually lasting about ten days. Such a period may be called a seismic storm. These storms are separated by periods of relative calms. The storms have their greater regularity



in winter, and sharp maximums are to be observed in spring and autumn. In the midst of such a period, or at its end, there is usually an earthquake. Usually these storms are closely related to barometric depressions. To distinguish these movements from those which occur under high pressure, they are called *baro-seismic* movements, the latter being called *volcano-seismic* movements. The relation of these storms to barometric fluctuation has been observed to be very marked during the time of a volcanic eruption. At the commencement of a storm the motions are usually small, and one storm lasting two or three days may be joined to another storm. In such a case the action may be a local one. It has been observed that a barometrical depression tended to bring a storm to a maximum, whilst an increase of pressure would cause it to disappear. Sometimes these actions are purely local, but at other times they may affect a considerable tract of land.

If a number of pendulums of different lengths are observed at the same place, there is a general similarity in their movements, but it is also evident that the free period of the pendulum more or less disturbs the character of the record. The greatest amplitude of motion in a set of pendulums is not reached simultaneously by all the pendulums, and at every disturbance the movement of one will predominate. From this Rossi argues that the character of the microseismical motions is not constant.

Bertelli observed that the direction of oscillation of the pendulums is different at different places, but each place will have its particular direction dependent upon the direction of valleys and chains of mountains in the neighbourhood. Rossi shows that the directions of movement are perpendicular to the direction of lines of faults, the lips of these fractures rising and falling, and producing two sets of waves, one set parallel to the line of fracture and the other perpendicular to such a direction. These movements, according to Bertelli, have no connection with the wind, rain, change of temperature, and atmospheric electricity.

The disturbances, as recorded at different towns, are not always strictly synchronous, but succeed each other at short intervals. If, however, we take monthly curves of the disturbances as recorded at different towns in Italy, we see that these are similar in character. The maximum disturbances occur about the winter solstice and the minimum about the summer solstice, and in this respect they show a perfect accordance with the curves drawn by Mallet to show the periodicity of earthquakes.

At Florence before a period of earthquakes there is an increase in the amplitude and frequency of vertical movements. The vertical movements do not appear to come in with the horizontal barometrical disturbances, but they appear to be connected with the seismic disturbances. They are usually accompanied with noises in the telephone, but as the microphone is so constructed as to be more sensitive to vertical motion than to horizontal motion, this is to be expected. This vertical motion would appear to be a local action, inasmuch as the accompanying motions of an earthquake which originates at a distance are horizontal. Storms of microseismical motions appear to travel from point to point. Sometimes a local earthquake is not noticed on the tromometer, whilst one which occurs at a distance, although it may be small, is distinctly observed. To explain this, Bertelli suggests the existence of points of interference and the existence of nodes.

Similar results were arrived at by Rossi when experimenting at different points on the sides of Vesuvius. Galli noticed an augmentation in microseismic activity when the sun and moon are near the meridian. Grablovitz found from Bertelli's observations a maximum two or three days before the syzigies, and minimum three days after these periods. He also found that the principal large disturbances occurred in the middle of periods separating the quadrature from the syzigies, the apogee from perigee, and the solstice period from the nodes, whilst the smallest disturbances happened in the middle of periods opposed to these.

P. C. Melzi says that the curves of microseismical motions, earthquakes, lunar and solar motions, show a concordance with each other. With the microphone Rossi hears sounds which he describes as roarings, explosions, occurring isolated or in volleys, metallic and bell-like sounds, ticking, &c., which he says revealed natural telluric phenomena. These are sometimes intolerably loud. At Vesuvius the vertical shocks corresponded with a sound like volleys of musketry, whilst the undulating shocks gave the roaring. Some of these sounds could be imitated artificially by rubbing together the conducting-wires in the same manner in which the rocks must rub against each other at the time of an earthquake, or by placing the microphone on a vessel of boiling water, or by putting it on a marble slab and scratching and tapping the under side of it.

These then are some of the more important results which have been arrived at by the study of microseismic motions. One point which seems worthy of attention is that they appear to be more law-abiding than their violent relations, the earthquakes, and as phenomena in which natural laws are to be traced they are certainly deserving of our attention. As to whether they will ever become the means of forewarning us against earthquakes is yet problematical. Their systematic study, however, will enable us to trace the progress of a microseismic storm from point to point, and it is not impossible that we may yet be enabled to foretell where the storm may reach its climax as an earthquake. This, I believe, is a view held by Prof. de Rossi.

Before the earthquake of San Remo, on December 6, 1874, Rossi's tromometer was in a state of agitation, and similar disturbances were observed at Livorno, Florence, and Bologna. Since February, 1883, I have observed a tromometer in Japan, and such results as have been obtained accord with results obtained in Italy.

The increase in microseismical activity with a fall of the barometer is very marked. The style of the pendulum does not always oscillate about the same point—there is a deflection in the vertical. In Manila Father Faura also makes observations with a tromometer, which I am told gives him by movements very decided indications of approaching typhoons.

As to the cause of tromometric movements we have a field for speculation. Possibly they may be due to slight vibratory motions produced in the soil by the bending and crackling of rocks produced by their rise upon the relief of atmospheric pressure. If this were so, we should expect similar movements to be produced at the time of an increase of pressure.

Rossi suggests that they may be the result of an increased escape of vapour from molten materials beneath the crust of the earth consequent upon a relief of external pressure. The similarity of some of the sounds which are heard with the microphone to those produced by boiling water are suggestive of this, and Rossi quotes instances when underground noises like those which we should expect to hear from a boiling fluid have been heard before earthquakes without the aid of microphones. One instance was that of Viduare, a prisoner in Lima, who, two days before the shock, 1824, repeatedly predicted the same in consequence of the noises he heard.

A possible cause of disturbances of this order may be the sudden fluctuations in barometric pressure which are visible during a storm.

In addition to the observations which have been especially made for the purpose of recording earth tremors, there are numerous observations which have been made upon these disturbances when they have appeared as intruders in investigations on other subjects. Amongst these may be mentioned the endeavours to measure changes in the vertical, as for instance those which might be produced by the attractive influence of the moon.

Prof. Zöllner, who invented the horizontal pendulum, found that the readings of his instrument were always changing.

M. d'Abbadie, who for several years observed a reflected image in a pool of mercury contained in a basin of solid rock, found it a rare occurrence that the surface of the mercury was tranquil. Sometimes it appeared to be in violent motion.

George and Horace Darwin, in their experiments at Cambridge to determine the disturbing influence of gravity by lunar attraction, found that the irregular and persistent tremors in the ground, as indicated by the instruments, were sufficient to mask whatever effects may have been due to the influence of the moon.

A full account of these latter observations is to be found in Messrs. G. and H. Darwin's Report for 1882 to the British Association.

The general conclusion, then, is that from observations in England, France, Germany, Italy, the Philippines, Japan, and, I may add, the West Indies, it would appear that the crust of the globe is practically in a constant state of tremor. The variations in these movements are more law-abiding than the large earth movements, and they show a direct relationship to barometric fluctuation.

Their relationship to many other telluric and atmospheric phenomena, together with their cause, has yet to be discovered. As every one has the opportunity to observe these phenomena, they call for attention. Just as a turbulent sea outraces a coming typhoon and gives mariners warning of approaching danger, it is possible that these microscopic disturbances of the soil may hold connection with subsequent phenomena, and lead us by their study to the better understanding of the complexity of phenomena with which we are surrounded.

Tokio, Japan JOHN MILNE

THE MECHANICAL THEORY OF MAGNETISM

IF Prof. Hughes were as great a master of writing English as he is of experimenting, his views on magnetism would receive speedier acceptation, for they would then probably be understood without that close study which his involved sentences and heterogeneous paragraphs now demand. It is very remarkable that such an ardent worker, such a deep thinker, and such a clear and simple experimenter should have such difficulty in expounding his views on paper. His experimental demonstrations are always clear and convincing, his recent lecture at the Royal Institution appealed to every degree of intelligence present, but his papers at the Royal Society want some strong external directing influence to render their meaning evident.

What is magnetism, according to this expert philosopher? It is an inherent quality of the molecules of matter, as determined and constant as that of their gravity, affinity, or cohesion, and like these qualities it differs in degree with every kind of matter. He does not attempt at present to define it closer than this. We cannot tell what gravity is, neither need we say what magnetism is. All Prof. Hughes says is that every molecule in nature is a little magnet imbued with a certain polarity varying in degree but constant for each substance, in virtue of which it has a north and a south pole along the same axis, and that the only change that takes place is a change in the direction of this polar axis. When these molecules are symmetrically arranged by some external directing influence, so that all their poles lie in the same direction, we have *evident magnetism*. Iron becomes a magnet in virtue of the fact that its molecules are free to move under the influence of external magnetic action, while copper is not a magnet because its molecules are immovable and irresponsive to the same cause. Steel becomes permanently magnetised because its molecules are rigid, and retain the axial direction impressed upon them. Soft iron is readily demagnetised because its molecules have great freedom of motion. Coercive force is therefore simply absence of freedom of molecular motion—it is, indeed, molecular rigidity. The extent to which the axis of polarity can be deflected from its normal direction is its *point of saturation*.

Evident magnetism is the symmetrical arrangement of the polarised molecules along one line; *neutrality* is symmetrical arrangement of the same molecules in closed curves. In both cases the sum of the magnetic influence of all the molecules is the same; but in evident magnetism it is directed outwards, in neutrality it is directed inwards. Remaining magnetism is partial neutrality. The experimental way in which Prof. Hughes demonstrated these conclusions is the most beautiful investigation he has yet made. He proves the existence of the same polarity in the atmosphere and in the ether, and he attributes diamagnetic effects to the higher magnetic capacity of the ether than of the substances suspended in it. It is therefore a differential action. Molecules, moreover, have inertia—they resist being put in motion; and when in motion they resist stoppage—they possess momentum. The direction of the axis of polarity can be displaced by the physical forces, such as mechanical stress, heat, or electricity. He shows that mechanical motion, heat, and electricity are of similar kind—they are vibratory, or some mode of motion. Magnetism, however, he considers not to be a mode of motion, and therefore it is not a physical force. It is simply an arrangement of the molecules of matter in symmetry or dissymmetry under the influence of some physical force. He seems to imply, though he does not directly say so, that the influence of electric currents upon magnets is not due to any direct action between them, but to the fact that the currents have polarised the ether in which both are suspended.

His views are very broad and highly suggestive, but there are some points that are not clear and that demand further elucidation. Why, for instance, does mechanical elongation and contraction take place when bars of iron are magnetised and demagnetised? How can heat and strong sonorous vibrations be produced unless there be a considerable expenditure of energy? How does he account for the attractive and repulsive properties of magnets, and for magnetic induction? He has certainly wrested magnetism from the realms of hypothesis and brought it within the domain of theory. The days of Coulomb and Poisson's fluids and Ampère's elementary currents of electricity are over; the molecular character of magnetism is experimentally established; but what is a molecule, and how becomes it polarised unless it be in rotation? How does the external directing influence act? We are also inclined to ask, Has Prof. Hughes sufficiently grasped Ampère's theory? It was purely mathematical, based on the assumption of the circulation of currents around each molecule. He goes no further than Ampère did, for he has not answered the question, What is polarity? In fact his polarised molecules are all little magnets, and no theory of magnetism will be complete until it explains these little magnets. Thus the difference between Ampère and Hughes is the difference between a current and a magnet.

However, on the assumption that a molecule is a magnet, Prof. Hughes has built up a very complete theory, which he has demonstrated experimentally in a way that places him in the very front rank of experimental philosophers.

NOTES

THE number of candidates up this session for the Fellowship of the Royal Society is sixty-seven.

WE understand that Sir Joseph Hooker has been nominated one of the vice-presidents for the Montreal meeting of the British Association. Instead of Mr. Crookes, Prof. W. G. Adams will give one of the public lectures. For the reduction of the fares of members the sum of 14,000 dollars has been allotted, only those elected at or before the Southampton meeting being entitled to share in the subsidy. This is in addition to the liberal reductions that will be made by the steamship and railway companies. All the American railways will reduce their fares by one-half. The American Association, which meets at Philadelphia on September 3, has given a cordial invitation to the Montreal visitors to take part in its meetings and excursions. Those wishing to share in the subsidy of 14,000 dollars must apply before September 25. For the Aberdeen meeting in 1885, Sir Lyon Playfair will be proposed as president. A well-attended meeting of the Organising Committee of the Chemical Section has been held under the presidency of Prof. Roscoe. Promises of papers were received from several well-known chemists, and a small executive committee was formed to draw up a list of papers and to communicate with Canadian and American chemists. Section G has been particularly active. The Committee has prepared a list of subjects for papers which it is thought would be interesting to English visitors if treated by engineers and mechanicians in Canada; a good supply of papers is expected both from this country and America. We regret to learn that Prof. Williamson, the General Treasurer, will be unable to be present, and the Council have decided to engage the services, *pro hac vice*, of Mr. Hamy Brown, Assistant Secretary and Accountant of University College, as "Financial Officer," while Prof. Burdon Sanderson has virtually consented to act as deputy for the Treasurer at Montreal.

M. CARO, for the French Academy, and MM. Pasteur and d'Abbadie, for the Academy of Sciences, will attend as delegates the *fêtes* at Edinburgh in commemoration of the tercentenary of the foundation of the University of Edinburgh.

DR. KOCH and his colleagues of the German Cholera Commission will proceed shortly to Goalpara and Darjeeling to prosecute further inquiries. After passing a few days there, they will return to Germany, but they hope to be back in India next winter to carry on their very important and useful labours.

DR. GEORGE ENGELMANN of St. Louis—the oldest United States botanist (excepting the venerable Lesquereux), as well as an eminent physician, for a time a fellow-student with Agassiz in Germany—died on February 11, at the age of seventy-five.

COMMODORE SAMUEL R. FRANKLIN, U.S.N., has been detached from duty on the United States Naval Examining Board, and ordered as superintendent of the naval observatory, to succeed Rear-Admiral R. W. Shufeldt, who was placed upon the retired list on February 21.

AT the sitting of the Academy of Sciences of March 10 M. Faye presented drawings which have been executed at Algiers by M. Trépied, Director of the Observatory, and which represent Pons' comet as seen on the very days on which have been noticed the changes that have excited such surprise amongst certain astronomers. M. Faye took advantage of this communication to give an explanation of these wonderful observations, which are more frequent than has been supposed in the history of astronomy. M. Faye does not suppose that they may be attributed to any collision with cosmical matter, but to a rapid change in the point of view of the comet itself, as observed from the earth. This theory will be illustrated by a woodcut published in the next number of the *Comptes Rendus*.

CONSIDERABLE progress has now been made in the carrying out of the works connected with the marine station which some time ago the Scottish Meteorological Society resolved to establish at Granton; and it is anticipated that the operations of the station will be properly commenced towards the close of the present month. As the first instalment of the work to be done, it is hoped that a tolerably complete description of the Firth of Forth, in its biological, meteorological, physical, and chemical relations, may be prepared in the course of the next few years; and when this has been carried out, the result will have an exceptional, and indeed unique value, as a piece of work of the greatest scientific and national importance, produced by cooperation amongst scientific men. The Council of the Scottish Meteorological Society, it may be mentioned, recently asked Her Majesty's Government for a subscription of 1000*l*. for the purpose of building permanent laboratories in connection with the station—undertaking at the same time to raise an additional 1000*l*. by public subscription. The Government, however, have not seen their way to assist this school of research, notwithstanding that the grant was warmly recommended by Prof. Huxley, President of the Royal Society. The Council of the Meteorological Society have, however, every confidence that the scheme will be liberally supported by the general public.

DR. CASEY, F.R.S., has just written a new work on Analytic Geometry, which covers about two-thirds of the ground occupied by Salmon's Conics; in the author's opinion it will contain more new matter than any work on the subject since Salmon's book was written.

AN interesting experiment is to be made by Dr. Zintgraff, who, in company with Dr. Chavanne, is about to visit the Congo and the interior of Africa. He takes with him a phonograph, wherewith to fix the speech and melodies of hitherto unknown tribes, which, thus received by the instrument, will be forwarded to scientific men in Germany. The apparatus (which will be used for such a purpose for the first time) has been made by Mr. Fuhrmann, of Berlin, and exactly corresponds with one he has in that city, so that the plates used in Africa can be sent to Berlin to be unrolled by that machine, and caused to re-emit the sounds received.

A REMARKABLE occurrence is reported from Bona (Algeria). An isolated mountain, Jebel Naiba, 800 m. in height, is rapidly decreasing in altitude, and round its base a considerable cavity is being formed. The whole mass of the mountain is evidently sinking. The neighbourhood of Bona must, however, have already been the scene of a similar phenomenon. Lake Fezzara, which measures over 12,000 hectares in extent, did not exist during the time of the Romans. Its depth in the centre is only 2·60 m. Investigations which were made in 1870 showed that the remains of a Roman town now lie in the lake; this town has therefore probably sunk in the same manner as the mountain.

A PREHISTORIC burial-ground has been discovered on the so-called Hasenburg, near Buhla (Kreis Nordhausen, Germany). Two complete human skeletons, numerous bronze rings, and several rings made of amber were found. The Hasenburg is an isolated rock on which stood formerly a castle of the Emperor Henry IV.; but the numerous prehistoric remains found in the neighbourhood point to its having been an ancient place of worship. The objects recently found have been deposited in the Museum of Nordhausen.

THE appointment by the Swedish Government of an entomologist to assist farmers has been found of so much value that it has been decided to continue the same. Dr. A. Holmgren has been appointed agricultural entomologist for this year.

THE city of Hamburg offers various prizes for the plans of a new Natural History Museum. The total cost of construction of the building must not exceed 45,000*l*. Five prizes of 50*l*. each will be awarded for the five best plans; further prizes of 200*l*. will be distributed amongst the victors for further work in connection with the scheme.

AT a recent meeting of the Straits Branch of the Royal Asiatic Society at Singapore, it was decided to prepare and publish a school geography of the Malay peninsula and the adjoining regions, as well as a skeleton map of the peninsula, on a scale of a quarter of an inch to a mile, to be gradually filled in as may be determined by subsequent survey and research.

DR. BENJAMIN SHARP has been appointed Professor of Lower Invertebrata by the Council of the Academy of Natural Sciences of Philadelphia. Dr. Sharp is a graduate of the University of Pennsylvania, from which he received the degrees of Doctor of Medicine and Doctor of Philosophy in 1881. He afterwards studied under Leuckart in Leipzig, and under Semper in the University of Wurzburg. Dr. Sharp was granted the privilege of studying at the Bavarian table in the Zoological Station at Naples, an honour rarely granted a foreigner. Dr. Sharp proposes delivering lectures, during the coming spring, on the lower forms of life.

PROF. KARPINSKY points out, in the *Memoirs of the St. Petersburg Society of Naturalists* (vol. xiii.), the following interesting feature of the geological structure of Russia. The unmetamorphosed rocks in Russia appear mostly quite, or nearly quite, undisturbed and horizontal. There is, however, besides the Crimea, a region where some dislocation and disturbance of these deposits are apparent. This disturbed region runs from north-west to south-east, through the Sandomir ridge in Poland to Kaneff in Kiev, Isakchi in Poltava, the coal-basin of the Don, the Bogdo Mountains of the Astrakhan Steppe, and finally to the Kara-tan and Ak-tan Mountains to the east of the Caspian. Beyond this region even the older deposits (Silurian and Devonian) remain undisturbed, while within it the older gneisses and crystalline schists are disturbed, not only by the Silurian upheaval which has had a direction from north-east to south-west, but also by the more recent one just referred to, which has a direction perpendicular to it. It is worthy of notice that this line of upheaval would join that line of ridges which runs in Western Europe through the mountains of the Weser and the Teutoburger Wald, while in Asia it would join the Sheikh-jeli and Uiz-Dagh Mountains.

WE notice in the same serial some very valuable observations of Prof. Beketoff about Dr. Sachs' theory as to the relations between the increase and segmentation of cells in the embryonal parts of plants. While he warns one against the application of geometrical theories to botany, he points out how some of the conclusions arrived at by Dr. Sachs could be more easily explained by the principles established by Wilhelm Hofmeister. Prof. Borodin's researches into the anatomy of the leaves of *Chrysosplenium* were made on very rich material collected by Prof. C. Maximowicz for his "Adumbratio Generis Chrysosplenii," and Prof. Borodin was enabled not only to thoroughly study the subject, but also to arrive at some most valuable conclusions as to the relations between the anatomical features of different species of this genus and the features on which the classification of these species has been made.

TRACES of glaciation in Siberia, so boldly denied a few years ago, have been discovered in different parts of the country. While failing to detect them on the outer parts of the Altai Mountains, M. Sokoloff has found unmistakable traces of an incomparably wider extension of glaciers in the central parts of the ridge, and especially in the Katun Mountains. Numerous traces have also been found, pointing to a greater extension of lakes during the post-Glacial period, and to the gradual drying up of the existing ones.

IN a paper recently published in the *Mémoires de l'Académie des Sciences de St. Pétersbourg* for 1883, Prof. Fr. Schmidt, while fully agreeing with the remarkable results of Mr. Walcott's researches as to the feet and respiratory organs of Trilobites (published in 1881 in the *Bulletin of the Harvard College Museum*), proposes to include in Mr. Walcott's second group of *Paleadæ* his own family of *Hemiaspidæ*. It consists of the genera *Hemiaspis*, Woodw., *Bunodes*, Eichw., and *Pseudoniscus*, Nieszk., which are much like Trilobites, but differ from them in the separate and freely-moving posterior parts of the body; formerly it was included in the group of Eurypterides.

PROF. TARKHANOFF contributes to the last volume of the *Memoirs* (*Trudy*) *of the Society of Naturalists of St. Petersburg* a very interesting inquiry into the structure of the eggs of birds. He has discovered that the albumen of the eggs of the *Insessores* (ousel, canary, pigeon, &c.) notably differs from that of the Autophagous birds (hens, ducks, geese, turkeys). When boiled it remains translucid; it is fluorescent; its rotation-power of the plane of polarisation is feebler; when diluted with much water it does not give a white deposit, but only gives a feeble opalescent coloration to the water; finally, it has a stronger basic reaction than the white of the eggs of the hen. It may, however, be transformed so as to become like it by various means, namely: the addition of neutral salts, or of bases, or of concentrated acetic and lactic acids, or even of carbonic acid. The most remarkable fact however is that the same result is also arrived at by incubation, and Prof. Tarkhanoff considers that the modifying agency in this case is the yolk; when moderately heated with yolk in closed vessels, during twenty-four hours or more, it is transformed into albumen like that of a hen's egg. As to the manner in which the yolk acts on it, it still remains unsettled; the supposition that the diffusion of salts is the cause of the change proved not to be true; and the cause must be searched for perhaps in the diffusion of gases. The interesting question, as to the albumen of hen's eggs not also undergoing the same stages of development within the ovarium, cannot yet be solved satisfactorily; but during his experiences M. Tarkhanoff observed once the most interesting fact that a small ball of amber introduced into the upper part of the ovarium occasioned the deposition around the ball of albumen and the formation of a shell, that is, the formation of a quite normal egg with its *chalazæ*, and other particularities of structure; this observation would thus strongly support the mechanical theory of the formation of the parts of an egg around its yolk.

DR. KING, retired Professor of Mineralogy, Geology, and Natural History in Queen's College, Galway, has lately been elected a Corresponding Member of the New York Academy of Sciences.

MR. E. L. LAYARD writes to us from Noumea, New Caledonia, under date Jan. 6, that the sunsets there have been quite as extraordinary as elsewhere. "As soon," he says, "as the sun's disk has disappeared, a glow comes up from the west like that of white-hot steel, reddening somewhat as it mounts to the zenith, but changing the while to blue. From the zenith it passes into the most exquisite green, deepening as it loses itself in the east. As the sun sinks lower and lower, the red tints overpower the white-hot steel tints, and the blue of the zenith those of the green. At 7 p.m., or a little after, nearly the entire western half of the horizon has changed to a fiery crimson; as time goes on, the northern and southern areas lose their glory, and the grays of night contract, from the northern end first, most rapidly; the east is of the normal gray. The south now closes in, and presently, about 8 p.m., there is only a glare in the sky, just over the sun's path as of a distant conflagration, 'till the fire in the west fades out.' I have been attempting to describe one of our cloudless evenings, of which we have had only too many, having just come through a fearful drought that has lasted all this while; but who shall paint the glory of the heavens when flecked with clouds! Burnished gold, copper, brass, silver—such as Turner in his wildest dreams never saw! and of such fantastic forms! The wonderful light from above was reflected on every tree and flower; our scarlet and crimson geraniums, fuchsias, &c., blazed in the light as I never saw them before, and the general effect was most extraordinary."

THE Cremation Society of Berlin now numbers 365 members, no less than 146 having joined the Society during 1883. The cremation movement is also progressing favourably at Hamburg, Königsberg, Dresden, Breslau, and Wiesbaden. At Gotha forty-six bodies were cremated during 1883, which is about double the number of those burnt in any of the four preceding years.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, a Pig-tailed Monkey (*Macacus nemestrinus* ♀) from Java, presented by Mr. G. H. Lee; two Herring Gulls (*Larus argentatus*), European, presented by Madam Fridaich; a Kagu (*Rhino-*

chetus jubatus) from New Caledonia, presented by Mons. J. M. Cornely, C.M.Z.S.; four Blue Titmice (*Parus caeruleus*), British, presented by Mr. Hanaeur; a Barn Owl (*Strix flammea*), British, presented by Mrs. W. Gittens; a Rhesus Monkey (*Macacus rhesus* ♂) from India, deposited; a Bosman's Potto (*Perodicticus potto*) from West Africa, purchased; a Yellow-billed Duck (*Anas xanthorhyncha*) from South Africa, received in exchange; a Bengalese Cat (*Felis bengalensis*) from India, received on approval; a Zebu (*Bos indicus* ♂), a Collared Fruit Bat (*Cynonycteris collaris*), an Emu (*Dromaeus novae-hollandiae*), bred in the Gardens.

GEOGRAPHICAL NOTES

ALTHOUGH the Chefoo Convention made with China in 1876 has never been ratified, we are now reaping various advantages from its provisions. With the object of exploring South-Western China, and of watching the possibilities of the development of trade in these regions, it was arranged that an English Consular Agent was to reside at Chung-King in Sze-chuan on the upper waters of the Yang-tse. The officers who have held this post for the past six years have travelled widely through Yunnan, Sze-chuan, Kweichow, and other provinces, and have made most valuable contributions to the geography of China by the reports which have been published by them. Thus we have Mr. Colborne Baber's explorations in South-Western China published by the Royal Geographical Society, Mr. Parker's papers in the *China Review*, which we have already noticed, and now Mr. Hosie has made two reports, which have recently been published as Parliamentary Papers. The last of these deals with a journey of nearly 2000 miles from Chung-King to Chêng-tu, the provincial capital of Sze-chuan, thence by Tali in Yunnan to Yunnan-Fu, the capital of this province, returning to Chung-King by another route. The traveller does not think much of the European maps of these districts, for on p. 58 we find him complaining that "the number of mistakes in these maps, whether as regards boundary lines, names of places, &c., not to mention omissions, is truly alarming. As fairly accurate native maps are procurable, the occurrence of such mistakes as the above is astonishing." Mr. Hosie also gives some account of the aboriginal tribes, who usually avoid the frequented routes, as as they are afraid of being taken by the Chinese. He saw several Lolos, and a Si-fan or "tame wild man," as he is called by a kind of Hibernicism, as well as representatives of several other frontier tribes. There can be little doubt that in a short time, with these able and energetic English officers travelling far and wide from Chung-King as a centre, the geography of the south-western corner of China will be as well known to us as that of the districts adjoining the coast.

AT the opposite corner of the China Seas, another English officer, Consul-General Leys of Borneo, is endeavouring to promote the commercial development of little-visited districts in that wonderful island. He has recently visited the tracts watered by three considerable rivers flowing into Brunei Bay near Labuan, and hopes to get the Chinese merchants of the latter colony, as well as of Singapore, to send trading parties up these rivers. He further suggests the appointment of consular agents in the interior of the dominions of the Sultan of Brunei: a step which cannot fail largely to increase our knowledge of the geography and resources of Borneo.

THE December number of Guido Cora's *Cosmos*, which completes the first series (1873–1883) of that useful publication, contains the first part of Capt. C. F. Crema's journey to Morocco in connection with the Italian Mission under Commander Scovasso in 1882. The text, which gives us a graphic account of the progress of the mission from Tangiers through the maritime provinces southwards to the mouth of the Sebu in the Atlantic Ocean, is richly illustrated with numerous woodcuts from photographs and sketches taken by Crema himself. Some of the heads in these illustrations, such as those of Scovasso, the Kaid Raka, and the Arab Surgeon of Caria-ben-Auda, are capital studies of character and ethnical types. Others vividly reflect the salient aspects of the land, the architecture, and industries of its inhabitants. Conspicuous amongst these is the fine north-west gate of Shella near Rabat, which, with its two hexagonal towers, is the grandest monument of Moorish architecture still surviving in Morocco. The paper is also accompanied with a map to the scale of 1 : 750,000, which, being based on an accurate survey of the route, forms a valuable contribution to geographical exploration. It fills up many blank spaces, and gives numerous rectifications of existing maps, even in districts that have already been frequently visited by European travellers. In the same issue Gustavo Bianchi gives an account of his recent explorations in the Gurageh territory during the spring of the year 1880, accompanied by a useful map of the Galla country to the south and east of Shoa, which, with the exception of Cecchi and Chiarini's expedition in 1878, had been visited by no traveller since the time of Major Harris and d'Abbadie (1843–46).

THE *Boletin de la Sociedad Geografica di Madrid* for December 1883 has a paper by D. José Gomez San Juan, on the Spanish possessions in the Gulf of Guinea. The object of the writer is to establish the exclusive right of Spain to the islands of Annobon, Corisco, and the two Elobeis, as well as to the portion of the opposite mainland stretching from Punta del Campo to Punta Santa Clara on the right bank of the Gaboon. The paper is ably written, and contains much interesting historical and geographical information on the whole of the west coast of Africa from Sierra Leone to the equator.

THE German and Austrian Alpine Club now consists of no less than 100 sections. The last two sections formed were those at Bonn, on the Rhine, and at Schladming Radstadt in the Upper Enns Valley.

THE Stuttgart branch of the Berlin Centralverein für Handelsgeographie contemplates the establishment of a Museum for commercial geography at Stuttgart.

THERE will be several special exhibitions at Munich on the occasion of the fourth German Geographentag. The following are planned: (1) new maps and books; (2) curiosities of cartography and geographical literature; (3) Bavarian maps; (4) maps, reliefs, and books relating to the Alps; (5) maps, reliefs, atlases, and other objects suitable for instruction in geography; (6) work done by pupils in geography, to illustrate the methods of teaching.

LETTERS have been received from Herr Junker and from the Khartoum Consul, Herr Hansal, which, however, do not give satisfactory details about the traveller's doings during the last two years, nor about his present position. They are principally short notes dating from December 1882, August and October 1883, in which he refers to longer letters and reports, which have, however, not yet come to hand. Nevertheless, these notes prove that Junker was in good spirits and health in the Sennis Country at the beginning of October last, and far from being disheartened or disturbed by events in the Soudan, of which he knew, was fully occupied with his travels and the drawing of his maps.

DR. FINSCH of Bremen has now published the "Anthropological Results" of his journey to the Pacific, and they form a valuable addition to anthropological literature. The traveller does not solely rely upon his own researches and observations, but also upon his (according to Virchow) unexampled collection of plaster casts from the faces of living men and women, natives of the islands he visited. This collection consists of no less than 164 casts, and represents natives of sixty-one different islands; besides Polynesians, Micronesians, and Melanesians, it also contains Malays of the Indian Archipelago, for the sake of comparison. Copies of the casts will be a welcome means of instruction in anthropology, and can be obtained through Herr Louis Castan at Berlin (Panopticum).

AN expedition to the North Pole is being prepared by Capt. Fondacaro of the Italian navy. It is several centuries since an expedition to the North Pole was despatched from Italy.

THE SIX GATEWAYS OF KNOWLEDGE[1]

II.

THE sense of sight may be compared to the sense of sound in this respect. I spoke of the sense of sound being caused by rapid variations of pressure. I had better particularise and say how rapid must be the alternations from greatest pressure to least, and back to greatest, and how frequently must that period

[1] An Address at the Midland Institute, Birmingham, October 3, 1883, by Prof. Sir William Thomson, LL.D., F.R.S., president. Continued from p. 440.

occur, to give us the sound of a musical note. If the barometer varies once a minute you would not perceive that as a musical note. But suppose by any mechanical action in the air, you could cause the barometric pressure—the air pressure—to vary much more rapidly. That change of pressure which the barometer is not quick enough to show to the eye, the ear hears as a musical sound if the period recurs twenty times per second. If it recurs twenty, thirty, forty, or fifty times per second, you hear a low note. If the period is gradually accelerated, you hear the low note gradually rising, becoming higher and higher, more and more acute, and if it gets up to 256 periods per second, we have a certain note called C in the ordinary musical notation. I believe I describe it correctly as the low note C, of the tenor voice—the gravest C that can be made by a flute. The note of a two-foot organ pipe open at both ends has 256 periods per second. Go on higher and higher to 512 periods per second, and you have the C above that—the chief C of the soprano voice. Go above that to 1024, you get an octave higher. You get an octave higher always by doubling the number of vibrations per second, and if you go on till you get up to about 5000 or 6000 or 10,000 periods per second, the note becomes so shrill that it ceases to excite the human ear and you do not hear it any longer. The highest note that can be perceived by the human ear seems to be something like 10,000 periods per second. I say "something like," because there is no very definite limit. Some ears cease to hear a note becoming shriller and shriller before other ears cease to hear it; and therefore I can only say in a very general way, that something like 10,000 periods per second, is about the shrillest note the human ear is adapted to hear. We may define musical notes, therefore, as changes of pressure of the air, regularly alternating in periods which lie between 20 and 10,000 per second.

Well now, are there vibrations of thirty or forty or fifty or a hundred thousand or a million of periods per second in air, in elastic solids, or in any matter affecting our sense? We have no evidence of the existence in matter of vibrations of very much greater frequency than 10,000 or 20,000 or 30,000 per second, but we have no reason to deny the possibility of such vibrations existing, and having a large function to perform in nature. But when we get to some degree of frequency that I cannot put figures upon, to something that may be measured in millions, if not in hundred-thousands of vibrations per second, we have not merely passed the limits of the human ear to hear, but we have passed the limits of matter, as known to us, to vibrate. Vibrations transmitted as waves through steel, or air, or water, cannot be more frequent than a certain number, which I cannot now put a figure to, but which, I say, may be reckoned in hundred-thousands or a few millions per second.

But now let us think of light. Light we know to be an influence on the retina of the eye, and through the retina on the optic nerve; an influence dependent on vibrations whose frequency is something between 400 million millions per second and 800 million millions per second. Now we have a vast gap between 400 per second, the sound of a rather high tenor voice, and 400 million millions per second, the number of vibrations corresponding to dull red light—the gravest red light of the prismatic spectrum. Take the middle of the spectrum—yellow light—the period of the vibrations there is in round numbers 500 million millions per second. In violet light we have 800 million millions per second. Beyond that we have something that the eye scarcely perceives—does not perceive at all perhaps—but which I believe it does perceive, though not vividly: we have the ultra-violet rays, known to us chiefly by their photographic effect, but known also by many other wonderful experiments, that within the last thirty years have enlarged our knowledge of light to a most marvellous degree. We have invisible rays of light made visible by letting them fall on a certain kind of glass, glass tinged with uranium—that yellowish green glass, sometimes called canary glass or chameleon glass. Uranium glass has a property rendering visible to us invisible rays. You may hold a piece of uranium glass in your hand, illuminated by this electric light, or by a candle, or by gas light, or hold it in the prismatic spectrum of white light, and you see it glowing according to the colour of the light which falls upon it; but place it in the spectrum beyond the visible violet end, where without it you see nothing, where a piece of chalk held up seems quite dark, and the uranium glass glows with a mysterious altered colour of a beautiful tint, revealing the presence of invisible rays, by converting them into rays of lower period, and so rendering them visible to the eye. The discovery of this property of uranium glass was made by Prof. Stokes, and the name of fluorescence from fluor spar, which he found to have the same property, was given to it. It has since been discovered that fluorescence and phosphorescence are continuous, being extremes of the same phenomenon. I suppose most persons here present know the luminous paint made from sulphides of calcium and other materials, which, after being steeped in light for a certain time, keep on for hours giving out light in the darkness. Persistence in emission of light after the removal of the source, which is the characteristic of those phosphorescent objects, is manifested also, as Edmund Becquerel has proved, by the uranium glass, and thus Stokes' discovery of fluorescence comes to be continuous with the old known phenomenon of phosphorescence, to which attention seems to have been first called scientifically by Robert Boyle about 200 years ago.

There are other rays, that we do not perceive in any of these ways, but that we do perceive by our sense of heat: heat rays as they are commonly called. But in truth all rays that we call light have heating effect. Radiant heat and light are one and indivisible. There are not two things, radiant heat and light: radiant heat is identical with light. Take a black hot kettle into a dark room, and look at it. You do not see it. Hold your face or your hand near it, and you perceive it by what Bunyan would have called Feel Gate; only now we apply the word feeling to other senses as well as Touch. You perceive it before you touch it. You perceive it with the back of your hand, or the front of your hand; you perceive it with your face, yes, and with your eye, but you do not see it. Well, now, must I justify the assertion that it is not light? You say it is not light, and it is not so to you, if you do not see it. There has been a good deal of logic-chopping about the words here; we seem to define in a vicious circle. We may begin by defining light—"It is light if you see it as light; it is not light if you do not see it." To save circumlocution, we shall take things in that way. Radiant heat is light if we see it, it is not light if we do not see it. It is not that there are two things; it is that radiant heat has differences of quality. There are qualities of radiant heat that we can see, and if we see them we call them light; there are qualities of radiant heat we cannot see, and if we cannot see them we do not call them light, but still call them radiant heat: and that on the whole seems to me to be the best logic for this subject.

By the bye, I don't see Logic among the studies of the Birmingham and Midland Institute. Logic is to language and grammar what mathematics is to common sense; logic is etherealised grammar. I hope the advanced student in grammar and Latin and Greek, who needs logic perhaps as much as, perhaps more than, most students of science and modern languages, will advance to logic, and consider logic as the science of using words, to lead him to know exactly what he means by them when he uses them. More ships have been wrecked through bad logic than by bad seamanship. When the captain writes down in his log—I don't mean a pun here, log has nothing to do with logic—the ship's place is so-and-so, he means that it is the most probable position—the position which, according to previous observations, he thinks is the most probable. After that, supposing no sights of sun or stars or land to be had, careful observation of speed and direction shows, by a simple reckoning (called technically the dead reckoning), where the ship is next day. But sailors too often forget that what they put down in the log was not the ship's place, but what to their then knowledge was the most probable position of the ship, and they keep running on as if it was the true position. They forget the meaning of the very words in which they have made their entry in the log, and through that bad logic more ships have been run on the rocks than by any other carelessness or bad seamanship. It is bad logic that leads to trusting to the dead reckoning, in running a course at sea; and it is that bad logic which is the cause of those terribly frequent wrecks; of steamers, otherwise well conducted, in cloudy but perfectly fine weather, running on rocks at the end of a long voyage. To enable you to understand precisely the meaning of your result when you make a note of anything about your own experience or experiments, and to understand precisely the meaning of what you write down, is the province of logic. To arrange your record in such a manner that if you look at it afterwards it will tell you what it is worth, and neither more nor less, is practical logic; and if you exercise that practical logic, you will find benefits that are too obvious if you only think of any scientific or practical subject with which you are familiar.

There is danger then of a bad use of words, and hence of bad reasoning upon them, in speaking of light and radiant heat; but if we distinctly define light as that which we consciously perceive as light—without attempting to define consciousness, because we cannot define consciousness any more than we can define free will—we shall be safe. There is no question that you see the thing; if you see it, it is light. Well now, when is radiant heat light? Radiant heat is light when its frequency of vibration is between 400 million millions per second and 800 million millions per second. When its frequency is less than 400 million millions per second it is not light; it is invisible "infra-red" radiant heat. When its frequency is more than 800 million millions per second, it is not light if we cannot see it; it is invisible ultra-violet radiation, truly radiant heat, but it is not so commonly called radiant heat because its heating effect is known rather theoretically than by sensory perception, or thermometric or thermoscopic indications. Observations which have been actually made by Langley and by Abney on radiant heat take us down about three octaves below violet, and we may hope to be brought considerably lower still by future observation. We know at present in all about four octaves—that is from one to two, two to four, four to eight, eight to sixteen, hundred million millions—of radiant heat. One octave of radiant heat is perceptible to the eye as light, the octave from 400 million millions to 800 million millions. I borrow the word octave from music, not in any mystic sense, nor as indicating any relation between harmony of colours and harmony of sound. No relation exists between harmony of sound and harmony of colours. I merely use the word "octave" as a brief expression for any range of frequencies lying within the ratio of one to two. If you double the frequency of a musical note, you raise it an octave: in that sense I use the word for the moment in respect to light, and in no other sense. Well now, think what a tremendous chasm there is between the 100 million millions per second, which is about the gravest hitherto discovered note of invisible radiant heat, and the 10,000 per second, the greatest number of vibrations in sound. This is an unknown province of science: the investigation of vibrations between those two limits is perhaps one of the most promising provinces of science for the future investigator.

In conclusion, I wish to bring before you the idea that all the senses are related to force. The sense of sound, we have seen, is merely a sense of very rapid changes of air pressure (which is force) on the drum of the ear. I have passed merely by name over the senses of taste and smell. I may say they are chemical senses. Taste common salt and taste sugar—you tell in a moment the difference. The perception of that difference is a perception of chemical quality. Well, there is a subtle molecular influence here, due to the touch of the object, on the tongue or the palate, and producing a sensation which is a very different thing from the ordinarily reckoned sense of touch, in the case now considered, telling only of roughness and of temperature. The most subtle of our senses perhaps is sight; next come smell and taste. Prof. Stokes recently told me that he would rather look upon taste and smell and sight as being continuous because they are all molecular—they all deal with properties of matter, not in the gross, but molecular actions of matter; he would rather group those three together than he would couple any of them with any of the other senses. It is not necessary, however, for us to reduce all the six senses to one, but I would just point out that they are all related to force. Chemical action is a force, tearing molecules apart, throwing or pushing them together: and our chemical sense or senses may therefore so far at least be regarded as concerned with force. That the senses of smell and taste are related to one another seems obvious; and if physiologists would pardon me, I would suggest that they may, without impropriety, be regarded as extremes of one sense. This at all events can be said of them, they can be compared—which cannot be said of any other two senses. You cannot say that the shape of a cube, or the roughness of a piece of loaf sugar or sandstone, is comparable with the temperature of hot water, or is like the sound of a trumpet, or that the sound of a trumpet is like scarlet, or like a rocket, or like a blue-light signal. There is no comparability between any of these perceptions. But if any one says, "That piece of cinnamon tastes like its smell," I think he will express something of general experience. The smell and the taste of pepper, nutmeg, cloves, cinnamon, vanilla, apples, strawberries, and other articles of food, particularly spices and fruits, have very marked qualities, in which the taste and the smell seem essentially comparable. It does seem to me, although anatomists distinguish between them, because the sensory organs concerned are different and because they have not discovered a continuity between these organs, we should not be philosophically wrong in saying that smell and taste are extremes of one sense—one kind of perceptivity—a sense of chemical quality materially presented to us.

Now sense of light and sense of heat are very different; but we cannot define the difference. You perceive the heat of a hot kettle—how? By its radiant heat against the face—that is one way. But there is another way, not by radiant heat, of which I shall speak later. You perceive by vision, but still in virtue of radiant heat, a hot body, if illuminated by light, or if hot enough to be self-luminous, red-hot or white-hot, you see it; you can both see a hot body, and perceive it by its heat, otherwise than by seeing it. Take a piece of red-hot cinder with the tongs, or a red-hot poker, and study it; carry it into a dark room, and look at it. You see it for a certain time; after a certain time you cease to see it, but you still perceive radiant heat from it. Well now there is radiant heat perceived by the eye and the face and the hands all the time; but it is perceived only by the sense of temperature, when the hot body ceases to be red-hot. There is then, to our senses, an absolute distinction in modes of perception between that which is continuous in the external nature of the thing, namely, radiant heat in its visible and invisible varieties. It operates upon our senses in a way that I cannot ask anatomists to admit to be one and the same in both cases. They cannot now, at all events, say that there is an absolute continuity between the retina of the eye in its perception of radiant heat as light, and the skin of the hand in its perception of radiant heat as heat. We may come to know more; it may yet appear that there is a continuity. Some of Darwin's sublime speculations may become realities to us; and we may come to recognise a cultivable retina all over the body. We have not done that yet, but Darwin's grand idea occurs as suggesting that there may be an absolute continuity between the perception of radiant heat by the retina of the eye and its perception by the tissues and nerves concerned in the mere sense of heat. We must be content in the meantime, however, to make a distinction between the senses of light and heat. And indeed it must be remarked that our sense of heat is not excited by radiant heat only, while it is only and essentially radiant heat that gives to the retina the sense of light. Hold your hand under a red-hot poker in a dark room: you perceive it to be hot solely by its radiant heat, and you see it also by its radiant heat. Now place the hand over it: you feel more of heat. Now, in fact, you perceive its heat in three ways—by contact with the heated air which has ascended from the poker, and by radiant heat felt by your sense of heat, and by radiant heat seen as light (the iron being still red-hot). But the sense of heat is the same throughout, and is a certain effect experienced by the tissue, whether it be caused by radiant heat, or by contact with heated particles of the air.

Lastly, there remains—and I am afraid I have already taxed your patience too long—the sense of force. I have been vehemently atacked for asserting this sixth sense. I need not go into the controversy; I need not explain to you the ground on which I have been attacked; I could not in fact, because in reading the attack I have not been able to understand it myself. The only tangible ground of attack, perhaps, was that a writer in New York published this theory in 1880. I had quoted Dr. Thomas Reid, without giving a date; his date chances to be 1780 or thereabouts. But physiologists have very strenuously resisted admitting that the sense of roughness is the same as that muscular sense which the metaphysicians who followed Dr. Thomas Reid in the University of Glasgow, taught. It was in the University of Glasgow that I learned the muscular sense, and I have not seen it very distinctly stated elsewhere. What is this "muscular sense"? I press upon the desk before me with my right hand, or I walk forward holding out my hand in the dark, and using this means to feel my way, as a blind man does constantly who finds where he is, and guides himself, by the sense of touch. I walk on until I perceive an obstruction by a sense of force in the palm of the hand. How and where do I perceive this sensation? Anatomists will tell you it is felt in the muscles of the arm. Here, then, is a force which I perceive in the muscles of the arm, and the corresponding perceptivity is properly enough called a muscular sense. But now take the tip of your finger and rub a piece of sandstone, or a piece of loaf sugar, or a smooth table. Take a piece of loaf sugar between your finger and thumb, and take a smooth glass between your finger and thumb. You perceive a difference. What is that difference? It is the sense of roughness and smoothness. Physiologists and anatomists have used the word "tactile" sense, to designate it. I confess that this does not convey much to my mind. "Tactile" is merely "of or belonging to touch," and in saying we perceive roughness and smoothness by a tactile sense, we are where we were. We are not enlightened by being told that there is a tactile sense as a department of our sense of touch. But I say the thing thought of is a sense of force. We cannot away with it; it is a sense of forces, of directions of forces, and of places of application of forces. If the places of application of the forces are the palms of the two hands, we perceive accordingly, and know that we perceive, in the muscles of the arms, effects of large pressures on the palms of the hands. But if the places of application are a hundred little areas on one finger, we still perceive the effect as force. We distinguish between a uniformly distributed force like the force of a piece of smooth glass, and forces distributed over ten or a hundred little areas. And this is the sense of smoothness and roughness. The sense of roughness is therefore a sense of forces, and of places of application of forces, just as the sense of forces in your two hands stretched out is the sense of forces in places at a distance of six feet apart. Whether the places be at a distance of six feet or at a distance of one hundredth of an inch, it is the sense of forces, and of places of application of forces, and of directions of forces, that we deal with in the sense of touch other than heat. Now anatomists and physiologists have a good right to distinguish between the kind of excitement of tissue in the finger, and the minute nerves of the skin and sub-skin of the finger, by which you perceive roughness and smoothness, in the one case; and of the muscles by which you perceive places of application very distant, in the other. But whether the forces be so near that anatomists cannot distinguish muscles, cannot point out muscles, resisting forces and balancing them—because, remember, when you take a piece of glass in your fingers every bit of pressure at every ten-thousandth of an inch pressed by the glass against the finger is a balanced force—or whether they be far asunder and obviously balanced by the muscles of the two arms, the thing perceived is the same in kind. Anatomists do not show us muscles balancing the individual forces experienced by the small areas of the finger itself, when we touch a piece of smooth glass, or the individual forces in the scores or hundreds of little areas experienced when we touch a piece of rough sugar or rough sand-stone; and perhaps it is not by muscles smaller than the muscles of the finger as a whole that the multitudinousness is dealt with; or perhaps, on the other hand, these nerves and tissues are continuous in their qualities with muscles. I go beyond the range of my subject whenever I speak of muscles and nerves; but externally the sense of touch other than heat is the same in all cases—it is the sense of forces and of places of application of forces and of directions of forces. I hope now I have justified the sixth sense; and that you will excuse me for having taxed your patience so long in not having done it in fewer words.

ELECTRICAL STANDARDS[1]

THE Committee report that, in accordance with suggestions made at the last meeting of the British Association, arrangements have now been completed for testing resistance coils at the Cavendish Laboratory and issuing certificates of their value. These arrangements have been made by Lord Rayleigh and Mr. Glazebrook, and the report contains an account by the latter of the methods employed and the conditions under which the testing is undertaken, in order that those who use such coils may have a more exact estimate of the value of the test.

When a coil is to be tested, a suitable standard is chosen, and the two are placed in the water baths and left at least three or four hours—more usually over night. The comparison is then made in the ordinary manner by Prof. Carey Foster's method (*Journal of the Society of Telegraph Engineers*, 1874), and the coils again left for some time without being removed from the water. After this second interval another comparison is made. The temperatures of the water baths are taken at each comparison, and as a rule differ very slightly.

[1] Abstract of Report of the Committee, consisting of Prof. G. Carey Foster, Sir William Thomson, Prof. Ayrton, Mr. J. Perry, Prof. W. G. Adams, Lord Rayleigh, Prof. Jenkin, Dr. O. J. Lodge, Dr. John Hopkinson, Dr. A. Muirhead (Secretary), Mr. W. H. Preece, Mr. Herbert Taylor, Prof. Everett, Prof. Schuster, Sir W. Siemens, Dr. J. A. Fleming, Prof. G. F. Fitzgerald, Mr. R. T. Glazebrook, and Prof. Chrystal, appointed for the purpose of constructing and issuing practical Standards for use in Electrical Measurements.

We thus have two values of the resistance of the coil to be tested at two slightly different temperatures.

The mean of these will be the resistance of the coil in question at the mean of the two temperatures.

We are thus able to issue a certificate in the following form:—"This is to certify that the coil No. *X* has been compared with the British Association Standards, and that its value at a temperature of *A*° C. is *P* B.A. Units or *P'* R. ohms; 1 B.A. Unit being ·9867 R. ohms." We further propose to stamp all coils in the future with this monogram and a reference number.

It will be noticed that nothing is said about the temperature coefficient of the coil or the temperature at which the coil is accurately 1 B.A. Unit. To determine this exactly is a somewhat long and troublesome operation, but at the same time it is one which every electrician, if he knows the value of the coil at one given temperature, can perform for himself with ordinary testing apparatus. It does not require the use of the standards. For many purposes the approximate value of the temperature coefficient obtained from a knowledge of the material of the coil will suffice; we may feel certain that any one requiring greater accuracy would be quite able, and would prefer, to make the measurement himself. We can state with the very highest exactness that the resistance of the coil *X* at a temperature *A*° C. is R. To obtain the temperature coefficient accurately requires an amount of labour which may be quite unnecessary for the purpose for which the coil is to be used.

In accordance with the resolution of the Committee, a fee of 1*l.* 1*s.* has been charged for testing single units, and of 1*l.* 11*s.* 6*d.* for others.

The only coils the testing of which is regularly undertaken are single units and multiples of single units by some powers of 10.

But though this is so, two standard ohms have been ordered, using for the value of the B.A. unit ·9867 ohms, and when they arrive and have been tested, it will be easy to determine the value of coils which do not differ much from a real ohm. At present, without these standards—the coils actually used in the recent experiments at the Cavendish Laboratory have a resistance of about ·1, 24, and 168 ohms—the operation is troublesome. The simplest accurate method seems to be to combine in multiple arc the real ohm, and one of the 100 B.A. unit standards, and to compare the combination with a single unit.

ON THE MEASUREMENT OF ELECTRIC CURRENTS[1]

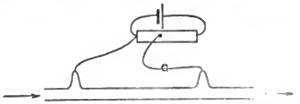
PERHAPS the simplest way of measuring a current of moderate intensity when once the electro-chemical equivalent of silver is known, is to determine the quantity of metal thrown down by the current in a given time in a silver voltameter. According to Kohlrausch the electro chemical equivalent of silver is in C.G.S. measure $1·136 \times 10^{-2}$, and according to Mascart, $1·124 \times 10^{-2}$. Experiments conducted in the Cavendish Laboratory during the past year by a method of current weighing described in the British Association Report for 1882 have led to a lower number, viz. $1·119 \times 10^{-2}$. At this rate the silver deposited per ampere per *hour* is 4·028 grams, and the method of measurement founded upon this number may be used with good effect when the strength of the current ranges from 1/20 ampere to perhaps 4 amperes. It requires, however, a pretty good balance, and some experience in chemical manipulation.

Another method, which gives good results and requires only apparatus familiar to the electrician, depends upon the use of a standard galvanic cell. The current from this cell is passed through a high resistance, such as 10,000 ohms, and a known fraction of the electromotive force is taken by touching this circuit at definite points. The current to be measured is caused to flow along a strip of sheet German silver, from which two tongues project. The difference of potential at these tongues is the product of the resistance included between them and of the current to be measured, and it is balanced by a fraction of the known electromotive force of the standard cell (see figure). With a sensitive galvanometer the balance may be adjusted to about 1/4000. The German silver strip must be large enough to avoid heating. The resistance between the tongues may be 1/200 ohm, and may be determined by a method similar to that of Matthiessen and Hockin (Maxwell's "Electricity," § 352). The propor-

[1] Abstract of a paper read at the Cambridge Philosophical Society.

tions above mentioned are suitable for the measurement of such currents as 10 amperes.

Another method, available with the strong currents which are now common, depends upon Faraday's discovery of the rotation of the plane of polarisation by magnetic force. Gordon found $15°$[1] as the rotation due to the reversal of a current of 4 amperes circulating about 1000 times round a column of bisulphide of carbon. With heavy glass, which is more convenient in ordinary use, the rotation is somewhat greater. With a coil of 100 windings we should obtain $15°$ with a current of 40 amperes; and this rotation may easily be tripled by causing the light to



traverse the column three times, or, what is desirable with so strong a current, the thickness of the wire may be increased and the number of windings reduced. With the best optical arrangements the rotation can be determined to one or two minutes, but in an instrument intended for practical use such a degree of delicacy is not available. One difficulty arises from the depolarising properties of most specimens of heavy glass. Arrangements are in progress for a redetermination of the rotation in bisulphide of carbon.

RAYLEIGH

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In spite of the large majority in favour of the preamble of the statute allowing women to enter for certain University Examinations, the statute was again opposed on March 11, on being brought up by Council after amendment. After a lengthy debate, the statute was carried by 107 against 72. The chief arguments used against the measure were based on the alleged unfairness to men in allowing women to compete under no restrictions of time and residence, and for portions only of any examination; and on the evil to the health of women which might arise from their competing with men. Mr. Pelham, of Exeter, pointed out that the statute was not one to confer degrees upon women, but to make Oxford an examining body for the various centres of female education in England, and enable it to confer certificates which would have a recognised value Mr. Sedgwick read letters from the heads of Newnham and Girton, at Cambridge, showing that the health of the students was excellent.

SCIENTIFIC SERIALS

THE *American Journal of Science*, February.—Examination of Alfred R. Wallace's modification of the physical theory of secular changes of climate, by James Croll. While agreeing with much that has been advanced by Wallace in his "Island Life," in explanation of geological climate, the author fails to perceive that any of the arguments or considerations there adduced materially affect his own theory as advocated in "Climate and Time." He still holds that with the present distribution of land and water, without calling in the aid of any other geographical conditions than now obtain, the physical agencies detailed in "Climate and Time" are sufficient to account for all the phenomena of the Glacial epoch, including those intercalated warm periods, during which Greenland would probably be free from ice, and the Arctic regions enjoying a mild climate.—Communications from the United States Geological Survey, Rocky Mountain division, No. v.; on sanidine and topaz, &c., in the nevadite of Chalk Mountain, Colorado, by Whitman Cross. The sanidine crystals contain gas inclusions, but no fluids, and the topaz, elsewhere found only in granite, gneiss, or other metamorphic or crystalline schists, here occurs in an eruptive rock probably of early Tertiary age.—On the occurrence of the Lower Burlington limestone in New Mexico, by Frank Springer. The observations made by the author in 1882 in the Lake Valley Mining District, Southern New Mexico, have brought to light numerous facts confirming the views of the Burlington geologists regarding the distinct character of the upper and lower subcarboniferous groups in that district, but demonstrating that the Lower Burlington limestone has a much wider geographical range than had hitherto been suspected.—The Minnesota Valley in the Ice Age (concluded, with two maps), by Warren Upham. —Glacial drift in Montana and Dakota, by Charles A. White. The author, who had already determined the presence of true northern Glacial drift in the region about the Lower Yellowstone River, now traces the same drift much further west. His observations were mainly confined to the Missouri Valley, but also reached to the vicinity of the Great Paw Mountains, extending for over a thousand miles at intervals from the Great Falls of the Missouri to Bismarck in Dakota.—Phenomena of the Glacial and Champlain periods about the mouth of the Connecticut Valley, that is, in the New Haven region (with two plates), by James D. Dana. The author concludes that during the Ice period the Mill River channel was excavated or deepened by glacier action. This channel, as it widened southwards below the mouth of the Pine Marsh Creek, became partly obstructed by sand-bars, which increased as the flood made progress, and ultimately merged in the wide terrace formation of the New Haven plain.—Supplement to paper on the paramorphic origin of the hornblende of the crystalline rocks of the North-Western States, by R. D. Irving.—On herderite, a glucinum calcium phosphate and fluoride from Oxford County, Maine, by William Earl Hidden and James B. Mackintosh.—Note on the decay of rocks in Brazil, by Orville A. Derby.

Bulletin de l'Académie Royale de Belgique, December 1, 1883. —Note on the presence of erratic boulders on the Belgian lowlands, by M. E. Delvaux. From the blocks of Scandinavian granites found at Limburg, in East Flanders, at Wachtebeke, and other places, the author concludes that during the Ice Age glaciation extended over the whole of the Netherlands, Belgium, and the shallow or exposed lands now flooded by the North Sea, terminating on the plains of Norfolk and Suffolk.—On amygdaline and germination, by M. A. Jorissen.—On the scintillation of the stars, in connection with the constitution of their light as revealed by spectrum analysis, by M. Ch. Montigny. The author's spectroscopic studies lead to the conclusion that those stars sparkle most whose spectra present the fewest bands, scintillation being weakest in those whose spectra are marked by broad dark bands.—On the fossil remains of *Sphargis rupeliensis* discovered in the brick clay of the Waas district, by P. J. van Beneden.—Note on a new differential dilatometer and its application to the study of the expansion of alums under the action of heat (one illustration), by W. Spring.—Some experiments on thin liquid layers of glycerine prepared from the oleate of sodium, by J. Plateau.—On the false appearances of aurora borealis observed in Belgium during the month of November 1883, by F. Terby.—Note on the anatomy and histology of a *Turbellaria rhabdocelis* (three illustrations), by P. Francotte. —On the laws regulating the proprietary rights of authors of musical and dramatical works in Belgium, by M. Cattreux.—An historical study of the reformer Froment and his first wife, Marie d'Ennetières, by M. Jules Vuij.—On a Society of Lawyers that flourished in Brussels during a great part of the eighteenth century, by Louis Hymans.—Remarks on the present state of music in the chief cities of Central Europe, by X. van Elewyck. —Generalisation of a property of surfaces of the second order, by M. Jamet.—Appearance of the satellites of Jupiter during the night of October 14, 1883, by F. Terby.—Note on the parallax of the sun deduced from the micrometric observations made at the Belgian stations during the transit of Venus on December 6, 1882, by means of specially constructed heliometers, by J. C. Houzeau.—Contributions to the history of the ovum; indirect relation of the germinative vesicle to the periphery of the vitellus (twelve illustrations), by Ch. van Bambeke.—Remarks on the study of biology and natural history in Belgium, by M. Ed. van Beneden.—On the salient features of the beds of the great marine basins, by M. A. Renard.

Atti della R. Accademia dei Lincei, December 16, 1883.—Notice of G. Orano's treatise on "Habitual Criminals," by S. Ferri.—On the causes of the retirement of the Alpine glaciers, by Roberto Paolo. The author concludes that the glaciers were developed under a mean summer temperature lower than at

[1] January, 1884. In a note recently communicated to the Royal Society (*Proceedings*, November 15, 1883) Mr. Gordon points out that, owing to an error in reduction, the number given by him for the value of Verdet's constant is twice as great as it should be. The rotations above mentioned must therefore be halved, a correction which diminishes materially the prospect of constructing a useful instrument upon this principle.

present, and that they are retreating not so much through cosmic or telluric causes as through meteorological changes depending partly on the prolonged action of man on the earth.—On the molecular velocities of gaseous bodies (continued), by Arnoldo Violi.—Experimental studies on Thapsia resin, by Francesco Canzoneri.—Distribution of the spots, faculæ, eruptions, and protuberances on the surface of the sun, deduced from the observations made at the Observatory of the Collegio Romano during the year 1882, by Pietro Tacchini.—Official return of the archæological discoveries made at Este, Bologna, Rome, Bolsena, Albano, and some other parts of Italy during the November of 1883, by S. Barnabei.—Meteorological observations made at the Observatory of the Campidoglio during the month of November, 1883.

January 6, 1884.—Notice of Prof. Carlo De Stefani's work on the "Lower Lias Formation of the Northern Alps," by S. Taramelli.—New determination of the optical characters of Christianite (anorthite) and Phillipsite (variegated copper ore), by Alfredo des Cloizeaux.—Note on the existence of two distinct optical axes in the Gismondine crystals (two illustrations), by the same author.—On the temperature corresponding to the Glacial period (continued), by Pietro Blaserna.—Some observations of the eighth satellite of Saturn, by E. Millosevich.—Meteorological observations made at the Observatory of the Campidoglio during the month of December, 1883.

Revue d'Anthropologie de Paris, No. 1, 1884, contains: Concluding part of Dr. P. Broca's "Description des Circonvolutions Cérébrales de l'Homme d'après le Cerveau Schématique," completed by Dr. Pozzi. The latter writer draws special attention to the third frontal circonvolution in man, which was first definitely shown by Broca to be the seat of the organ of speech. This function, in thirteen out of fourteen cases, is associated with the left frontal, and in one out of fourteen with the right frontal, as has been proved by loss of the faculty of speech, known as "aphasia," or, according to the writer, more correctly as "aphemia," which is due to lesions of that portion of the brain. Dr. Pozzi suggests that, in deference to the scientific importance of Broca's discovery, this special convolution should henceforth be distinguished by his name.—The continuation of M. Mathias Duval's lectures on "Le Transformisme," in which the writer treats specially of heredity and natural selection, drawing his materials, as in the earlier parts, almost exclusively from English sources.—"Les Cafres et plus spécialement les Zoulous," by Elie Reclus. This is the first of a series of papers intended by the author to elucidate the history of primitive peoples.

Rivista Scientifico-Industriale, Florence, December 15–31, 1883.—Account of the economic earthquake-warners constructed by the brothers Brassart of the Roman Central Meteorological Bureau (two illustrations), by E. Brassart.—De Tromelin's new aperiodical galvanometer.—On the electric resistance of porcelain, sulphur, and some other non-conducting substances.—On the measurement of electromotor forces.—On the determination of the work executed and absorbed by a dynamo.—Contribution to palæontological studies in Southern Italy, by Michele del Lupo.

Rendiconti del R. Istituto Lombardo, Milan, January 10, 1884.—On numbers irreducible by complex numbers (concluded), by Prof. C. Formenti.—Contribution to the physiology of the enteric juice, by Prof. L. Solera.—Clinical demonstration of a lymphatic infiltration of mechanical origin in the cornea; preliminary notice, by Dr. R. Rampoldi.—On the declaration of bankruptcy at the instance of the creditors, in the new Italian Commercial Code, by L. Gallavresi.—Attenuating and aggravating circumstances in the Criminal Code (concluded), by Prof. A. Buccellati.

SOCIETIES AND ACADEMIES

London

Royal Society, February 21.—"On an Explanation of Hall's Phenomenon." By Shelford Bidwell, M.A., LL.B.

Mr. E. H. Hall's papers, giving a full account of his well-known discovery, are printed in the *Philosophical Magazine* for March 1880, November 1880, September 1881, and May 1883. His original experiment was as follows:—A strip of gold leaf was cemented to a plate of glass and placed between the poles of an electromagnet, the plane of the glass being perpendicular to the magnetic lines of force. The current derived from a Bunsen cell was passed longitudinally through the gold, and, before the electromagnet was excited, two equipotential points were found by trial near opposite edges of the gold leaf, and about midway between the ends: when these points were connected with a galvanometer there was of course no deflection. A current from a powerful battery being passed through the coils of the magnet, it was found that a galvanometer deflection occurred, indicating a difference of potential between the two points, the direction of the current across the gold leaf being opposite to that in which the gold leaf itself would have moved across the lines of force had it been free to do so. On reversing the polarity of the magnet the direction of the transverse electromotive force was reversed; and when the magnet was demagnetised the two points reverted to their original equipotential condition.

Subsequent experiments showed that the direction of the effect differed according to the metal used. Thus with silver, tin, copper, brass, platinum, nickel, aluminium, and magnesium, the direction of the transverse electromotive force was found to be the same as in the case of gold: with iron, cobalt, and zinc the direction was reversed, and with lead there was no sensible effect in either direction.

Hall's results may be expressed by saying that the equipotential lines across the strip are rotated in a definite direction with respect to the lines of force. This effect was attributed by him to the direct action of the magnet on the current; and very great importance has been attached to the phenomenon in consequence of the opinion expressed by Prof. Rowland and others that it is connected with the magnetic rotation of the plane of polarisation of light, and thus furnishes additional evidence of an intimate relation between light and electricity.

A number of experiments made by the author convinced him, however, that no direct action of the kind supposed was ever produced, and he ultimately found that Hall's phenomenon might be completely explained by the joint action of mechanical strain and certain thermo-electric effects.

The strain is produced by electro-magnetic action. It will be convenient to refer to the metallic plate or strip (which for the purposes of this explanation may be assumed to be rectangular) as if it were an ordinary map, the two shorter sides being called respectively west and east, and the two longer north and south. Let the south pole of an electro-magnet be supposed to be beneath the strip, and let the strip be traversed by a current passing through it in a direction from west to east. Then the strip will tend to move across the lines of force in the direction from south to north. Since, however, it is not free to move bodily from its position, it will be strained, and the nature of the strain will be somewhat similar to that undergone by a horizontal beam of wood which is rigidly fixed at its two ends and supports a weight at the middle. Imagine the strip to be divided into two equal parts by a straight line joining the middle points of the west and east sides. Then in the upper or northern division the middle district will be stretched and the eastern and western districts will be compressed, while in the lower division the middle part will be compressed and the two ends will be stretched. If now a current is passing through the plate from west to east, the portion of the current which traverses the northern division will cross first from a district which is compressed to one which is stretched, and then from a district which is stretched to one which is compressed; while in the southern division the converse will be the case. And here the thermo-electric effects above referred to come into play.

Sir Wm. Thomson, in 1856, announced the fact that if a stretched copper wire is connected with an unstretched wire of the same material, and the junction heated, a thermo-electric current will flow from the stretched to the unstretched wire through the hot junction, while if the wires are of iron, the direction of the current is from unstretched to stretched. From this it might be inferred that a current would flow through the heated junction from an unstretched or free copper wire to a longitudinally compressed copper wire, and from a longitudinally compressed iron wire to a free iron wire; and experiment shows this to be the case. *A fortiori* therefore the direction of the current through the heated junction will be from stretched to compressed in the case of copper wire, and from compressed to stretched in the case of iron. If therefore a current is passed from a stretched portion of a wire to a compressed portion, heat will (according to the laws of the Peltier effect) be absorbed at the junction if the metal is copper and will be developed at the junction if the metal is iron. In passing from compressed to stretched portions the converse effects will occur.

It follows from the above considerations that if the metal plate (which is acted upon by a force from south to north and is traversed by a current from west to east) be of copper, heat will be developed in the western half of the northern division and absorbed in the eastern half; while heat will be absorbed in the western half of the southern division and developed in the eastern half. But the resistance of a metal increases with its temperature. The resistance of the north-western and south-eastern districts of the plate will therefore be greater, and that of the north-eastern and south-western districts smaller than before it was strained; and an equipotential line through the centre of the plate, which would originally have been parallel to the west and east sides, will now be inclined to them, being apparently rotated in a counter-clockwise direction.

If the plate were of iron instead of copper, the Peltier effects would clearly be reversed, and the equipotential line would be rotated in the opposite direction.

The peculiar thermo-electric effects of copper, and iron discovered by Thomson are thus seen to be sufficient to account for Hall's phenomenon in the case of those metals. It became exceedingly interesting to ascertain whether the above explanation admitted of general application, and the author therefore proceeded to repeat Thomson's experiments upon all the metals mentioned by Hall. The results are given in the following table, where those metals which in Hall's experiments behave like gold are distinguished as negative, and those which behave like iron as positive:—

Metals	Forms used	Direction of current	Hall's effect
Copper	Wire and foil	S to U[1]	Negative
Iron	Wire and sheet; annealed	U to S	Positive
Brass	Wire, commercial	S to U	Negative
Zinc	Wire and foil	U to S	Positive
Nickel	Wire	S to U	Negative
Platinum	Wire and foil	S to U	Negative
Gold	Foil, purity 99·9 per cent.	S to U	Negative
	Wire, commercially pure	*U to S*	
	Jeweller's 18 carat wire and sheet	S to U	
	Jeweller's 15 carat sheet	S to U	
Silver	Wire and foil	S to U	Negative
Aluminium	*Wire and foil, pure*	*U to S*	*Negative?*
Cobalt	Rod: 8 mm. diameter	U to S	Positive
Magnesium	Ribbon	S to U	Negative
Tin	Foil	S to U	Negative
Lead	Foil (assay)	No current	Nil

It will be seen that in every case, excepting that of aluminium and one out of five specimens of gold there is perfect correspondence between the direction of the thermo-electric current and the sign of Hall's effect. With regard to the aluminium, a piece of the foil was mounted on glass, and Hall's experiment performed with it. As was anticipated, the sign of the "rotational coefficient" was found to be positive like that of iron, zinc, and cobalt. Either, therefore, Mr. Hall fell into some error, or the aluminium with which he worked differed in some respect from that used by the author. The anomalous specimen of gold, being in the form of wire, could not be submitted to the same test. It probably contained some disturbing impurity.

It is submitted that the considerations and experiments above detailed render it abundantly evident that the phenomenon described by Mr. Hall involves no new law of nature, but is merely a consequence of certain thermo-electric effects which had been observed nearly thirty years ago.

"Some Relations of Chemical Corrosion to Voltaic Current." By G. Gore, F.R.S., LL.D.

The author states that the chief object of this research was to ascertain the amounts of voltaic current produced by the chemical corrosion of known weights of various metals in different liquids, and to throw some light upon the conditions which determine the entire conversion of potential molecular energy into external (*i.e.* available) electric current. The metals used were magnesium, zinc, cadmium, tin, lead, aluminium, iron, nickel, copper, and silver; some of them being also used in an amalgamated state. The liquids employed were solutions of nitric, hydrofluoric, hydrochloric, sulphuric, fluosilicic, and acetic acids; and potassic hydrate and cyanide, also of different degrees of strength.

The chief numerical results are given in a series of ten tables, a table for each metal. Each table contains the electromotive of the current, the loss and rate of loss of the corroded metal, and of a comparison sheet not producing a current; and the percentage of current obtained in ninety-seven different cases.

The results show that the proportion of loss of the positive plate by "local action" to that by corrosion producing external current varied greatly in different cases, viz. from 1·3 to 95·25 per cent. In no case was the whole of the metal dissolved by "local action," nor did the whole of the corrosion produce external current. In about 6 per cent. of the cases the comparison plate was more corroded than the one which was used to produce a current. Whilst also the contact of a negative metal with the corroding plate usually increased the total corrosion, it commonly decreased the corrosion due to "local action."

The proportion of corrosion attended by external current to that due to "local action," varied with the kind of metal and of liquid; with cadmium it averaged 75·63, and with copper 30·33 percent. of the total corrosion; with solution of potassic cyanide it averaged 63·27, and with dilute nitric acid 31·14 per cent. It varied also with other conditions; and the kind of metal had more influence than that of the liquid. Amalgamation of the metal also had distinct effects upon the proportion, but opposite in different cases. The rate of total corrosion of the positive plate appeared to be related to the degree of electromotive force of the current. The chief cause of the great variation in the proportion of corrosion by "local action" to that producing external current was probably a variation of electric conduction resistance.

March 6.—"Magnetic Polarity and Neutrality." By Prof. D. E. Hughes, F.R.S.

The author, citing the researches of Page, Marianini, Wertheim, Joule, Wiedemann, De la Rive, Weber, Beetz, and Maxwell, together with his own published researches, demonstrating that the molecules of magnetic bodies, such as iron, have inherent polarity, and that all the known effects of magnetism can be explained by the demonstrable rotation of the molecules whenever a change of polarity occurs, now gives a new series of experiments verified by several independent methods, in which he shows that the penetration of the apparent polarity diminishes rapidly from the exterior to the interior of a bar, due to the frictional resistance of its molecules. In rotation, as when the rod or bar is vibrated whilst under the exciting influence, the penetration is four times greater than previously. In all cases, however, there is no reversal of polarity in the interior whilst under the influence of its exciting cause. The instant this is withdrawn neutrality takes place in soft iron, or a partial return to the same state even in the hardest of steel.

The author has discovered that this neutrality is not caused by a mixing of the fluids as assumed by Coulomb, or a heterogeneous arrangement of the molecules as assumed by Ampère and all other theories up to the present time, but that a reaction takes place between the outside or strongest polarity with that of the weaker inside, completely reversing it to a remarkable extent.

A bar of iron under the influence of its exciting cause may be represented by three series of letters, the centre representing the inside of a bar, thus—

N N N
S S S

, but when this influence is withdrawn we should have—

N S N
S N S

. And if the inner reversed polarity exactly balanced the exterior the sum of both would be zero, and consequent neutrality.

The paper describes the methods employed, and gives diagrams of these curves. In certain cases the exterior becomes reversed, as shown by magnetising a soft strip of steel half a millimetre thick, and then reducing it to a nearly perfect neutral state, either by mechanical vibrations, or by heating the strip to red heat. That the outside is reversed is shown by dissolving the exterior in dilute nitric acid, when its previous polarity reappears.

[1] S means stretched; U means unstretched.

The author cites several methods by means of which an apparent neutrality is shown to be the result of internal reaction, and that in all cases, even in the most permanent magnet, there is a portion of it reversed to its apparent polarity.

The author shows the importance of the knowledge of this fact in the construction of electro-magnets, whenever we desire to have the maximum of effect whilst under the influence of a current with a minimum of remaining magnetism when the influence ceases.

This is shown by experiments upon bars of similar length but of different thickness, solid bars having far greater effect than tubular ones. Experiments were made on electro-deposited iron of varying thickness, showing the remarkable retentive power of extremely thin coatings of soft iron.

The result is given of a series of researches not yet completed (the details of which will be published in a future paper) upon the saturating point of soft iron and steel. The author has found that the atmosphere as well as all gaseous matter has precisely a similar curve of magnetic rise from neutrality to its magnetic saturation, and that bismuth as well as all so-called diamagnetic bodies obey the same law of saturation. Consequently he assumes that all matter is strongly magnetic, the widest limit yet found, from bismuth to soft Swedish iron, being only forty times greater for the iron.

An explanation is given of the well-known disappearance of magnetism at yellow red heat, in which the author assumes, from observed effects of violent mechanical vibrations, that this disappearance is due to a violent molecular oscillation destroying its symmetrical arrangement of polarity.

The author concludes by saying, "Whatever theory we adopt as an explanation of evident magnetism, it will be found that neutrality occurring after the cessation of an external inducing force upon a bar of iron or steel is the result of symmetrically opposed polar forces, producing apparent waves of opposite polarity, or reactions between the exterior and interior of a bar of iron."

Linnean Society, March 6.—Sir J. Lubbock, Bart., president, in the chair.—Dr. A. B. Shepherd and Mr. Jas. Dallas were elected Fellows, and Mr. W. Hodgson an Associate of the Society.—The President announced the receipt of an intimation from the Foreign Office (through the Science and Art Department) of an International Ornithological Congress to be held in Vienna in the beginning of April.—Mr. J. Britten exhibited specimens of *Lithospermum purpureo cæruleum*, illustrating points in the life history of the plant as described by Mr. J. W. White in the *Journal of Botany*.—Mr. F. O. Bower drew attention to a figure published in the *Gardener's Chronicle* representing a case of proliferation of the so-called "double needle" of *Sciadopitys verticillata*. He alluded to the various views as to the morphological value of the "double needle," and concluded that the one first propounded by Prof. A. Dickson, afterwards discussed adversely by Von Mohl, but favourably by Goebel, appears most in accordance with the history of its development.—Dr. M. Masters showed and made remarks on an example of bud variation of *Pinus silvestris*.—There was exhibited for Mr. T. E. Gunn a stuffed specimen of a male variety of the common moorhen (*Gallinula chloropus*), shot near Norwich last spring.—Mr. A. W. Bennett drew attention to specimens under the microscope of species of *Ptilota* and *Callithamnion* which demonstrated the continuity of the protoplasm.—Prof. Cobbold gave a verbal account of a communication from Dr. P. Manson of Hong Kong, in which the author furnishes fresh evidence as to the *rôle* of the mosquito considered as the intermediary host of *Filaria sanguinis-hominis*. Dr. Manson has verified his previous observations in the most complete manner, and he now recognises and describes six well-marked stages of the Filariæ whilst they are dwelling within the body of the insect. In the discussion following, Dr. T. R. Lewis confirmed Manson's statements in many particulars.—The Secretary read an abstract of a paper on the Indian species of *Cyperus*, with remarks on some others that specially illustrate the subdivisions of the genus. The author divides this memoir into three sections: (1) a descriptive account of each part of a *Cyperus*, viz. the culm, inflorescence, &c., comparing these successively in all the Indian species; (2) contains a discussion of some difficult species and disputed genera; (3) is a systematic arrangement with descriptions of the Indian species, with short citations of some non-Indian species that more particularly illustrate the subdivisions and groups.—Prof. St. G. Mivart read a paper on the relations between instinct and other vital processes. In this he contended that instinct cannot be divided by a very hard and fast line from such vital processes as reflex action, processes of repair after injuries, and the process of development of the individual; and that these latter were more readily explained as activities especially instinctive, than that instinct could be explained by reflex action or by lapsed intelligence. The vital processes referred to were also shown to have an important bearing on the question of the origin of species.—Then followed a paper, notes on Afghanistan algæ, by Dr. J. Schaarschmidt, founded on material derived from Surgeon-Major Aitchison's collection of plants made during the Afghanistan Expedition in 1880.

Zoological Society, March 4.—E. W. H. Holdsworth, F.Z.S., in the chair.—Mr. Howard Saunders, F.Z.S., exhibited and made remarks on specimens of two Gulls (*Xema sabini* and *Larus philadelphia*) in the breeding-plumage, both killed in Scotland. Mr. Saunders also made some observations upon the specimen of *Larus atricilla* in the British Museum, said to be the one killed by Montagu at Winchelsea, and came to the conclusion that the bird in question was not Montagu's specimen. Mr. Saunders likewise exhibited a specimen of *Puffinus griseus* killed off the Yorkshire coast.—A letter was read from Dr. Ch. W. Lütken, Foreign Member, calling attention to a specimen of an Echidna in the Zoological Museum of Copenhagen, which seemed to be different from the ordinary *Tachyglossus aculeatus*, and which Dr. Lütken was of opinion might possibly be referable to the lately-described *T. lawesi* of New Guinea.—Mr. J. E. Harting, F.Z.S., exhibited and made observations on some antlers of roe deer from Dorsetshire and Scotland.—Mr. W. R. Ogilvie Grant read a paper on the fishes of the genera *Sicydium* and *Lentipes* (belonging to the family Gobiidæ), in which an attempt was made to arrange the species of *Sicydium* into smaller groups, the members of which were found to be allied together by convenient and distinctive characters. Five new species of *Sicydium* were described.—A communication was read from Mr. F. Moore, F.Z.S., on some new Asiatic Diurnal Lepidoptera, chiefly from specimens in the Calcutta Museum.—A communication was read from the Count T. Salvadori, C.M.Z.S., containing some critical remarks on an African Duck, *Anas capensis*, Gmelin.

Chemical Society, March 6.—Dr. W. H. Perkin, president, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting (March 20).—The following papers were read:—Studies on sulphonic acids, No. i.; on the hydrolysis of sulphonic acids, and on the recovery of benzenes from their sulphonic acids, by Drs. H. E. Armstrong and A. K. Miller. By passing steam through a solution of the sulphonic acids or the sulphonates in their own weight of sulphuric acid, the authors find that all the benzenes can be recovered. No decomposition of any of the benzenes tried takes place, and an almost theoretical yield is obtained. The method has been of great value in separating the hydrocarbons obtained from camphor.—On a relation between the critical temperature of bodies and their thermal expansions as liquids, by T. E. Thorpe and A. W. Rücker. By combining the simple expression recently published by Mendeléeff for the expansion of liquids with some of the conclusions arrived at by Van der Waals, the authors arrive at the result that the density of a liquid is very nearly proportional to the number obtained by subtracting its absolute temperature from twice its absolute critical temperature.—Remarks on the densities of members of homologous series, by Dr. W. H. Perkin. The author has plotted curves in the usual way, taking the number of carbon atoms as abscissæ, and a scale of numbers embracing those of the densities at 20° C. as ordinates. The bodies examined consisted chiefly of very carefully purified acids and ethers of the fatty series. It is obvious from the curves that the densities of the homologous acids and ethers follow a regular law.—Note on some experiments made at the Munster Agricultural School to determine the value of ensilage as a milk- and butter-producing food. Cows were fed on ensilage for a week and on mixed food for a week, and the author has analysed the milk and weighed the butter produced. The results in the two experiments are almost identical, so that ensilage is not inferior to ordinary food.—Note on the behaviour of the nitrogen of coal during destructive distillation and a comparison of the amount of nitrogen left in cokes of various origin, by Watson Smith.—On a hitherto unnoticed constituent of tobacco, by T. J. Savery. The author, having noticed in tobacco a substance which strongly reduced Fehling's solution, investigated the subject, and separated a body closely resembling caffetannic acid, and which he proposes to call tabacotannic acid.

Geological Society, February 20.—Prof. T. G. Bonney, F.R.S., president, in the chair.—Thomas Lionel Bates, G. J. Williams, and Alfred Prentice Young were elected Fellows of the Society.—The following communications were read:—On a recent exposure of the shelly patches in the Boulder-clay at Bridlington, by G. W. Lamplugh, communicated by Dr. J. Gwyn Jeffreys, F.R.S.—On the so-called *Spongia paradoxica*, S. Woodward, from the Red and White Chalk of Hunstanton, by Prof. T. McKenny Hughes, F.G.S.—Further notes on rock-fragments from the South of Scotland embedded in the low-level Boulder-clay of Lancashire, by T. Mellard Reade, C.E., F.G.S.—Ripple-marks in drift, by T. Mellard Reade, C.E., F.G.S.

CAMBRIDGE

Philosophical Society, February 25.—The following were elected Fellows of the Society:—Mr. A. R. Forsyth, B.A., Trinity College, Mr. W. J. Ibbetson, B.A., Clare College.—The following communications were made to the Society:—On the sums of the divisors of a number, by Mr. J. W. L. Glaisher.—On primitive roots of prime numbers and their residues, by Mr. A. R. Forsyth.—A comparison of Maxwell's equations of the electro-magnetic field with those of Helmholtz and Lorentz, by Mr. R. T. Glazebrook. The author pointed out that the main difference between the two theories turned on the fact that while Maxwell considers the electric displacement throughout the field, Helmholtz deals with the electric moment of each element of volume supposing that by the action of the inducing force opposite electricities are driven to opposite ends of each element. Maxwell's displacement corresponds to the induction in the magnetic field, Helmholtz's polarisation to the induced magnetisation. The existence of a normal wave was discussed, and it was shown that Maxwell's equations without the solenoidal condition $\frac{df}{dx} + \frac{dg}{dy} + \frac{dh}{dz} = 0$, lead to the same result as those of Helmholtz, at any rate in the case in which a plane wave is traversing the medium. It was further pointed out that in the case in which the induction is due to the presence of electricity at rest outside the portion of the field considered, the above solenoidal condition must hold.

EDINBURGH

Royal Society, February 4.—The Right Hon. Lord Moncreiff, president, in the chair.—The President gave a review of the hundred years' history of the Society, a full report of which appeared in our issue of February 14 (p. 368).—The Abbé Renard and Mr. John Murray communicated notes on the microscopical characters, the chemical composition, and distribution of volcanic and cosmic dust; and also a paper on the nomenclature, origin, and distribution of deep-sea deposits. Dust obtained by melting snow from Ben Nevis was not volcanic in character.—The Abbé Renard gave a note on a large crystal of calc-spar found by Prof. Tait in Lough Corrib.

DUBLIN

Royal Society, January 21.—Physical and Experimental Science Section.—G. F. Fitzgerald, F.R.S., in the chair.—Prof. W. N. Hartley, F.R.S.E., read a paper on a simple method of observing faint lines with diffraction spectroscopes. The author states that he works in a darkened room, the goniometer of the spectroscope being illuminated by a shaded lamp which stands to right of the telescope. The grating is movable, while the collimator and telescope are fixed in such a position as to include as small an angle between them as possible. The telescope being to the right of the collimator, a small gas jet is placed upon the left, the rays of which proceed to the grating and are reflected into the field of the telescope. By the adjustment of this light the field may be illuminated in any colour of the spectrum, and by selecting that tint which is complementary to the colour of the lines to be measured, they are sure to stand out apparently in relief on a bright ground.—Howard Grubb, M.E., F.R.S., read a paper on a new form of equatorial telescope. The author referred to an instrument of his construction which has been at work in Cork Observatory for the last two years, in which the eyepiece is placed in a fixed position in the interior of a building. The success of this instrument induced the author to attempt to carry out the same principle on a larger scale, the difficulty to be overcome being that of producing a perfect plane of sufficient size. The author described a form of instrument which, by a combination of a dialytic telescope and his siderostatic form of mounting, would admit of its being of the largest dimensions without the necessity for employing very large reflectors, as in the case of the new French instrument described in NATURE, November 8, 1883 (p. 36). Mr. Grubb claimed that the form of instrument now described possesses all the chief advantages of the French form, while the difficulties of manufacture would be one-ninth, and the cost about the same as the ordinary construction, including dome. Another important advantage claimed is that the difficulty of construction is not increased in the same proportion as in the French form, and therefore Mr. Grubb's arrangement would be applicable to instruments of the largest size.—Greenwood Pim, F.L.S., communicated a paper on the rendering by photography of light and dark colours in their natural values, in the course of which he pointed out that while the ordinary bromide gelatine plates at present so extensively employed rendered a blue of low illuminating power almost white and a yellow of high illumination very dark, by using the isochromatic plates patented by Messrs. Attout-Tailfer and John Clayton of Paris these colours were reproduced in shades corresponding to the illuminating power. Numerous prints from ordinary and from isochromatic plates of ribbons, coloured fabrics, coloured drawings of flowers, &c., were exhibited, clearly showing the superiority of the latter plates when blue and yellow colours had to be photographed; thus avoiding over-exposing the blue in order to bring out the detail of the yellow portion. These isochromatic plates are prepared with eosine in presence of an alkali, usually ammonia, and appear to owe their property more to the chemical action than to the physical action of its red colour; for a screen of eosined collodion interposed between a band of coloured ribbons and the sensitive plate, so as to cover part and leave part uncovered, had but little effect, all that could be noticed being a general slowing action, and not more in the blue than in the yellow.

Natural Science Section.—Rev. Maxwell Close, M.A., in the chair.—Rev. S. Haughton, F.R.S., read a paper entitled "Remarks on the unusual sunrises and sunsets that characterised the close of the year 1883." The older writers on astronomy, such as Brinkley and Maddy, state that on the average twilight lasts until the sun is 18° below the horizon. From this it has been computed that the height of the twilight-producing atmosphere is—

40 miles	on hypothesis of	one reflection,
12 ,,	,,	two reflections,
5 ,,	,,	three ,,
3 ,,	,,	four ,,

Herschel and Newcomb make no statement whatever as to the duration of twilight. Chambers (in his compilation) says that the average depression of the sun is 18°, which is reduced to 16° or 17° in the tropics, but in England a depression ranging from 17° to 21° is required to put an end to the twilight phenomena. Dr. Ball informs me that Prof. Schmidt, of Athens, gives for that place 15° 51′, and also that Liais (Paris) fixes the first twilight arc to set at 10° 41′, and the second at 18° 18′. In the following observations I calculate the zenith distance of the sun at the close of the phenomena by the well-known formula—

$$\cos z = \alpha + \beta \cos h,$$

where

z = sun's zenith distance,
h = sun's hour angle,
$\alpha = \sin \lambda \sin \delta$,
$\beta = \cos \lambda \cos \delta$,
λ = latitude of place of observation,
δ = declination of sun.

Observation I.—Mr. Bishop, observing at Honolulu, found the phenomenal sunsets to commence on September 5, 1883, and to last up to 7.25 p.m.

Here $\lambda = 22°$,
$\delta = 6° 16'$.

This gives the sun's place 18° 22′ below the horizon. This indicates twilight phenomena intensified by some unusual cause, but does not denote an extension of twilight reflection into regions of the air higher than the time-honoured traditional 40 miles. The epoch of the main eruption of Krakatoa has been fixed by Gen. Strachey at August 27 9.32 a.m. If the explosion of Krakatoa on August 27 was the cause of the brilliant sunset at Honolulu on September 5, the result is nothing short of miraculous! The Editor of NATURE writes on December 20 (p. 174), with an enthusiastic glow worthy of the twilights: "The extraordinary fact now comes out that before even the lower currents had time to carry the volcanic products to a region so near the eruption as India, an upper current from the east had taken them in a straight line *viâ* the Seychelles, Cape Coast Castle, Trinidad, and Panama, to Honolulu, in fact very nearly back again to the Straits of Sunda!" [The note of admiration is not mine]. It is worth our while to calculate the rate at which this wonderful journey of volcanic dust was performed. The actual distance is 255° of a great circle, and the time of journey nine days, from which I calculate the speed of the train to have been eighty-two miles per hour! This is absolutely incredible, and becomes still more so when we know that the phenomena observed at Honolulu were unusual twilight phenomena, but had no connection whatever with reflection from the upper regions of the air. In point of fact, my calculation of the sun's position disproves the presence of dust or any reflecting substance in the upper air. Observation II. Dunsink Observatory (a letter received from Dr. R. S. Ball, F.R.S., January 7, 1884):—"Sunday evening, December 30, was exceptionally fine, and the sunset was so well seen, that the moon, though only twenty-seven hours old, was well seen by Cathcart and myself from the roof of the Observatory. We estimated that the twilight lasted certainly for two hours after sunset, and that for ten minutes longer there was still enough light in the western sky to distinguish it from other parts of the horizon. At two hours the sun's zenith distance is 15° 56′; at two hours and ten minutes it is 16° 51′. The first figure coincides almost exactly with the 15° 51′ given by that most skilful observer Schmidt (*vide Astron. Nach*, No. 1495), of Athens, as the zenith distance at the end of astronomical twilight. The 18° which the text-books state to be the limit, seems to be a survival from Kepler, who had it from Ptolemy. There seems to be rather a dearth of careful observations on the subject, at least I can find but few good references to it in Houzeau's *Astronomy*. The only one of this century there contained besides Schmidt is Liais' (*Comptes Rendus*, t. xlviii. p. 110); he says that the first 'arc crépusculaire' sets at 11° 42′, and the second at 18° 18′. It appears to me that on the whole the truth lies nearer to 16° than to any other figure." Observation III. (a letter received from Mr. R. S. Graves, Kingstown, Co. Dublin, December 26, 1883):—"I was on Kingstown Pier yesterday evening (25th inst.), and as the after-glow of sunset looked so beautiful behind the hill, I lingered on the pier, looking at the wonderful brightness and beauty of the whole west sky. The red glow continued to throw *distinct* light on the harbour's shipping till 5.20; from that time, however, the light faded very fast, and at 5.30 it was black night, although the sky was still very red. After this hour the light-giving power seemed to have gone. I see the sun set at 3.53 p.m. (Dublin almanac). The lights in Kingstown presented a very curious appearance: looking at the bright red above the hill, then the hill, and under the hill the hundreds of lights looked just like one of those fancy foreign pictures with pinholes stuck in everywhere to represent the lights. I wish you could have seen the whole scene." N.B. The sun was 14° 15′ below horizon at close of phenomena. Observation IV. (a letter received from a correspondent in Old Derrig, Co. Carlow, December 31, 1883):—". . . I have, of course seen a good deal of the after-glow. Some evenings the appearance is like the glare of limelight at a theatre, the effect on grass or garden very strange. With back to west each blade of grass is like fire, a bit of straw like a red-hot needle; but facing the light, it is all lurid light and shade. Last night sun set by almanac at 3.47; here the sun disappears twenty and twenty-five minutes before, owing to hills. At 4.30 the glow was splendid; at 5.10 I could see seconds-hand of watch 23 minutes after sunset, or nearly 1¾ hour after sun had vanished from us. A planet from 4.30 to 5.10 was in the glow, and from 5 and 5.30 was bright emerald green." N.B. The sun was 15° 15′ below horizon at close of phenomena.—Prof. W. R. McNab, M.D., read a paper entitled: "Note on the botanical topographical divisions of Ireland." The districts adopted by the authors of the "Cybele Hibernica" not being readily comparable with the divisions into provinces, vice-provinces, and vice-counties, as defined by Watson, it is proposed to treat the "districts" as equivalent to provinces, and to arrange thirty-six vice-counties under the twelve provinces. The divisions Dr. McNab thus proposes to adopt in the "Cybele Hibernica" collection at Glasnevin, Dublin, are the following:—Province I. West Munster.—Vice-counties: 1. Kerry. 2. S. Cork. II. East Munster.—(3) N. Cork; (4) Waterford; (5) S. Tipperary. III. West Leinster.—(6) Kilkenny; (7) Carlow; (8) Queen's County. IV. East Leinster.—(9) Waterford; (10) Wicklow. V. North Leinster.—(11) Kildare; (12) Dublin; (13) Meath; (14) Louth. VI. West Shannon.—(15) Limerick; (16) Clare; (17) East Galway. VII. East Shannon.—(18) North Tipperary; (19) King's County; (20) Westmeath; (21) Longford. VIII. West Connaught.—(22) West Galway; (23) West Mayo. IX. East Connaught.—(24) East Mayo; (25) Sligo; (26) Leitrim; (27) Roscommon. X. South Ulster.—(28) Fermanagh; (29) Cavan; (30) Monaghan; (31) Tyrone; (32) Armagh. XI. West Ulster.—(33) Donegal, and City of Londonderry. XII. East Ulster.—(34) Down; (35) Antrim; (36) Derry.—Prof. A. C. Haddon communicated a paper on an apparatus for demonstrating systems of classification, &c.—The apparatus, which was exhibited last March, consists of a series of glass plates placed horizontally one over the other, leaving a small space between each plate. On these plates oblong blocks of wood rest on which are printed the names of the forms whose affinities it is desired to indicate, thus constituting a classification in *three dimensions of space*. This apparatus is especially useful in palæontology.

PARIS

Academy of Sciences, March 3.—M. Rolland in the chair.—Researches on explosive gaseous mixtures, by MM. Berthelot and Vieille. The results are here tabulated of 250 experiments made with forty-two distinct explosive compounds, including not only mixtures of oxygen and hydrogen, the oxide of carbon and formene, pure or mixed with nitrogen, but also mixtures including cyanogen, acetylene, ethylene, methyl, methylic ether, and common vapour of ether. Studies were also made of mixtures of oxygen with two combustible gases together, such as the oxide of carbon and hydrogen, as well as combinations of the protoxide of nitrogen mixed with hydrogen, with the oxide of carbon, with cyanogen, and the bioxide of nitrogen mixed with cyanogen. The main object of the experiments was to determine the amount of pressure developed at the moment of explosion, the temperature produced, and the specific heats of the gases at various temperatures, and especially those of the compound gases.—On a recent note of M. D. André, by Prof. Sylvester. It is shown that M. André's theorem is a direct consequence of the generalisation given by the author to Newton's theorem ("Universal Arithmetic," part 2, chap. ii.) on the imaginary roots of equations.—Remarks on the maps of Madagascar from the Middle Ages to the present time, by M. Alf. Grandidier. The author, who identifies Ptolemy's Menuthias with Madagascar, shows that this island was known to the Greek and Arab geographers long before its rediscovery by the Portuguese in 1500 (not in 1506 as is usually supposed).—On the principle of separate watertight compartments in ship-building, and on the first men-of-war constructed on this principle, by M. Bertin.—New experiments showing how Nobili's electro-chemical rings may be imitated by means of a continuous stream of water falling from a cylindrical tube vertically on a horizontal sheet of black glass moistened all over, by M. C. Decharme.—Description of a new process of generating steam, by M. Bordone.—Theorem by means of which it may be ascertained that certain algebraic equations have no positive root, by M. Désiré André.—Note on hyperfuchsian functions, by M. E. Picard.—On the groups of finite order contained in the group of undeterminative and reversible substitutions of the second order, that is, the quadratic substitutions of Cremona, by M. Autonne.—On linear equations of the second order with partial differences, by M. R. Liouville.—Note on the oxychloride of barium, by M. G. André.—On a new group of nitrous compounds, by M. R. Engel.—On the oxidation of menthol by means of the permanganate of potassium, by M. G. Arth.—On two campholurethanes with an isomerous relation analogous to that presented by M. Pasteur's right and left tartaric acids, by M. Haller.—Experiments on the toxic or medicinal substances which modify hæmoglobin, and especially on those that convert it into methæmoglobin, by M. G. Hayem.—On the conditions favourable to the development of root-suckers in plants, by M. E. Mer.—Analysis of the mineral substances friedelite, discovered by M. Bertrand, and pyrosmalite, found at Dannemora in Sweden, by M. Alex. Gorgeu.—Note on the existence of manganese in a state of complete diffusion in the blue marbles of Carrara, Paros, and the Pyrenees, by M. Dieulafait.—On the coincidence of the transformations observed in the Pons-Brooks comet with its passage across currents of a cosmic character, by M. Chapel.—Notice of two Chinese works on elementary and analytical chemistry presented to the Academy by M. Billequin of the Imperial College, Pekin.

BERLIN

Physical Society, February 8.—Prof. Lampe referred to two recent works on mechanics, one by Herr Streintz, the other by Herr Mach, and brought forward certain problems, which were there dealt with at full length.—Prof. Schwalbe described a peculiar ice-formation he had observed in the Harz towards the end of December last. Under a temperature of from + 2° to + 3° C. by day and − 1° to − 2° C. by night, he perceived, on a road covered with gravel and withered leaves, swellings of the surface at various spots, which, on closer inspection, proved to be ice-protuberances rising from the ground and pushing up its topmost stratum. On the unfrozen earth stood separate, diminutive ice-columns of from three to four centimetres in height, each supporting at its upper extremity a little stone or a withered leaf which it had loosened from the ground and in the course of growth had lifted upwards. Similar swellings were found by Prof. Schwalbe on rotten twigs lying on the ground. In these the rind over a large surface was pushed from the wood by ice-excrescences of soft, brilliant, asbestine appearance, and uncommonly delicate to the touch. They adhered in large numbers to the body of the wood, and reached as great a length as one decimetre. Prof. Schwalbe brought some of these withered and rotten twigs with him to Berlin, and it was in his power to produce on them at any time the phenomenon just described. For this purpose all that was needed was thoroughly to moisten the twig, in such a manner, however, that no water dropped off, and then to let it cool slowly in a cold preparation. Ice-excrescences also appeared of themselves on twigs lying in the garden whenever the temperature fell below 0° C. in the night. In reference to the explanation of this phenomenon, Prof. Schwalbe favoured the view of Le Conte, who had described the matter thirty years ago, and considered it as an instance of capillary action. In the process of slow cooling, the water in the pores became frozen into a small capillary tube, which sucked the water up, and this in turn becoming congealed shot continually further upwards. In this way the little stone or the withered leaf lying on the road, or the rind on the rotten twig, was pushed constantly further away from the substratum, and lifted upwards.

Physiological Society, February 15.—In continuation of the address delivered by him at the last sitting of the Society, Dr. J. Munk set forth the further course of his investigations into the resorption, formation, and deposition of fats in the animal body. After, by feeding a dog on rape-seed oil, he had demonstrated that heterogeneous fats were absorbed and deposited in the animal body, he passed to the question in what manner was the resorption effected. It was universally assumed that the fats in the intestinal canal were emulged, and, as emulsion, entered through the intestinal villi into the chyle vessels. In order to the production of an emulsion it was now first of all necessary that the fat should become fluid at the temperature of the body; and second, that the intestinal contents should be alkaline. As was, however, well known, there were fats which did not melt unless at a temperature of over 40° to 50° C., that is, they could not become fluid at the temperature of the body—mutton suet, for example, which was therefore incapable of being emulged in the intestinal canal. Still less so were the sebacic acids of mutton, which could be only melted at higher temperatures. It had therefore to be experimentally proved whether such fats generally were resorbed. Dr. Munk had a year ago briefly related to the Society an experiment directed to this end, in which he fed a dog with mutton suet. It had yielded a positive result. The fat taken from the body of the dog which had been fed on mutton suet was essentially distinct from the normal fat of a dog, both by its whiter colour and by its greater consistence. On chemical examination, too, it was confirmed that the dog had deposited mutton suet in its body. The experiments now in question, which the speaker described at greater length, were of such a kind that a dog was brought to a state of equilibrium in respect to nitrogen, that is, to such a state that just as much nitrogen was secreted from the body as was supplied it with the food. At certain epochs along with the albumen, either lard or mutton suet, or the sebacic acids of mutton, were administered for a number of days, and during that time careful analyses were made of the evacuations. By these analyses, besides the above-mentioned fact of the deposition of mutton suet in the canine body, it was established that the lard was almost completely used up, only 2 per cent. having been lost to the body in the evacuations, while of the mutton suet about 94 per cent. was absorbed in the intestinal canal, and even of the sebacic acids of mutton 86 to 87 per cent. was taken up. In the last case the quantity of nitrogen secreted was somewhat greater than the quantity received, so that a part of the alimentary albumen was decomposed. Mutton suet, or the sebacic acids of mutton, might therefore be used for feeding; in the excrements a larger quantity of free sebacic acids and of soaps along with neutral fat was always found, a fact which indicated a splitting of the neutral alimentary fats in the intestine. The existence of such a splitting of the neutral fats was also confirmed by the demonstration that the contents of the small intestine never showed alkaline reaction, but reacted either in an acid or neutral manner. This could not be referred to any extensive transition of the contents of the stomach, for the small intestine was found to be always very lax and almost empty, if an excitement of stronger peristaltic movements were carefully avoided during the experiments. A process of emulsion on the part of the mutton suet, which from its consistence offered great difficulties, must therefore, even on account of the reaction of the intestinal contents, be excluded from the problem, and Dr. Munk was of opinion that the demonstrated splitting of the fats must play a very important part in the absorption, the nature and manner of which would have to be studied by further investigations. Lately, microscopical demonstrations had been given by other observers that lymphatic corpuscles strayed towards the free intestinal surface, and there supplied themselves with alimentary substances, laden with which they again strayed back. Such a mechanical absorption was, in Dr. Munk's opinion, highly probable in cases in which the fat was not liquefied by the temperature of the body, as, for example, in the case of feeding on mutton suet.—Dr. Benda described microscopic preparations which he made from tuberculous kidneys, and which he exhibited to the members of the Society for their inspection.

CHRISTIANIA

Society of Science, February 1.—Dr. Collet described the *Beryx borealis*, a remarkable deep-sea fish, and the northern representative of the genus *Berycidæ*, so common in the Chalk period, and its relation to *Beryx decadactylus* of Madeira and Japan.—Prof. Lochmann mentioned a case of poisoning by gas, and referred to the influence of subterranean air on the human organism.—Prof. Lie presented a paper on the common theory of differential equations.—Dr. Kjær described two species of moss, *Hylocomium squarrosum* and *Climacium dendroides*, which were discovered in the clay in the hill in which the famous Norse Viking ship was found near Sandefjord in 1880.

CONTENTS

THURSDAY, MARCH 20, 1884

A BIOLOGICAL LABORATORY ON THE ENGLISH COAST

ARRANGEMENTS have been made for a meeting in the rooms of the Royal Society at half-past four, on Monday, March 31, the object of which is to found a Society having for its purpose the establishment and maintenance of a well-equipped laboratory at a suitable point on the English coast, similar to, if not quite so extensive as, Dr. Dohrn's Zoological Station at Naples.

The value of such an institution to the progress of zoological science, and the simple necessity which exists for the thorough and detailed knowledge only to be gained by the constant work of a well-supported laboratory devoted to the complete exploration of a definite area of sea-bottom, if any reasonable action is to be taken in regulating and improving British sea fisheries, have been set forth at various times in these pages during the past year in connection with the conferences held at the Fisheries Exhibition.

English naturalists have at length determined to do their best to bring about the foundation of the desired laboratory. A large sum of money will be needed in order to secure a site and erect the necessary buildings, besides the provision of an annual income. The Society will be able to raise these funds and to administer them in a more satisfactory way than would be possible were the matter taken in hand by a few private individuals only. The laboratory, when once set going, together with its boats and fishermen, will be used for the purpose of carrying on investigations by any naturalists who are members of the Society, and may desire from time to time to avail themselves of its resources. Its work will therefore be chiefly carried on by volunteers, and it is quite certain that there are a very large number of thoroughly competent naturalists who are only waiting for the opportunity thus afforded. At present such men are to be found scattered here and there on our coasts, making shift to carry on observations without laboratory, boats, or any efficient appliances. Eventually it will no doubt be possible to place a qualified observer in charge of the laboratory. The laboratory will also be available for special investigations, for which a public body or other authority may have employed the services of a naturalist.

Apart from the conveniences which it can afford and the value of the moral effect of combined action even in scientific investigation—the continuous working of a number of naturalists at one spot has a most important reaction upon their work. In proportion as a particular area becomes thoroughly familiar in this way, it becomes easy to obtain special animals and plants for study which were at first regarded as rare, or were altogether unknown in the locality. The thorough and long-continued operations of such a laboratory have naturally enough the value of systematised work as compared with the casual dippings and exploratory incursions of the isolated naturalist who spends a month in one year at this place and a month in another year at another place.

Already in Scotland, on the Firth of Forth, close to Edinburgh—through the admirable energy of Mr. John Murray, the director of the *Challenger* Expedition publications—a small laboratory has been set up, and funds obtained for carrying on its work by the engagement of young naturalists to investigate special problems. The English laboratory will be erected at a point as rich as possible in respect of its marine fauna, and at the same time in proximity to important fishing grounds. No locality has yet been decided upon, but both Torquay and Weymouth have been suggested as presenting the desired combination. Everything depends on the amount of pecuniary support which the Society will be able to obtain. A great work may be done if sufficient funds are forthcoming; a smaller work will be accomplished with smaller funds, and carried on in the firm expectation of gaining increased means of activity as results are produced justifying the enterprise.

But as a matter of fact, no tentative method of procedure is needed. It is quite certain, from the experience obtained in other countries, that a properly provided observatory—with good working-rooms, large and small tanks, sea-water pump, a steam launch and well-trained fishermen and permanent staff—can turn out results which are numerous and valuable in proportion to the completeness of the arrangements and the experience of the permanent staff. France was the first country to start such marine laboratories or observatories. At present there are several in operation on the French coast—viz. at Roscoff, at Concarneau, at Villefranche, and near Cette. Italy boasts of the great international laboratory founded and carried on with wonderful perseverance and success by Dr. Dohrn at Naples. An idea of the cost of a really first-rate institution of the kind may be gathered from the fact that the palatial building in the Villa Nazionale at Naples with its fittings and fishing-boats represents a capital of 20,000*l.*, whilst the annual expenditure is over 4000*l.* Austria has such a laboratory at Trieste, maintained by the Imperial Government. Among the most successful of such laboratories have been those established on the eastern coast of the United States. That at Beaufort, directed by the Johns Hopkins University, has furnished an extraordinary amount of interesting results through the activity of Mr. Brooks and the young naturalists of the United States who make use of it. That erected by Prof. Alexander Agassiz at Newport (Maine) is no less satisfactory as an evidence of the utility of such institutions. Since the foundation of these laboratories (within the past decade) our knowledge of marine organisms has increased at an enormous rate: without them we should have gone on in the casual, uncertain way which necessarily arose from the fact that every naturalist, before the foundation of these laboratories, had to establish his own little workshop for the summer and to make a fresh start in an unexplored locality, or in one explored only by the efforts of himself alone.

The meeting on March 31 promises to be one of great influence. Prof. Huxley, P.R.S., is to preside. Prof. Flower, Prof. Moseley, Prof. Milnes Marshall, Sir Lyon Playfair, Mr. W. S. Caine, M.P. (one of the Commission on Trawling), Prof. Michael Foster, Prof. Ray Lankester, Dr. Albert Günther, Dr. W. B. Carpenter, Mr. Gwyn Jeffreys, Dr. P. L. Sclater, Mr. Frank Crisp, Sir John

Lubbock, and other gentlemen, have signified their intention of being present and supporting the resolutions which are to be submitted to the meeting.

We beg to refer those of our readers who are interested in this subject to the articles published during the past year in NATURE, and to the arguments advanced in support of the proposal to found such a laboratory, together with a sketch of the relation of zoological science to the well-being of British fisheries, in the address on the Scientific Results of the Fisheries Exhibition delivered by Prof. Ray Lankester at the conference on July 19, and published by the Exhibition Committee.

THE UNITY OF NATURE

The Unity of Nature. By the Duke of Argyll. (London: Strahan, 1884.)

THIS book is in our judgment a dreary failure. Although in the mere matter of style it is a well written popular exposition of what we may call the comfortable way of looking at things, in all matters of deeper importance it is utterly barren. Throughout its five or six hundred pages there is no single original observation in science, nor any single original thought in anything that deserves to be called philosophy. Moreover, if regarded only as an exposition, the first chapters are tedious on account of the redundant manner in which elementary science is explained, while the later chapters, in which the author's views on various philosophical questions are unfolded, display a feebleness of thought and argument which renders them even more tedious than the earlier ones. In short, the successive essays strongly remind us of a series of Scottish sermons. There is everywhere a narrow consistency in the doctrine, which is presented in a rhetorical precision of style; but the discussion never seems to get below the surface, while even surface difficulties are either unperceived or intentionally avoided. On this account the discussion itself tends to illustrate the principle of "unity" with which it is concerned; it begins, continues, and ends in a monotone. No matter how fearfully out of tune this may be with any of the notes struck by the greatest men of our time, the Duke of Argyll, like a Highland piper, is deaf to every other music, and drowns all else in the one continuous drone of his own particular instrument.

The pages of a scientific journal are not suited to an examination in any detail of the parts of the book to which these general remarks apply. We shall, therefore, proceed to examine the more purely scientific strands which are woven into the texture of the work. In this connection the chief topic which meets us is that of "Animal Instinct in Relation to the Mind of Man." Here the main question which is dealt with—that as to the mode of origin and development of instincts—appears to us most inefficiently treated. The object of the writer is to argue that the phenomena of instinct point directly to the design of a Creator, who correlates instinct with structure and environment. So far, of course, every evolutionist, who is also a theist, may go. But, in order to enforce this view, the Duke proceeds to argue that the phenomena in question are of so mysterious a nature that it is not possible to point to any causes of a proximate or physical kind which may reasonably be supposed to produce them. Now it would be easy to show—were this the place to show it—that the writer has here adopted a weak position even as an apologist; but, to consider the matter only from the side of science, surely it shows some grave want either of judgment or of consideration to make the kind of statements of which the following may be taken as fair examples:—

"I can therefore see no light in this new explanation to account for the existence of instincts which are certainly antecedent to all individual experience—the explanation, namely, that they are due to the experience of progenitors 'organised in the race.' It involves assumptions contrary to the analogies of nature, and at variance with the fundamental facts, which are the best, and indeed the only, basis of the theory of evolution. There is no probability—there is hardly any possibility—in the supposition that experience has had, in past times, some connection with instinct which it has ceased to have in the present day. . . . There was a time when animal life, and with it animal instincts, began to be. But we have no reason whatever to suppose that the nature of instinct then or since has ever been different from its nature now. On the contrary, as we have in nature examples of it in infinite variety, from the very lowest to the very highest forms of organisation, and as the same phenomena are everywhere repeated, we have the best reason to conclude that, in the past, animal instinct has ever been what we now see it to be—congenital, innate, and wholly independent of experience."

Such passages as these scarcely admit of comment, because all that can be said about them is that the writer has either never read, or has completely forgotten, the whole of the literature to which he alludes. No evolutionist has ever entertained the suicidal "supposition that experience has had, in past times, some connection with instinct which it has ceased to have in the present day;" and the conclusion that in the absence of so absurd a supposition the only alternative is to regard instinct as always having been wholly independent of experience is a conclusion which stands in direct opposition to all that constitutes "evolution" a "theory." Of course no one is bound to accept this theory; it may be rejected, or it may be left unmentioned; but it is futile to set up a nonsensical form of words, and then to call the absurdity the "theory of evolution."

And these are no mere chance expressions, which, if standing alone, might be indicative only of carelessness. The whole of the dissertation on instinct is pervaded by a similar misapprehension, or want of apprehension, of the fundamental ideas of the newer philosophy which the writer appears to suppose that he is considering. Thus, he fails to perceive that the doctrine of natural selection has any bearing upon the subject, while, with reference to the factor of what Mr. Darwin called "inherited habit," he says:—

"If the habits and powers which are now purely innate and instinctive were once less innate and more deliberate, then it will follow that the earlier faculties of animals have been higher, and that the later faculties are the lower in the scale of intelligence. This is hardly consistent with the accepted idea of evolution," &c.

Comment is needless. We shall, therefore, notice only one other point with reference to the essay on instinct, and this is the difficulty which is thus manufactured to meet the experience theory.

"Did there ever exist in any former period of the world what, so far as I know, does certainly not exist now—any animal with dispositions to enter on a new career, thought of and imagined for the first time by itself, unconnected with any organs already fitted for and appropriate to the purpose? . . . The questions raised when a young dipper, which had never before seen the water, dives and swims with perfect ease, are questions which the theory of organised experience does not even tend to solve; on the contrary, it is a theory which leaves these questions precisely where they were, except in so far as it may tend to obseure them by obvious confusions of thought."

Here one would have thought that the writer need not have gone further than the instance which he himself gives to have found evidence of the growth of an instinct by the accumulation of hereditary experience or habit, and as yet unconnected with the "organs already fitted for and appropriate to the purpose." For the dipper belongs to a non-aquatic family of birds, and therefore has no organs specially adapted to its aquatic instincts. In particular it has no webs to its feet; and therefore, so far as the structure and affinities of the bird can in themselves argue anything, they speak most distinctly in favour of the view that the species must have developed aquatic instincts while not yet having had time to develop the "appropriate organs." It would be no answer to say that this *species* does not need these organs; else why are they needed by all the *families* of birds which present the same instincts? Or, conversely, can it be said that these same organs, *i.e.* webbed feet, stand in any special correlation with the existing instincts of the upland geese, which, being terrestrial in their habits (though aquatic in their affinities), never use them for swimming or diving? Short of historical or palæontological knowledge (which in the case of instinct is of course impossible), we could have no stronger evidence of transmutation than is afforded by these two complementary cases, in one of which the absence of a structure points to the recent acquisition of the instinct, while in the other the presence of this structure points to the former existence of the instinct now obsolete. Analogous cases occur in the species of ground-parrots and tree-frogs which, while retaining their ancestral structures adapted to climbing, have nevertheless entirely lost their arboreal instincts.

Moreover, a strange want of thought is shown by the remark that, so far as the writer knows, "there certainly does not exist now any animal with dispositions to enter on a new career, thought of and imagined for the first time by itself." It is enough to quote the complete change in the instincts of nidification which has been observed to take place in the house-sparrow, and in several species of swallow, since these birds first had the opportunity of building on houses; or the more recent and perhaps more remarkable case of the mountain parrot, which has been observed to manifest a "progressive development of change in habits from the simple tastes of a honey-eater to the savageness of a tearer of flesh." Many similar instances might be given, and, as showing that they are not uncommon, I may remark that a very instructive one is published by Dr. Rae in a recent number of this journal.

So much, then, for the Duke of Argyll's views on instinct. Scarcely less unsatisfactory are his views on rudimentary organs. The explanation which he adduces to account for these structures is, not that they are remnants of organs useful in the past, but that they are prophesies of organs which, when more fully developed, are to be of use in the future. We have no space to criticise at any length this wholly untenable inversion of Mr. Darwin's teaching; but we think it will be enough to notice the singularly unfortunate instance which the Duke selects to illustrate his theory. This instance is that of the whales, and he says that Mr. Darwin's views of the rudimentary organs here to be met with "obliges us to suppose that the ancestors of the whales were once terrestrial quadrupeds, and in that case we start with the conception of hind limbs, and of the quadrupedal mammal, fully formed and perfectly developed. Whereas, if we accept the possibility of useless organs being the beginnings and rudiments of structures which are there because the germ has always within it the tendency to produce them, then we catch sight of an idea which has the double advantage of going nearer to the origin of species, and of being in harmony with the analogy of natural operations as we see them now." Is not this enough? When we remember the eloquence, as it were, with which the whole organisation of the Cetacea tells us of their having been originally, like other mammals, terrestrial, it seems that the Duke could have chosen no worse example whereby to illustrate his hypothesis.

Passing now to the long discussion of the question whether savages should be regarded as the product of evolution from lower levels of human life, or of degradation from higher levels, we may say in general terms that by adopting the latter hypothesis as applying to all savages, the Duke sets himself in opposition to the theory of evolution as a whole. Moreover, he does not appear to have reflected that the question is not one which can be investigated or decided, as it were, in the lump. It is quite likely that some savages have fallen from a higher to a lower level of savagery; it by no means follows that all savages have done the same. Further, if we were to suppose that they did, from what level of civilised or of uncivilised life are we to suppose that they all started? This hypothesis, as a general explanation of the savage state of man is, indeed, as incoherent as it is obsolete; yet it is not more so than certain other views upon the savage state to which this writer gives expression. Thus, his chief contention is that savage man shows himself to be, as it were, out of joint with the rest of Nature, or, as he expresses it, an "evident departure" from the unity or order of Nature. Perhaps it is enough to say of a doctrine which from a scientific point of view is so peculiar, that it ought to have prevented the author from styling his book "The Unity of Nature."

We have no space left to consider the only other topic that calls for consideration in these columns, viz. the essay on the Moral Sense. The whole treatment of this subject appears to us most feeble. It is also most inaccurate, as the following quotation will suffice to show:—

"It has been laid down that evolution, in its most perfect conception, would be such that the development of every creature would be compatible with the equal development of every other. In such a system it is said there would be no 'struggle for existence—no harmful competition, no mutual devouring—no death' (Herbert Spencer, 'Data of Ethics,' chap. ii. pp. 18, 19). The inspired imaginings of the Jewish prophets of some future time when the lion shall lie down with the lamb, and the ideas which have clustered round the Christian heaven, are more probably the real origin of this conception than any theory of evolution founded on the facts and laws of nature."

It is needless to say that no more ridiculous travesty than this could well be imagined, or that no such absurdity as that which professes to be formally quoted from Mr. Spencer is to be found either under the reference given or in any other part of his writings. In short, this "most perfect conception" of evolution is a pure invention, which reads almost as if it were intended to misinform the uninformed. We do not, however, suppose that such is the case. This extreme of inaccuracy we take to have been reached by the habit of drawing upon "inner consciousness," until not only the whole sense and substance of other writings are perverted, but even the most pure and delicious nonsense is seen by "the mind's eye" to occur in particular words on a particular page of some other book.

If space permitted or need required, we could point out other inaccuracies, and even still greater absurdities, both in this chapter and elsewhere; but we have doubtless already said more than enough to show that "The Unity of Nature" can scarcely be considered a successful work from a scientific point of view.

GEORGE J. ROMANES

OUR BOOK SHELF

The Electrician's Directory, with Handbook for 1884. 67 pp. (London: *Electrician* Office, 1884.)

THIS work, now in the second year of publication, contains much information of use to electric and telegraphic engineers. Amongst its contents are comprised a list of new electric companies, a list of provisional orders granted by Parliament for electric lighting, a list of the "British Cable Fleet," a list of British railways and railway officials, a fairly complete directory of the professions and trades connected with electricity; also a large amount of statistical information about different kinds of dynamo machines, electric lamps, and telegraph tariffs, much of which will doubtless be out of date in twelve months' time. There is also an obituary of electricians deceased in 1883, a table by Mr. Geipel of the cost of electric conductors as calculated by Sir W. Thomson's formula, and a set of tables by Mr. Crawley for corrections of measurements in horse-power and in watts. These two sets of tables are the only portion of the work claiming independent scientific value. We object entirely to Mr. Crawley's gratuitous remark in the prefatory paragraph of his section that the accepted system of electric units was "really foisted upon electricians by men devoted more to theoretic than to practical work." Nothing could be further from the truth than to accuse Mr. Latimer Clark, Sir Charles Bright, who originated the system, and Sir William Thomson, who did so much to perfect it, of not being practical workers. As a matter of fact, *ohms*, *volts*, *farads*, and *webers* were used by practical electricians for years before they found their way into the text-books written by the theorists.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On a "Magnetic Sense"

SIR WILLIAM THOMSON, in his presidential address at the Midland Institute, which is reported in NATURE for March 6 (p. 438), draws attention to the marvellous fact that hitherto we have no evidence to show that even the most powerful electromagnets can produce the slightest effect upon a living vegetable or animal body. But Sir William "thinks it possible that an exceedingly powerful magnetic effect may produce a sensation that we cannot compare with heat, or force, or any other sensation," and hence he cannot admit that the investigation of this question is completed,—for although the two eminent experimenters named by Sir W. Thomson felt nothing when they put their heads between the poles of a powerful electromagnet, it does not follow that, therefore, every member of the human race would feel nothing.

May I be permitted to point out that some slight evidence already exists in the direction sought by Sir W. Thomson? Scattered in different publications there are numerous statements made by different observers in different countries during the present century, which, if trustworthy, indicate that upon certain human organisms a powerful magnet does produce a very distinct and often profound effect. Unfortunately, with the exception of the careful and excellent observations made by Dr. W. H. Stone, who tried Charcot's experiments on a patient of his at St. Thomas's Hospital, the observations referred to are singularly wanting in precision of statement and in a due recognition of the precautions needful in order to avoid fallacious or ambiguous results from illusions of the senses.

This being the case, an attempt is being made by the Society for Psychical Research to ascertain—by direct and careful experiment, extending over a wide range of individuals—whether any trustworthy evidence really exists on behalf of a distinct magnetic sense. The sectional Committee of that Society intrusted with this and cognate work has published a preliminary report,[1] which contains a fragment of evidence pointing in the direction of the existence of a magnetic sense in certain individuals. Three persons have been found by the Committee, who, when their heads were placed near the poles of a powerful electromagnet, could tell by their sensations when the magnet was excited or not. One of these "sensitives" told the investigating Committee accurately twenty-one times running whether the current was "on" or "off" from a peculiar and unpleasant sensation he alleges that he experienced across his forehead. Every precaution that suggested itself was taken to prevent the subjects gaining any information through the ordinary channels of sensation of what was being done at the contact-breaker placed in another room. But I am sure the Committee will gratefully welcome any criticism of their procedure or suggestions for future experiment which Sir William Thomson may feel inclined to give. The honorary secretary of the Committee is Mr. W. H. Coffin, Cornwall Gardens, S.W.

Two or three months ago one of the gentlemen who appeared to have this magnetic sense was in Dublin, and I took the opportunity of repeating with care in my own laboratory the experiments previously made at the Society's rooms in London. The result satisfied me that this individual did in general experience a peculiar sensation, which he describes as unpleasant, when his head was within the field of a powerful magnet. Nevertheless the keenness of his magnetic sense, if such it be, varied considerably on different days, and sometimes he stated that he could detect little or no sensory effect. Usually the effect was felt most strongly when the forehead was in the line joining the two poles; but one day, when he was suffering from facial neuralgia, he found that his face was the most sensitive part, and complained of a sudden increase of pain whenever the magnet was excited, his face being near the poles. Sufferers from neuralgia among the students of science may therefore have a new and useful career before them, in the pursuit of which

[1] *Proceedings of the Society for Psychical Research*, Part 3. (Trübner and Co.)

their increased torture will, it is to be hoped, be vanquished by a far stronger intellectual joy.

The peculiar and unpleasant sensation which the magnet appeared to produce on the subject just referred to was described as slowly rising to a maximum in fifteen or twenty seconds after the current had been sent round the coils of the electromagnet. In like manner the effect seemed to die down slowly after the contact was broken. Unknown to the subject, the circuit was closed and opened several times, and the magnetism correspondingly evoked or dissipated, the result being that there was a fairly accurate correspondence between the physical and the psychical effect. The faint molecular crepitation which accompanies the magnetisation of iron, and can be heard when the ear is very near the magnet, is, however, very apt to mislead the imagination. To avoid this, the subject was placed at a distance where this faint sound conld not be heard, and he was then requested to walk up to the electromagnet, and, judging only from his sensations, to state if the current were "on" or "off." The experiment was made twelve times successively, and he was correct in ten out of the twelve trials. He had no means of seeing or hearing the contact-breaker; of course, it is possible for a trickster, using a concealed compass-needle, to be able to impose on a careless experimenter, but care was taken, and I have not the least reason to doubt the entire *bonâ fides* of the subject of this experiment. Obviously the foregoing observation is but of little value unless corroborated by a far more extensive series of experiments, conducted with the most stringent precautions to avoid the creation of illusory effects.

I have tried experiments with large helices encircling the limbs and head, and animated by powerful currents, but have not observed any peculiar sensory effect in my own case, though I am inclined to think the headache which I have often experienced when working with a large magnet may not be altogether an accidental coincidence. Meanwhile experiments are in progress in my laboratory to ascertain, if possible, whether any sensory effect is produced upon lower organisms. I hardly anticipate any affirmative results, but it seemed worth making a systematic investigation from minute structures up to man Sir W. Thomson's address will, I hope, stimulate other workers in this field. W. F. BARRETT

Royal College of Science, Dublin, March 11

Instinct

I WRITE one more letter on this subject, in order to observe that I do not think the only remaining difference between Mr. Lloyd Morgan and myself is so great as it may be apt to appear. In my books I have been careful to point out the peculiar disabilities under which the science of comparative psychology labours from its necessarily ejective character. But while in Mr. Morgan's view these disabilities are so great as to render any science of comparative psychology impossible, in my view they are not quite so great. I quite agree with the quotation which he gives from Prof. Huxley on the crayfish; but this does not amount to saying that no science of comparative psychology is possible. We may still, for instance, feel perfectly certain that a dog is a more intelligent animal than a crayfish, and in this we have a purely scientific proposition.

The difference, therefore, between Mr. Morgan and myself is more apparent than real, and depends upon what we mean by "a science." This is the question that must be answered before we can proceed to consider the question raised by him, viz. "Is a science of comparative psychology possible?" In my estimation the possibility of a science is furnished wherever there is material to investigate. The more vague the material, the less exact must be the science, and on this account, no doubt, comparative psychology is the least exact of all the sciences. But so long as its subject-matter admits of any investigation at all, so long, it seems to me, comparative psychology is a science.

GEORGE J. ROMANES

The Remarkable Sunsets

WITH reference to the theory that the red sunsets are due to volcanic dust in the air, I think that the following extract from a letter which has been forwarded to me is of considerable interest. The writer is Mr. Frederick Spofforth, and his letter is dated January 29, from Collaroy, 150 miles from Sydney. It will be observed that the corroboration which he gives to the theory in question is the more striking from the fact of its being so completely unconscious. GEORGE J. ROMANES

"A most peculiar sight this summer are the sunsets. The sun always goes down as red as can be, and half the night there is the same roseate hue, which lasts till past midnight. Many causes are given for it, but nearly all differ.

"Another curious thing is the enormous amount of dust—even up here, where you see nothing but trees as far as the horizon on all sides. Some days the whole landscape will be covered in dust, and where the dust comes from nobody can tell. It is always worst in the early morning."

Right-sidedness

MR. LE CONTE (NATURE, xxix. p. 452) seems rather to complicate than to simplify this question. If the right side of his body shows more dexterity than the left, surely it is his left eye that should share this excellence, if we are to suppose that this difference in dexterity depends upon any central origin. A person paralysed on the left side of the body loses sight—if sight be lost at all—in the right eye, and *vice versâ*. Further, I am right-handed, and use an eyeglass in my left eye; yet, though the right eye is the weaker, I use it for a telescope or microscope by unconscious preference. On the other hand, most persons who use a single eyeglass wear it in the right eye. I may have adopted the left for ease in adjusting the glass, so that my right hand might be free. When I am reading, if I put my hand in front of my left eye, I am conscious of some muscular alteration; if I obscure my right eye, I notice nothing but a slight diminution of the sense of light, white objects seeming less white to my right eye than to my left. And this effect is just as noticeable when I wear spectacles as when I am reading without them; so that my myopia is not the cause of the difference.

In discussing right sidedness—whether we regard the decussation of the nerves in the medulla oblongata or not—we must not forget that prize-fighters normally strike with the left hand, using the right as a guard or to deliver the second blow; perhaps this is to gain the advantage of the greater strength of the right leg. Moreover, the habit among Western nations of writing from left to right appears to argue that right-handedness is the rule among them; but Orientals reverse the process, so that the majority of mankind must be left-handed. What do the anthropologists say to this?

Mr. Charles Reade, writing in the *Daily Telegraph* some years ago, argued that if the habitual use of the right hand led to a greater development of the left side of the brain, a further acquired use of the left hand would aid the development of the right cerebral hemisphere, and so increase the general power of the brain. But is there any evidence to show that ambidextrous people, left-handed apparently by nature, and right-handed from habit, have any general mental advantage over their fellows? I think not. HENRY T. WHARTON

39, St. George's Road, Kilburn, March 17

IN my own experience (I can with confidence only give that) I differ almost wholly from that of Mr. Joseph Le Conte, as expressed in NATURE (p. 452). In my case strength and dexterity of arm do not *in everything* go together. For instance, although strongly left-handed, I learnt to write with the right hand and shoot from the right shoulder, and could do either very indifferently indeed if attempted with the left hand or arm. I perhaps may call myself with truth a rather handy man, improved upon by living for many years in places where tradesmen were not to be had. In all connected with pencil, pen, ink, and paper, such as printing, chart-making, my left hand, although strongest, was clumsy, whereas my right showed considerable skill, as was exhibited once in rather a ludicrous manner by the Hydrographer of the Admiralty mistaking my pen-and-ink chart of some seven hundred miles of Arctic discovery for an engraving of the same. My left leg is the stronger, yet I use it in kicking and in other ways requiring dexterity; *e.g.* when very many years younger I could perform the many curious movements or steps of some of our Scottish dances with much more accuracy and ease with the left foot than with the right. I fear the subject-matter of this note may be scarcely considered a valid excuse for so much self-notice. JOHN RAE

4, Addison Gardens, March 15

Ravens in the United States

On p. 336 of Nature for February 7, Manhattan asks a question about "ravens." I do not propose to answer his question, but to state a fact. I was raised from boyhood to manhood in Tioga Co., Penn., and in my boyhood days, when the primeval forests were broken only by the recent settler's small patch scattered here and there along the valleys, the raven was a. common as the crow; nor could the one ever be mistaken for the other. Before I had attained the years of manhood, however, the raven had become a *rara avis*, while the crow, on the contrary, had become vastly more abundant. The bald-eagle, and the fish-hawk, too, were then very often seen, now seldom or never. Other birds could be added to the list if desirable. The question, *why?* is not so easily disposed of as it is to state the fact. Should one be disposed to answer by saying *the rifle*, it would be pertinent to reply that the rifle was just as active against the crow, the common hen-hawk, and the crow-blackbird, as it was against the raven, the fish-hawk, and the bald-eagle; but these latter birds have all disappeared, while, in spite of the rifle, the former have increased. We must look deeper for the cause.

Ira Sayles

Washington, D.C., March 3

In answer to the query of your correspondent "Manhattan," who writes from New York, under date of Jan. 11, concerning the prevalence of ravens in the United States, I would like to remark that ravens quite replace the crow in Nevada. I have never seen them here in the east. Mr. Ridgway who was with me in 1867-68 could give you much valuable information in regard to their habits and range.

W. W. Bailey

Brown University, Providence, R.I. (U.S.A.), March 1

Thread-twisting

In Nature, January 31 (p. 305), I read some remarks by Prof. E. B. Tylor on a "rude method of making thread by rolling palm or grass fibre into a twist with the palm of the hand on the thigh," which Prof. Tylor regards as a "savage art" of old native tribes of Gniana, who were thigh-twisters. I have often seen shoemakers when at work prepare their threads by twisting them on the thigh with the palm of the hand. May this practice be one which has survived from a barbarous period?

Truro, March 14

J. S.

BICYCLES AND TRICYCLES IN THEORY AND IN PRACTICE [1]

When I was honoured by the invitation to give this discourse on bicycles and tricycles, I felt that many might think the subject to be trivial, altogether unworthy of the attention of reasonable or scientific people, and totally unfit to be treated seriously before so highly cultured an audience as usually assembles in this Institution. On the other hand, I felt myself that this view was entirely a mistaken one, that the subject is one of real and growing importance, one of great scientific interest, and, above all, one of the most delightful to deal with that a lecturer could wish to have suggested to him.

It is quite unnecessary for me to bring forward statistics to show how great a hold this so-called new method of locomotion has taken upon people of all classes: the streets of London, the roads and lanes in all parts of the country, testify more forcibly than any words of mine can do to what enormous numbers there are who now make use of cycles of one sort or other for pleasure or for the purposes of business.

Not only has the newly developing trade brought prosperity to towns whose manufactures were dying a natural death, but the requirements of cyclists have given rise to a series of minor industries, themselves of great importance. Riders of bicycles and tricycles come along so silently that instruments of warning have been devised. There are bells that jingle, bells that ring, whistles, bugles, and a fiendish horn which will utter anything from a gentle remonstrance to a wild, unearthly shriek. Lamps, tyres, saddles, seats, springs, &c., are made in unending variety; these form the endless subject of animated conversation in which the cyclist so frequently indulges. Cyclometers or instruments for measuring the distance run are also much used. Some show the number of revolutions made by the wheel, from which the distance can be found by a simple calculation; others indicate the distance in miles. There is on the table a home-made one of mine with a luminous face which at the end of every mile gives the rider a word of encouragement; it now indicates that a mile is nearly complete; in another turn or two you will all hear it speak.

Cyclists have a literature of their own. There are about a dozen papers wholly or largely devoted to the sport. They can even insure themselves and their machines against injury by accident in a company of their own.

The greatest and by far the most important growth is the Cyclists' Touring Club, a gigantic club to which every right-minded rider in the country belongs. This club has done more to make touring practically enjoyable than could have been thought possible when it began its labours. Railway companies have with few exceptions consented to take cycles at a fixed and reasonable rate; in almost every town in the country an agreement has been made with the leading, or at any rate a first-class, hotel, in virtue of which the touring member may be sure of meeting with courtesy and attention for himself and with clean quarters and an intelligent groom for his horse, instead of finding himself as hitherto a strange being in a strange place at the mercy of some indifferent or exorbitant landlord. In consequence of this, thousands now spend their holidays riding over and admiring the beauties of our own country instead of being dragged with a party of tourists through the streets and buildings of a foreign town. Of the delightful nature of a cycling tour I can speak from grateful experience; last autumn alone I travelled nearly 1500 miles, meeting on my way with almost every variety of beauty that the scenery of this country affords. Wherever I went I felt the beneficial influence of the C.T.C., as the touring club is called. At all the hotels—our headquarters—at which I stopped, I found the most sanguine wishes of the club amply fulfilled, our wants understood and provided for.

The C.T.C. have also done a great service in providing us with a uniform which has been proved to be as near perfection as possible. They have also designed a ladies' cycling dress, which can be seen in the library.

Though touring in the country is the perfection of our art, town riding has its advantages. I, in common with a fair number, ride daily to and from my work no matter what the weather may be: rain, snow, wind, or hail, cycling affords the pleasantest means of crossing London. Instead of waiting in draughty railway stations, of catching cold outside or being stewed inside omnibuses, or of being smoked in the Underground Railway, we, the regular cyclists, look forward to our daily ride with pleasure, for the healthy exercise, the continuous necessity of watching the traffic and avoiding ever-approaching danger, form between them a relief from mental worry or business anxiety which we alone can appreciate.

Of the dangers of the streets I have little to say: the regulation of the traffic by the police, and the consideration of drivers, though they are not in general too fond of us, make danger in the quarter from which it might be expected very remote. Our chief difficulty is due to the irregular and utterly unaccountable movements of pedestrians, whose carelessness keeps us in a continual state of anxiety.

There remains one point of the utmost importance on which I would say a few words, I refer to the effect of cycling on our general health. About a year ago there appeared in the *Lancet* an article condemning in no

[1] Lecture delivered by C. Vernon Boys, A.R.S.M., at the Royal Institution, Ma[illegible] 7.

measured terms the evils likely to result from the development of this new craze, in which, as far as I remember, it was stated that we are now sowing the seeds of a series of new diseases, the symptoms of which will only appear possibly in years to come. I would not for a moment question the accuracy of opinion held by any professional man; whether this is or is not the case I cannot tell; however, I may mention that the only symptoms which I have so far discovered in myself are an improved appetite, increased weight, and a general robustness to which I was formerly a perfect stranger. Having, I trust, succeeded in showing that the advantages offered to riders are sufficient to account for the rapid development of cycling, that it is in fact no mere temporary craze, I shall now proceed to consider the theory and construction of the various machines at present known.

From the hobby horse to the bone-shaker, and from the bone-shaker to the bicycle, the steps are so simple and obvious that it is quite unnecessary for me to trace them. It is also needless for me to describe the modern bicycle: every one must be familiar with it, every one must have seen the ridiculous zigzag of the beginner, and have admired the graceful gliding of an accomplished rider. Of the theory of the balance little need be said; anything supported in a mere line, in unstable equilibrium as it is called, must fall one way or the other. The machine and rider would of necessity capsize if some action of recovery were not possible. To whichever side the machine shows any inclination, to that side the rider instinctively directs it. By this means the tendency to fall to one side is balanced by the property of the rider to continue moving in a straight line, and so to go over on the other side. This action of recovery is always overdone, so that a second turn in the opposite direction must follow. Hence the extraordinary path traced by the beginner. Even with the most skilful rider, though he appears to travel in a perfectly straight line, a slightly sinuous course is essential, as the highly characteristic track left on the road indicates. If anything should happen to check this slightly serpentine motion, as, for instance, occurs when the driving-wheel drops in the groove of a tram-line, the balance at once becomes impossible, and the rider is compelled to dismount.

The extraordinary stability of the bicycle at a high speed depends largely on the gyroscopic action of the wheels. On the table is a top supported in a ring which is free to move how it pleases. So long as the top is spinning the ring is as rigid as a block; on stopping it, the freedom of the support is at once apparent.

It is a marvel to many how anything so light, how anything so delicate, can carry the weight or can travel at the speed so common without utterly collapsing. The wheels especially attract attention. In a hoop no one part can be pushed in unless some other part can go out. A bicycle wheel is a hoop in which every part is prevented from going out by the tension of the spokes. To give the wheel lateral stability, the spokes are carried not to the centre, but to the two ends of the hub, thus lying on two cones. Such a wheel is abundantly strong in its own plane: it can withstand the jars and shocks of a bad road without a groan, but once subject it to serious side strain, such as I can with ease put upon it with a jerk of my wrists, and the wheel will crumple up like an umbrella in a storm. Till this year there has been no change in the principle of construction, though in detail many improvements have been carried out and are largely adopted. By the use of hollow rims a stiffer and lighter wheel can be made; thick-ended, crossed and laced spokes are employed, and other details modified. Essentially, however, the "spider" wheel as a structure is the same as it was when first introduced. Suddenly two radical changes are presented to us. Mr. Otto, whose great work I shall describe in its proper place, has devised a wheel on a new system, in which the spokes that form the structure lie in the plane of the rim, in which position they are best able to withstand direct shocks. Such a wheel would be unstable, but requires very little to keep it true. Delicate spokes, not screwed up very tight, are therefore placed on either side, so that a side-strain is met by the whole strength of the spokes on one side, which are not as hitherto weakened by the pull of the spokes on the other. On this system much narrower wheels can be made than was possible before. The other change, due to the same inventor, is still more striking. He has found, contrary to the opinion of every one, that wheels, either of his narrow type or of the usual form, can be made and will remain true when the spokes are made elastic by being bent into a wavy or slightly spiral form. If only these wheels will stand the test of time—and I see no reason why they should not—one of the greatest discomforts and possible causes of injury from which the cyclist suffers—the vibration and jolting due to a bad road—will have been removed.

The bearings in a bicycle are perhaps more to be admired than any single part. Instead of allowing the axle to slide round in its bearings, hard steel rollers or balls are introduced, so that the parts which are pressed together roll over and do not slide upon one another. Any one who has trodden on a roller or a marble must have found in a possibly unpleasant manner the great difference between rolling and sliding friction. I can now give for the first time the result of an experiment only completed this morning, which shows the extraordinary perfection to which this class of work has attained. I have observed how much a new set of balls which I obtained direct from the well-known maker, Mr. Bown, has lost in weight in travelling 1000 miles in my machine. Every 200 miles I cleaned and weighed the balls with all the care and accuracy that the resources of a physical laboratory will permit. The set of twelve, when new, weighed 25·80400 grm. After 1000 miles, they weighed 25·80088 grm., the loss being 3·12 mgrm., which is equal to 1/20·8 grain, that is, in running 1000 miles, each ball lost 1/250 grain. This corresponds to a wear of only 1/158,000 inch off the surface. At this rate of wear—3·12 mgrm. per 1000 miles—the balls would lose only 1/34·3 of their weight in travelling as far as from here to the moon.

The twelve balls, after the first 200 miles, each weighed in grammes as follows. The loss of each in running 600 miles is appended:—

Weight in grm.		Loss in 600 miles	Weight in grm.		Loss in 600 miles
2·16605	...	·00050	2·14725	...	·00020
2·16180	...	·00025	2·14725	..	·00020
2·15550	...	·00035	2·14700	...	·00020
2·15480	...	·00015	2·14500	...	·00020
2·15000	...	·00015	2·14280	...	·00025
2·14730	...	·00015	2·13875	...	·00020

I did not weigh each ball on the first and last occasion. However, the wonderfully uniform wear in the intermediate 600 miles speaks well for the equal hardness of the balls.

The wear of the dozen during each journey of 200 miles was as follows:—

Miles		Wear in grm.
0—200	...	·00055
200—400	...	·00070
400—600	...	·00055
600—800	...	·00075
800—1000	...	·00062

I have given the results of these experiments at length, for I do not think that accurate and systematic observations of the kind have been made before.

We may consider, then, that the balls are practically indestructible. Knowing this, Mr. Trigwell has applied the ball-bearing to the construction of the "head" of the bicycle, not so much with the view of diminishing the friction there, but of preventing wear in a place where any shake is highly objectionable. One of his ball-heads is on the table.

The frame of the bicycle, consisting merely of the fork and backbone, is made of thin steel tube, the type of all that is light and strong. Indiarubber, besides being used for the tyres of all machines, has been worked into every part of the structure to diminish, so far as is possible, that perpetual and wearying vibration of which all bicyclists so bitterly complain. The number of improvements in every detail is so great that any attempt to enumerate them is out of the question. Suffice it to say that the modern bicycle is the perfection of all that is perfect; as a machine for racing, as a machine for hurrying over good and level roads nothing can approach it. Unfortunately, however, there is ever present danger, and danger of the most objectionable sort, for the most skilful rider knows too well that should he strike a stone of even an ordinary size he must expect to be pitched over the handles, and come with a crash to the ground. It is true that in general no harm is done, but such a fall may bring any one to a sudden and horrible end.

Many have attempted, while still retaining the advantages of the bicycle, to make these involuntary headers impossible by modifying in some way its construction. One of the earliest attempts in this direction is well named the "Extraordinary." On it the rider is placed much further behind the main wheel, but can still employ his weight to advantage, as the treadles are placed below him and are connected by levers with the cranks. In another safety bicycle a third wheel is carried in front, just above the ground, so as to resist at once any tendency to tilt forward. In another type much smaller wheels are employed, and the feet, now nearer the ground, are connected with the cranks, by levers in the "Facile," or by a hanging pedal in the "Sun and Planet." There is a bicycle with two large wheels—one in front of the other—which two can ride, which should be both safe and rapid.

By far the most curious and utterly unintelligible of all machines of the bicycle type is Mr. Burstow's "Centre-cycle." So incomprehensible did this machine seem to me that I took the trouble one afternoon last week to ride to Horsham to see it in its native place. A careful examination has convinced me that it is not only correct in its design, but that it is in many respects the most wonderful cycle at present made. There is on the table a model Plympton skate. When this is level, it runs straight; when inclined either way, it wheels around in a manner that was so familiar a few years ago. The four wheels of the Centre-cycle are a counterpart of the four wheels of the skate; when the frame leans either way, they turn in an appropriate manner, or, conversely, when they turn, the machine leans in the proper direction. It might be thought that a thing with five wheels is more nearly allied to a tricycle than to a bicycle; but this is not so, for the Centre-cycle, when ridden skilfully, has rarely more than one wheel on the ground; the leaning to one side in turning a corner (tricycles unfortunately must remain upright), and the general action is essentially that of a bicycle. The great peculiarity of this machine is the power that the rider possesses of raising or lowering any wheel he likes. Now that I have mounted it you will see that I can rest on one, three, four, or five wheels as I please. In consequence of this power of lifting the wheels, a rider can travel over an umbrella without touching it, lifting the wheels as they approach, and dropping them as they pass, after the manner of a caterpillar.

Whatever difficulty I may have had in doing justice to the bicycle, the corresponding difficulty in the case of tricycles is far greater. The number of makers and the variety of their work is so great that it would be sheer madness on my part to attempt to describe all that has been done. Those who wish to see the great variety of detail which chiefly constitutes the difference between one make and another must go to one of the exhibitions of these things which are now so common.

All I shall attempt will be an explanation of the leading principles which are involved in the design of a tricycle. For this purpose it will be necessary for me to mention occasionally some particular machine; but in justice to the hundreds to which I cannot even refer, I wish it to be understood that those named, though typical, are not of necessity better than any other.

Till a few years ago the bicycle was the only velocipede which was worthy of the name. Inventive genius and mechanical skill have given rise to a series of machines on three wheels on which any one can at once sit at ease, and which require but little skill in their management. Men who do not care to risk their necks at the giddy height of the bicyclist, ladies to whom the ordinary bicycle presents difficults which they cannot well surmount, each find in the tricycle the means of obtaining healthy and pleasant exercise, and of enjoying to a certain extent the advantages which the bicycle affords. Thanks to the perfection of the modern tricycle, cycling has become one of the most popular institutions of the day.

It is first necessary to know what combinations of three wheels will, and what will not, roll freely round a curve. The few possible arrangements determine the general forms which a tricycle can take. A wheel can only travel in its own direction; no side motion is possible without the application of considerable force, entailing strain and friction of a most injurious kind. In any combination, then, of three wheels, each must be able, in spite of the united action of the other two, to move in its own direction. There is on the table a model in which the three wheels can take every possible position. To begin with, two large ones are placed opposite to, but independent of, one another, and parallel, and a small one, parallel to the others, is mounted between them at one end. This arrangement rolls along in a straight line with perfect freedom; on twisting the plane of the third wheel it is also free to roll round a curve whether the little wheel is before or behind. If I shift the position of one of the large wheels so that, though still parallel to, it is no longer opposite, the other, then, though they can freely move in a straight line, they can by no possibility be induced to roll round a curve. It is clear, then, that two wheels that are parallel cannot be employed in a tricycle unless they are opposite one another. The only class of people who frequently appear to be familiar with this fact are nursemaids, who always tip up the front of a perambulator in turning a corner.

If one wheel is in front of and another behind a third, the combination can only roll round a curve when the front and rear wheel are turned to proportionate extents in opposite directions. The model is so arranged now; if either of the little wheels is not turned to exactly the right amount, they can no longer roll, they can only be dragged round a curve. It is not sufficient that two parallel wheels should be opposite one another, they must be able to turn at different speeds. I have now the two large wheels keyed on the same axle, so that they must of necessity turn together; this combination is ready enough to go straight, but no amount of encouragement by the steering wheel will induce it to go in any other direction.

Bearing these facts in mind, it will not be difficult to follow the development of the tricycle. It would seem impossible in the first arrangement (that with two wheels opposite one another, and a third, or steering wheel, before or behind between them) to drive both sides, for the wheels must be able to turn at different speeds; let therefore one be free to go as it pleases, if the other only is driven, we have at once a very common form of tricycle, in which one wheel drives, one steers, and one is idle.

Machines of this class have many defects. The feeble steering power, combined with their unsymmetrical driving, render them altogether untrustworthy. If any power is applied to the driver, which can only have its share of the weight upon it, it slips on the ground; if the machine is quickly stopped, owing to the small weight on the steering wheel, it is apt to swing round and upset; nevertheless, those who are content with pottering about on our wood pavement and gravel roads find this class of machine answer their purpose, and owing to their cheapness and simplicity they do not care to get a better.

The second arrangement of the model, in which riders must have recognised the Coventry Rotary, is free from most of the defects of the form just described; there is more weight on the driver, but not enough to prevent its being made to slip round; there are two steering wheels a long way apart, with plenty of weight upon them, so that the guiding power in this type of tricycle is all that can be desired.

Let me now return to the first arrangement, in which two parallel wheels are opposite one another. If by any possibility both wheels could be driven, and yet be free to go at different speeds, then there being so large a weight on the drivers they could not be made to slip; the driving being symmetrical, most of the twisting strain would be taken off the steering wheel, and still the machine would be capable of rolling round a curve with perfect freedom.

All the methods of solving the problem of double driving come under two heads, one depending on the action of a clutch and the other on differential or balance gear.

The clutch action being the simplest, I shall describe that first. In going round a corner the inner wheel must lag behind, or the outer wheel must run ahead of the other; as either wheel may be inner or outer according to the direction of the curve, each must be able to lag behind or each must be able to run ahead. If both were able to lag behind, the machine could not be driven forward, and it would be of little use; if both were able to run ahead, the machine could not be driven backwards—a matter of small importance. There is on the table a large working model, showing how a four-sided wheel is free to revolve in a ring, but is instantly seized when turned the other way, owing to a jambing action on one or more of four rollers. The four-sided wheel then can be employed to drive the ring one way but not the other. One of these "clutches" or "friction grips" is placed at each end of the crank shaft in the "Cheylesmore" tricycle, and a chain round the ring of each drives the corresponding wheel. The machine named is a rear-steerer; the clutch is also employed in some front-steerers.

The other method of double driving depends on the use of the well-known gear of three bevel wheels or of some equivalent mechanism. If the axle of the middle of the three wheels is turned round the common axle of the other two, the applied force is divided between those two wheels, yet the pair are free to move relatively. Let then the chain drive a wheel carrying the middle bevel, and let the side bevels be connected with the two drivers. Whatever happens, the power of the rider will be equally divided between them, yet the machine will be free to roll round a curve.

There are a great number of devices which are exactly equivalent to this the simplest of all, which is known as Starley's gear. There is on the table a beautiful model of the gear used in the Sparkbrook tricycle, which has been lent me by the makers of that machine, Bown's differential gear, and some others; but time will not allow me to describe them. There is one gear, however, which presents many peculiarities, which I have devised, and which may be of interest. A large working model is on the table. Between the conical edges of two wheels which are connected to the drivers lie a series of balls, outside which is a ring with sloping recesses. If the ring be turned by a chain or otherwise, the balls jamb in the recesses as the rollers do in the clutch gear. Nevertheless they are free to turn about a radial axis, and so allow the two driven cone wheels independent motion. The bursting strain on the ring and the side thrust on the cones acting on rolling balls balance one another. With this gear the rider can cause the balls to jamb one way or both ways, and so have or avoid the "free pedal" as he pleases.

In almost all good designs of front-steering tricycles the power applied to the cranks is transmitted to a differential gear by a chain. The crank and connecting rod have also been used to transmit the power, but then the clutch is necessary.

There is, however, another type of tricycle, in which the use of cranks is avoided, among which may be mentioned the "Omnicycle," the "Merlin," and that highly ingenious machine, the rowing tricycle. On the table there is the Omnicycle gear. In all these the power is applied direct to the circumference of a wheel or sector, and so dead points are avoided, which is a point in their favour when meeting with much resistance. On the other hand, the sudden starting and stopping of the feet in the two former machines and of the body in the latter make this type utterly unsuitable for obtaining anything more than a moderate speed. In the Omnicycle ingenious expanding drums are employed, so that the power may be applied with different degrees of leverage according to circumstances.

There remains one type of tricycle which, for rapid running, surpasses many: I refer to what is known as the Humber pattern. So excellent is this form in this respect that the leading manufacturers have, by turning out machines on the same lines, paid the original makers a compliment which is not altogether appreciated. This pattern departs less from the ordinary bicycle than any other; it is one, in fact, in which, instead of one, there are two great wheels, giving width to the machine, between which the power is divided by the usual differential gear.

Having spoken of the differential gear and the clutch, I had better show the comparative advantages and disadvantages of the two methods of double driving. With the differential gear the same force is always applied to each wheel, so in turning a corner the outer one, which travels furthest, has most work expended upon it (work = force × distance). In this respect the differential gear is superior. On the other hand, when one wheel meets with much resistance from mud or stones, and the other with hardly any, the latter has still half the strength of the rider spent upon it, which is clearly a mistake. With a clutch-driven machine running straight, the wheels take such a share of the rider's power as is proportional to the resistance they individually meet. When the machine is describing a curve, that is generally, only the inner wheel is driven, and the machine is for the time only a single driver, with the driver on the wrong side.

I must now describe some devices which are attracting much attention at the present time, the speed and power gears. Let us suppose there are two machines with wheels of different sizes, but in other respects alike. Then each turn will take the larger wheeled machine further than the smaller. In going up a hill the larger wheel will take its machine up a greater height than the other in one revolution, which involves more work and therefore more strength. If on the large wheel the chain pulley were increased in size, then for the same speed of the treadles it would not turn so quickly, it would not take the machine so far up the hill as before, it would in fact be equivalent to a smaller wheel, so that less strength than before would be necessary. This diminution of speed, though of great advantage when climbing a hill, is the reverse on the level, for then very rapid pedalling would be necessary to maintain even a moderate speed. To obtain the advantage of high wheels or high gearing on the level and at the same time low wheels or low gearing on the hills, some highly ingenious devices are employed. On the table is a well-known one of these, the "Crypto-dynamic," which by a simple movement changes the relative speed of wheel and treadle Time will not permit me to describe the details of this arrangement, but it contains an epicyclic gear which is or is not in action according as the rider desires power or speed. There are several other devices having the same object, some depending on an epicyclic gear in a pulley, others on the use of two chains, only one of which is active at a time. These arrangements have the further advantage of enabling the rider to disconnect the treadles from the wheels whenever he pleases.

Tricycles on which two, three, or a whole family can go out for a ride together, involve few new principles, and I shall not for this reason have a word to say about them.

There remains one machine forming a class by itself, more distinct from all others than they are from one another. It is not a bicycle in the ordinary sense of the word; it is not a tricycle, for it has only two wheels. This machine is, from a scientific and therefore from your point of view, more to be admired than any other. It is called, after its inventor, the "Otto." The Otto bicycle and the Otto gas-engine will be lasting memorials to the ingenuity of the brothers who invented them.

No machine appears so simple, but is so difficult to understand as this. Tricyclists who have been in the habit of managing any machine at once, are surprised to find in this something which is utterly beyond them. They cannot sit upon it for an instant, for so soon as they are let alone it politely turns them off. When at length, after much coaxing, they can induce it to let them remain upon it, they find it goes the way they do not want. Riding the Otto, like any other accomplishment, must be learnt. Some seem at home on it in half an hour, others take a week or more. It is not surprising that that quick perception, in which ladies have so much the advantage of men, enables them to quickly overcome the apparently insurmountable difficulties which this machine presents to the beginner.

The rider when seated is above the axle of two large equal wheels; being then apparently in unstable equilibrium, he would of necessity fall forwards or backwards if some movement of recovery were not possible. The Otto rider maintains his balance in the same way as the pedestrian. If he is too far forward, pressure on the front foot will push him back; if too backward in position, pressure on the rear foot will urge him forward. That this must be so is clear, for, whatever turning power he applies to the wheels, action and reaction being equal and opposite, they will produce an equal turning effect upon him. The steering of this machine is quite peculiar. In the ordinary way both wheels are driven by steel bands at the same speed; so long as this is the case, the Otto of necessity runs straight ahead. When the rider desires to turn, he loosens one of the bands, which causes the corresponding wheel to be free; if then he touches it with the brake or drives the other wheel on, it will lag behind, and the machine will turn. It is even possible to make one wheel go forwards and one backwards at the same time, when the machine will spin like a top within a circle a yard in diameter.

There being no third wheel the whole weight is on the drivers, the whole weight is on the steerers; the frame, which is free to swing, compels the rider to take that position which is most advantageous, making him upright when climbing a hill, and comfortably seated when on the level. Owing to a curious oscillation of the frame which occurs in hill climbing, the dead points are eliminated, so the rider need not waste his strength at a position where labour is of no avail.

Though it has been impossible for me to do more than indicate in the most imperfect manner how numerous and beautiful are the principles and devices employed in the construction of cycles, I trust I have disappointed those who were shocked and horrified that so trivial a subject should be treated seriously in this Institution.

DANGERS FROM FLIES

IN a note communicated to the *Gazzetta degli Ospitali* for August 1883, and republished in the current number of the *Archives Italiennes de Biologie* (tome iv. fasc. ii.), Dr. B. Grassi calls attention to the fact that flies are winged agents in the diffusion of infectious maladies, epidemics, and even parasitic diseases. During the summer season, when flies occur in swarms, it seems impossible to prevent them from settling on any and every object. In these countries, though sometimes troublesome, they are scarcely ever so numerous as in the warmer climates of the Continent, and even in these latter they are not often to be found such plagues as they are in Egypt; but in all these countries alike they may be seen to alight on all moist substances without distinction. It may be the expectorations of a phthisical or the ejecta of a typhoid patient that have last attracted these inquiring diptera; but, irrespective of the material they may have been investigating, their next visit may be to the moist lips or eyes of a human being. Their feet, their mouth, and the pectoral portion of their bodies will have all come in contact with the infective mass, and will all in turn be more or less cleansed of it by the moisture of the freshly visited mucous membranes. But this danger has already been known and recognised, and it seems scarcely doubtful that in Egypt ophthalmia is constantly carried to the eyes of the infant natives by such winged visitors. Dr. Grassi calls our attention to even greater danger, and this from the ejecta of the flies themselves. Every housekeeper knows how the bright surface of a mirror or the gilt moulding of a picture-frame can be covered over with the little flecks left by these flies,—no English words occur to us to translate therewith the phrase "les méfaits des mouches." The following experiences of Dr. Grassi relate to these:—At Rovellasca, between his laboratory, which is on a first floor, and his kitchen, which is on the ground floor, there lies a courtyard, with a distance between the windows of the two rooms of about ten metres. On a plate on the table of his laboratory he placed a large number of the eggs of a human parasite (Trichocephalus). After a few hours he found, on some white sheets of paper hanging in the kitchen, the well-known spots produced by the excreta of the flies, and on a microscopical examination of these spots, several eggs of the parasite were found in them. Some flies coming into the kitchen were now caught, and their intestinal tract was found quite filled with an enormous mass of fœcal matter, in which the presence of eggs of Trichocephali were detected. As it was practically impossible to keep all alimentary substances from contact with these flies, it follows that the chances of Dr. Grassi and his family being infected with Trichocephali were very great. As a matter of fact, the experiment was tried with non-segmented eggs of this worm. Another experiment was in the same direction Dr. Grassi took the ripe segments of a *Tænia solium* (which had been in spirits of wine) and broke them up in water, so that a great number of the tapeworm's eggs remained suspended in the fluid. The flies came to the mixture, attracted by the sugar, and in about half an hour the ova of the tapeworms were to be found in their intestines and in the spots. Had these eggs been in a recent and living state, they would doubtless have been just as easily transported. To those who care to try these experiments, it is suggested that lycopod powder mixed with sugar and water is a good material, as the lycopod spores are easily detected.

It is self-evident that if the mouth-apparatus of the fly will admit of the introduction of such objects as have been above noted, that there will be no difficulty in its admitting scores of the spores of many parasitic fungi, and above all of those belonging to the Schizomycetes, the possible cause of so much disease. Already has Dr. Grassi detected in fly excrement the spores of *Oidium lactis*, and the spores of a Botrytis, this latter taken from the bodies of silkworms dead of muscardine.

There arises, of course, the question of how far the active digestion in the intestines of the flies may not destroy the vitality of germs or spores thus taken in, but it would seem probable that in many instances the larger bodies swallowed may not serve as objects for assimilation, but may be got rid of as foreign bodies, and it will be borne in mind that the flies themselves fall victims to the growth of a parasitic fungus (*Empusa muscæ*, Cohn), which is probably taken first into their own stomachs.

Dr. Grassi promises to publish the results of his experiments in fuller detail. Judging of their interest by this abstract, they will well deserve to be followed up, and though in these countries our modern sanitary arrangements do not tend to the development of such immense swarms of flies as are so constantly to be met with in Italy, still the dangers to be apprehended from them there are possibly, though in a less degree, to be encountered here, and the investigation of the fact is easy to any one possessing a fairly average microscope and the power of catching a fly. E. P. W.

EDINBURGH MARINE STATION

AT the half-yearly meeting of the Scottish Meteorological Society held on Monday last, Mr. Murray submitted a statement on the work done by the Fisheries Committee. This included preliminary reports from the Rev. A. M. Norman on the invertebrate fauna of the Scottish fresh-water lochs; Prof. Herdman's report of his researches connected with the fisheries of Loch Fyne, and similar reports from Messrs. Hoyle and Beddard from Peterhead and Eyemouth. After reading several interesting extracts from these reports, which will shortly appear in the Society's *Journal*, he then stated that the marine station at Granton would be formally opened for scientific work about the 10th of next month by Prof. Haeckel of Jena. The floating laboratory, which has been named the *Ark*, was successfully launched on Saturday last, and it has accommodation for seven biologists. The steam yacht of thirty tons, which is to be called the *Medusa*, is to be launched on the 26th inst. at Glasgow, and will be at the station ten days thereafter.

The Station will then be possessed of the three most important requisites, viz. the floating laboratory, with abundance of sea water; a steam vessel fitted with all modern appliances for sounding, dredging, and other biological and physical investigations; and lastly, a most complete library in marine biology and physics. Mr. J. T. Cunningham, B.A. Oxon., Fellow of University College, Oxford, has been appointed Naturalist in charge of the Station; Mr. Hugh Robert Mill, B.Sc., who holds a Research Fellowship in the University of Edinburgh, is to carry on physical and meteorological investigations under the superintendence of Prof. Tait; Mr. Alexander Turbyne, fisherman, Keeper; Mr. William Bell, late Royal Navy, Engineer; and it is hoped the arrangements will shortly be made that will enable a botanist and geologist to carry on systematic work at the Station. The captain of the yacht will be appointed next week.

British and foreign naturalists are invited to make use of the resources of the Station free of charge, and those who desire to do so are requested to communicate with Mr. John Murray, *Challenger* Office, Edinburgh, stating the kind of work they propose to undertake and the length of time they will probably remain. Efforts are now being made to provide living accommodation for the naturalists and others who may be working at the Station. Immediately after the meeting Mr. Murray received anonymously a donation of 100*l.* towards the further equipment of the Station. We wish every success to this undertaking, and, from the liberal spirit shown in placing at the service of scientific men the unique facilities afforded by the Station for the prosecution of inquiries of the highest practical importance, we have every confidence that the public will not be slow in seeing that the funds required for its efficient maintenance are forthcoming.

THE DEEP-SEA FISHES OF THE "TALISMAN"

AMONG the many wonderful animal forms collected during the voyage of the *Talisman* none surpass the fishes in interest. In the exhibition, now open at the Jardin des Plantes, Paris, of the various specimens collected during this voyage, the collection of fishes holds a chief place. During the cruises of the *Travailleur*, owing to the apparatus employed, the capture of a fish was a rare event, but by the employment of a kind of drag-net on board the *Talisman* the number both of species and individuals taken was quite surprising. Once, on July 29, in 16° 52′ N. lat. and 27° 50′ W. long., in one haul of the drag-net no less than 1031 fishes were taken from a depth of 450 metres. The chief surface fish noted in M. Filhol's very interesting papers, which are in course of publication in our French contemporary *La Nature* (to the editor of which journal we are indebted for the illustrations accompanying this notice), were the well-known shark (*Charcharias glaucus*), very common between the Senegal coast and the Cape de Verde Islands; its strange attendant fish, the so-called pilot fish (*Naucrates ductor*), and the very curious and odd-looking fish of the Sargassum Sea, *Antennarius marmoratus*. It is noted that not only were the pilot fishes never molested by the sharks but that they constantly swam around them, sometimes even they were seen placing themselves against the shark's sides between their pectoral fins. Many observations were made on the strange Antennarius, the colour of whose body so closely approaches to that of the alga amidst which it lives that it enables these fish to approach almost unseen, and so quite easily take their prey. It is not, however, altogether unworthy of remark that this prey, consisting for the most part of small crustacea and mollusks, is also of the same general shade of colour as the mass of the weed, so that the assuming of this uniform dull tinge of colour must mean a heightened danger to some of these forms of life.

The great interest, however, of the fish captures of the *Talisman* centres in the remarkable forms taken from the depths of the sea, which were both considerable in the number of individuals and in the newness of the forms. The question of whether certain fish inhabit certain zones of depths was closely considered, and is answered in the affirmative. These zones are of very considerable depth, varying from 600 to over 3650 metres, and in bringing up specimens from such areas of great pressure these suffer immensely through the phenomena caused by the rapid decompression of the air, the more remarkable effects being dilatation of the swim bladder, the eyes being squeezed out of their orbits, and the scales clothing the body are shed. In some cases even the fish's body has become smashed into pieces. Notwithstanding all these phenomena, the area in depth of the distribution of many of the deep-sea fish is very considerable. Thus *Alepocephalus rostratus* is met with between a depth of 868 and that of 3650 metres; *Scopelus maderensis*, between

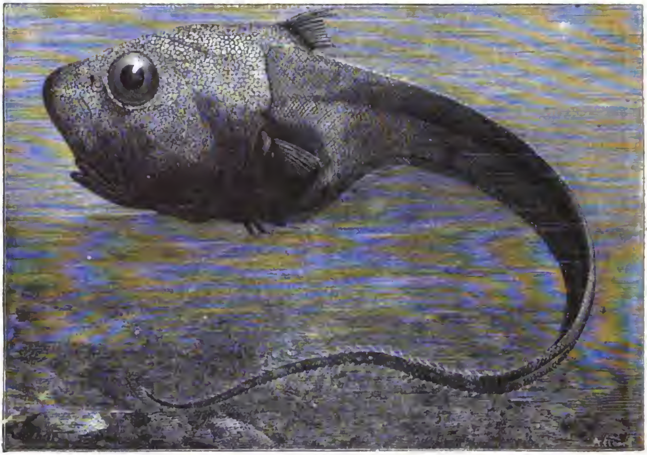


Fig. 1.—*Macrurus globiceps*, Vaill.

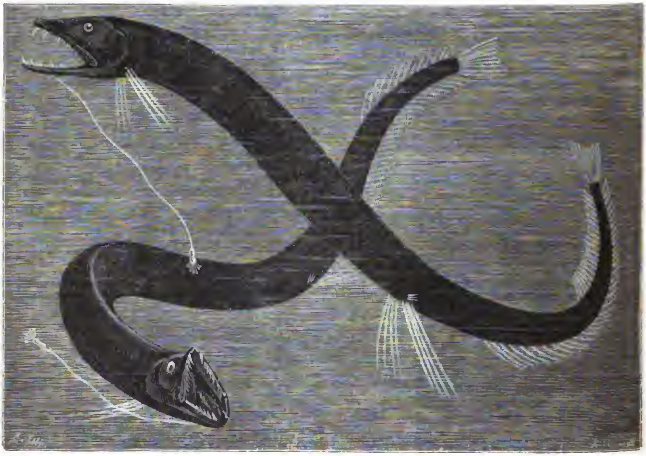


Fig. 2.—*Eustomias obscurus*, Vaill.

depths of 1090 and 3655 metres; *Lepioderma macrops*, between 1153 and 3655 metres; and *Macrurus affinis*, between 590 and 2220 metres. The explanation would seem to be not only that the organisation of these fishes is such as enables them to support the enormous pressures at the greater depths of the ocean, but that in the course of their movements of ascent and descent they proceed very slowly so as gradually to get accustomed to the alterations in pressure. These fishes are all flesh eaters, with well developed dental systems; the absence of light prevents the growth of marine algæ in these depths, and as a general rule all the fish found below 150 metres are of necessity predatory. These deep-sea fishes, as Dr. Günther reminds us, do not belong to any peculiar order, but are chiefly modified forms of surface types; some of these modifications being no doubt very extreme, but serving as indications not only of the struggle for existence, but also of the plasticness of the forms to adapt themselves to the extreme conditions under which they live. The most remarkable phenomena in connection with their deep-sea life is doubtless the tremendous pressure which has to be borne. No one seems to doubt but that these deep-sea forms live as active a life as surface forms, indeed their very appearance seems to indicate a swiftness and energy of movement not to be surpassed by surface swimmers; and we may believe that the abyssal pressure has a great deal to do with keeping their feebly calcareous bones and delicate muscular system compact and in a condition for effective use. The placid state of the water at these depths must also be borne in mind—no storms affect them, and the extraordinary attenuation of some organs may be directly ascribed to this phenomenon. Thus *Macrurus globiceps* (Fig. 1), which forms one of a family of deep-sea Ganoids, known as living at depths of from 600 to 2200 metres, and occurring in considerable variety and great numbers over all our oceans, is a new species, described by M. L. Vaillant as found at a depth of between 1500 and 3000 metres. Its body, globular in front, will be seen to be very greatly attenuated behind.

In some of the deep-sea fishes peculiar organs, unknown for the most part among surface fishes, are to be found; these are sometimes "more or less numerous, round, showing mother-of-pearl coloured bodies embedded in the skin"; in some fish these are to be met with on the head, or near the eyes, or along the sides and back. Dr. Günther informs us that of these strange bodies the following hypotheses are possible: (1) all these different organs are accessory eyes; (2) only those having a lens-like body in their interior are sensory, those with gland-like structure are not sensory but are phosphorescent; and (3) all are producers of light. Many serious objections can be urged against the first view. Some of the fish with immense eyes have these bodies, others without eyes want them, while as to glandular bodies being sense organs this is not yet scientifically realisable. One seems therefore justified in adopting the middle hypothesis, and though on first thought it seems strange that fish with large eyes should have accessory eyes, yet Dr. Günther's supposition may be the true one—that there are light producers behind the lenses, and that these latter may act the part of "bull's-eyes" in a lantern. This form of "light organ" might constitute a very deadly trap for prey, one moment shining it might attract the curiosity of some simple fish, then extinguished the simple fish would fall an easy prey.

Long filamentous organs are to be met with showing apparently a brilliant type of phosphorescence. Among the many curious forms of development of these tactile organs to be met with, one of the most singular is that to be seen on a fish referred by M. L. Vaillant to a new genus and species found at a depth of 2700 metres, and represented in the annexed woodcut (Fig. 2). In this form (*Eustomias obscurus*) the tactile organ takes the appearance of a long filament, which is placed underneath the lower jaw, and which ends in an inflated and rayed knob-like phosphorescent mass.

Another peculiarity now well known in deep-sea fishes is the enormous development of the mouth and stomach of these fish. In the genus Melanocetus and in Chiasmodus the capacity of the stomach is such that it can contain prey twice the size of the fish which swallowed it, and perhaps the largest gape of jaws known is that of *Eurypharynx pelecanoides*. The greatest depth at which a fish was taken during the cruise of the *Talisman* was 4255 metres; the fish was *Bythytes crassus*: but it will be remembered that during the *Challenger* Expedition a specimen of *Bathyopis ferox* was taken at a depth of 5000 metres.

We hope again to have the opportunity of referring to other of the deep-sea forms taken by the *Talisman*.

ANCIENT JAPAN[1]

THIS volume contains a literal translation of the oldest Japanese book in existence, accompanied by introductions, notes, and appendices, and is beyond doubt the most learned and remarkable work which European scholarship has yet produced from Japan. Of the many important propositions on the early history of the Japanese race established by it we shall have to speak later on; but of the work itself it may be said now that the translator claims it to be "the earliest authentic connected literary product of that large division of the human race which has been variously denominated Turanian, Scythian, and Altaïc, and it even precedes by at least a century the most ancient extant literary compositions of non-Aryan India." Indeed more than this may be said; for if the claim of Accadian to be an Altaïc language be not substantiated, not only the archaic literature of Japan (to which the *Kojiki* belongs), but also its classical literature, precedes by several centuries the earliest extant documents of any other Altaïc tongue. This alone would render the work an object of much interest, but it derives additional importance from its contents as well as from the period at which it was written. It is the earliest record of the language, customs, mythology, and history of ancient Japan, and soon after the date of its compilation, as Mr. Chamberlain points out, most of the salient features of distinctive Japanese nationality were buried under a superincumbent mass of Chinese culture; it is therefore to these "Records" and one or two other ancient works that the investigator must look if he would not be misled at every step into attributing originality to modern customs and ideas which have simply been borrowed wholesale from the neighbouring continent. It appears beyond doubt that, though the work existed in tradition for some years before that period, it was not committed to writing till the year 712 of our era, and from it a picture can be formed of the Japanese of that remote epoch. It is to the sections devoted by the translator to the manners and customs of the early Japanese and their political and social ideas that we propose to direct special attention now.

As pictured, then, in these "Records," the Japanese of the mythical era had emerged from the Stone Age and from the savage state. They were acquainted with the use of iron for weapons of the chase, such as arrows, swords, knives; but there is a curious silence about ordinary implements, such as axes and saws, though they had the fire-drill, pestle and mortar, wedge, and shuttle for weaving. The art of sailing appears to have been quite unknown, but boats for use on the inland lakes are mentioned. As would naturally be expected, the population was scattered along the seashore and on the banks

[1] *Transactions of the Asiatic Society of Japan*, vol. x. Supplement. Translation of the "Kojiki" or "Records of Ancient Matters." By Basil Hall Chamberlain. Yokohama, 1883.

of the larger rivers, while house and temple building are the subjects of frequent reference. The Japanese of the present day appear to have inherited their habits of great personal cleanliness from their early forefathers, for we read more than once of bathing, and bathing-women are said to have been specially attached to an imperial infant. Among the religious practices, too, was that of lustration. A custom of the early Japanese, which is still found existing in the island of Hachijô, off the east coast, was that of a woman before childbirth erecting with her own hands a one-roomed hut without windows, into which she was expected to retire and give birth to her child. In Hachijô formerly a woman was driven out from the village under these circumstances to a hut on the mountain side, which she was not permitted to leave under any circumstances whatever before the birth of the infant; but in later times the custom was so far relaxed that the hut was allowed to be put up within the homestead. Each sovereign on his accession, also, had a new palace erected for him; but these so-called "palaces" were nothing more than ordinary wood huts. Although cave-dwellers are referred to in the "Records," it appears that at the date to which the work refers they had quite passed away. The principal food was fish and the flesh of wild animals. Rice is mentioned in such a manner that there can be no doubt of its cultivation from immemorial antiquity; *saké*, the native rice-beer, is also referred to. In dress the mythical Japanese appear to have reached a high level, and we find many garments specialised, such as skirts, trousers, girdles, veils, and hats; while it is interesting to note that although jewellery forms no part of the attire of the modern Japanese, their ancestors adorned themselves with necklaces, bracelets, and other articles formed from stones considered precious. They appear to have had a tolerably extensive acquaintance with the animal and vegetable kingdoms, but the tea-plant was evidently not yet introduced among them. Iron, which was used from time immemorial, was the only metal they knew; and their acquaintance with colours was confined to black, blue (including green), red, white, and piebald (of horses). In the Japan of to-day the different degrees of relationship are distinguished in much the same way as in Europe, except that brothers and sisters, instead of being considered as mutually related in the same manner, are divided into two categories, elder and younger, in accordance with the Chinese usage. But the ancient Japanese had a complicated system of nomenclature, which appears to have perplexed native commentators themselves, the foundation of which was a subordination of the younger to the elder born, modified by a subordination of the females to the males. A distinction also appears to have been drawn between the chief and secondary wives, and the wife is constantly spoken of as "younger sister." It appears that consanguinity, however close, was no bar to marriage, as we hear of unions with half-sisters, step-mothers, and aunts. When the Chinese ethical code was imported, these gradually disappeared, but not, it is said, without political troubles. Exogamy did not exist, and there appear to have been no artificial impediments in the way of marriage. On death the hut of the deceased was abandoned; and there was a tradition of an earlier custom of burying alive some of the retainers in the neighbourhood of a royal tomb. This is the only trace of human sacrifice to be found in the records of the Japanese race, and there is also a total absence of any trace of slavery. They were unacquainted with any of the arts by which their descendants are best known; they had neither tea, fans, lacquer, or porcelain. They knew nothing of vehicles, money, or the computation of time. They were ignorant of writing, and of course had no books.

This brings us to another interesting part of the subject, viz. the antiquity claimed by native writers for their monarchy, and the reliability of their early chronology. There is no break in their history between the fabulous and the real, and the continuity of their mythology and history is a tenet of the native commentators. They hold the age of the gods to have ceased and that of their human kings to have commenced at an era corresponding with 660 B.C., and the then ruler of Japan is claimed as the first of an unbroken line of sovereigns extending down to the Mikado of to-day. All the earlier European writers on Japan have accepted 660 B.C. as the commencement of historical Japan; the Mikado himself has claimed this long descent; frequently in official publications we find this accepted as the Japanese year 1.[1] In native chronologies we find the names of a series of Emperors who have reigned from that time. This antiquity, though as yesterday compared to that of the Chinese, is highly respectable if correct, but unfortunately there is nothing whatever to support it. For, in the words of Mr. Chamberlain, this era, this accession of the first emperor, "is confidently placed thirteen or fourteen centuries before the first history which records it was written, nine centuries before (at the earliest computation) the art of writing was introduced into the country, and on the sole authority of books teeming with miraculous legends." Another scholar, who made the chronology of Japan a special study, and who has published a valuable monograph on that subject, the late Mr. Bramsen, does not scruple to say that "the whole system of fictitious dates applied in the first histories of Japan is one of the greatest literary frauds ever perpetrated, from which we may infer how little trust can be placed in the early Japanese historical works." In short it appears that, for all historical purposes, Japan is a newer country than England by several centuries. Another proposition for which native scholars have always strenuously contended will also have to be abandoned. It is usual to say that early Japanese civilisation was a purely indigenous product, and that even a certain form of writing called "letters of the Divine Age" existed long before there was any contact with China. European scholars have always been doubtful about this divine alphabet, and it is now beyond doubt that they are the invention, or adaptation from Corea, of a later age; but it is also certain from these "Records" that, "at the very earliest period to which the twilight of legend stretches back, Chinese influence had already begun to make itself felt in these islands, communicating to the inhabitants both implements and ideas." It would occupy too much space here to exhibit the evidences of this. One must suffice. "Curved jewels," *magatama* as they are called, figure largely in the Japanese mythology as ornaments of the early Japanese. These are generally made of jade, or a jade-like stone, and Prof. Milne shows that no such mineral has ever been discovered in Japan. Further proofs of Chinese influence are found in the nature of the myths, the existence of the intoxicant *saké*, the language, &c. The religion of the early Japanese appears to have been merely "a bundle of miscellaneous superstitions," not an organised system. We find no body of dogmas, or code of morals, authoritatively enforced by a sacred book. The gods of their mythology were of course the object of worship; conciliatory offerings of a miscellaneous kind were made to them. Purification by water is the sacred rite of which we hear most. Trial by hot water also existed; compacts, too, resembling our oaths, were entered into with a god. Priests are mentioned, but the impression conveyed is that in early times they did not exist as a separate class. In his "History

[1] In an interview with the Japanese Minister in London, published in the *Pall Mall Gazette* of February 26, His Excellency is reported to have attributed the ardent attachment of the Japanese to his country to two facts, one that Japan has been unconquered for 2500 years, the other that for the same period it has been governed by the same dynasty. "No other State can point to such a record," said Mr. Mori, "and it is but natural that we should feel a pride in our country," &c., &c. The Minister, as will be seen, would have to deduct nearly fifteen hundred years from his major premiss before he touched the solid ground of fact.

of Civilisation," Buckle attributes some of the superstition of the inhabitants of Spain and Italy to the occurrence of earthquakes and other volcanic phenomena; but in Japan there is "no testimony to any effect produced on the imagination by the earthquakes from which the Japanese islanders suffer such constant alarms." Nor is there any tradition of a deluge, which is the more remarkable as Noah's deluge has recently been claimed as a myth of Altaïc origin. "Yet here we have the oldest of *undoubtedly* Altaïc nations without any legend of the kind." There is no such thing as star-worship, nor are there any fancies such as the imagination of other races has connected with them.

Much, very much, more might be written on this deeply interesting volume. Although more than a thousand years of Japanese history must be cut away, "the Japanese mythology is the oldest existing product of the Altaïc mind." When to this are added the facts that here we have the *ipsissima verba* (for the translation is literal) of the Japanese compiler of eleven centuries ago, that it is the first complete translation of an archaic Japanese work, that it is the first work in which an attempt is boldly made to separate Japanese history from myths, and to fix the commencement of the historical era, and that it contains abundant illustrations of the manner and ideas of this primitive race as recorded by themselves, we have said enough to attract a wide circle of students. Besides the very valuable preliminary discussions, the text is abundantly annotated by the translator, who has for this purpose made use of the works of the numerous native commentators and editors of the work.

NOTES

THE gold and silver Rumford Medals have been presented by the American Academy of Arts and Sciences to Prof. Rowland of Baltimore for his researches on heat and light.

WE are sure that every field-naturalist and working geologist will be grateful to Prof. Bryce for introducing into Parliament his Bill "to secure access to mountains and moorlands in Scotland." Since the substitution of deer for sheep and cattle on the Scottish moors and mountains, great restrictions have been placed on access to these favourite haunts of the lover of nature, so that in some districts the tourist and collector are faced by the trespassers' board in all directions. We have no wish whatever to infringe the rights of private property, but surely the great landed proprietors of Scotland can afford to be generous to those whose noblest game is a rare butterfly, an Alpine flower, or a chip from the rocky escarpment of a hill. Already some of the most valuable hunting grounds of science have been shut up, and in the present condition of things we may soon hear of such natural phenomena as the Parallel Roads of Glenroy being rendered inaccessible, and the traveller confined to the dusty highways. The Bill embodies every possible precaution against the abuse of the access craved, and we strongly advise the members of the many natural history societies and field clubs all over the country to use every legitimate means to obtain for it Parliamentary sanction. We need scarcely point out how greatly interested in the provisions of the Bill are all artists and the great army of tourists.

SIR J. H. LEFROY, we are glad to learn, has accepted the presidency of the Geographical Section at the Montreal meeting of the British Association.

SIGNOR QUINTINO SELLA, whose death on March 15 is announced, was president of the R. Accademia dei Lincei.

WE regret to learn of the death of Dr. Behm, the eminent geographer of Gotha, the editor of the *Geographische Mittheilungen*, the *Geographisches Jahrbuch*, and, along with Prof. Wagner, of the well-known "Bevölkerung der Erde."

WE are glad to notice the hearty manner in which the *Times* recognises the necessity for scientific education among all classes. In an excellent leading article on the Technical Institute, it maintains that the old rule-of-thumb methods will no longer suffice, and that science and organised knowledge are bound to invade industry as they have already invaded almost every branch of human endeavour.

THERE can be no doubt of the great scientific value of a bathymetrical survey of the Scottish lochs, about which Lord Balfour of Burleigh asked a question in the House of Lords on Tuesday, and concerning which there has been a correspondence between the Royal Society of Edinburgh and the Government. No one wishes to retard the completion of the English Survey for the purpose of this special undertaking; but this is not necessary, as, without going to any great expense, Government might easily employ other existing agencies in carrying out the work.

SIR RICHARD OWEN was on Saturday presented with a framed and illuminated address by the Geologists' Association, on the occasion of his retirement from the post of Director-General of the Natural History Department of the British Museum. A large audience assembled in the lecture-hall at South Kensington to witness the ceremony. The address was presented by Dr. Henry Hicks, F.G.S., who said that in his retirement Sir Richard Owen would take with him the good wishes and warm interest of all who appreciated his scientific work, and his great personal kindness in communicating its results to others. Sir Richard Owen, in reply, said that, of all the recognitions which he had recently received of his years of service in the State museums, none would be more valued by him than that testimonial from his fellow workers in those walks of natural science in which he had been for over half a century more or less occupied. He would value the address amongst the rarest of his treasures, and he trusted that its contemplation would stimulate his sons and grandsons, particularly the latter, to walk in their grandfather's footsteps. He returned his grateful thanks, and wished the members and all present every happiness.

IT is intended at the forthcoming celebration of the tercentenary of Edinburgh University to confer the degree of LL.D. on sixty-nine gentlemen, among whom are Prof. Cayley, Mr. Archibald Geikie, Prof. Helmholtz, Sir John Lubbock, Sir Henry Maine, and Prof. Haeckel.

AT its last private sitting the Academy of Sciences of Paris debated the question of the sale of the Observatory grounds in order to find the funds required for the erection of a *succursale* in the vicinity of Paris. The matter was postponed for fifteen days, after a long and interesting discussion. The majority of the Academy is of opinion that it would be desirable to grant the credits required for the erection of a new establishment; but many members are against the sale of any parcel of ground. They contend that the present position of the Observatory must not be deteriorated under any pretence whatever. MM. Wolf and Janssen delivered addresses defending the *statu quo*.

THE convention for the protection of cables has been signed in Paris by the plenipotentiaries of the following nations:—Germany, Argentine Republic, Austria-Hungary, Belgium, Brazil, Costa Rica, Denmark, San Domingo, Spain, United States of America, United States of Colombia, France, Great Britain, Greece, Guatemala, Italy, Netherlands, Persia, Portugal, Roumania, Salvador, Sweden, Norway, Turkey, and Uruguay. The protocol has been left open for acceptation by the other countries. This is the final step towards the accomplishment of the work originated at the Congress of Electricians in Paris.

THE exhibition of the submarine objects at the Museum of Paris was closed on March 15, but will be opened on a larger scale on the occasion of the session of the Délégués des Sociétés Savantes, which will take place as usual in the Easter holidays.

THE number of members of the French Alpine Club is yearly increasing, and the financial position of the Society is very prosperous indeed. The general sitting of the Paris section took place on March 10. M. Janssen delivered an address on the sun. The discourse was illustrated by projections exhibiting all the phenomena connected with the eclipse of 1883, as observed by him on Caroline Island. It is the first time these pictures have been presented to the public, and they have been very successful.

AMONGST the latest publications in the domain of electricity we notice "Das Elektrische Potential," by A. Serpieri; "Die Elektrische Kraftübertragung," by Jos. Popper; and "Die Atmosphärische Elecktricität," by Prof. Palmieri. Hartleben of Vienna is the publisher of all the works mentioned.

M. PERRIER presented on Monday to the Academy of Sciences of Paris six sheets of the map of Tunisia, which the French military geographers are executing on the scale of 1 : 100,000. The mapping of the whole country from Algeria to the Tripolitan territory will be published in a few weeks. The publication, which will contain twenty-one sheets, will be completed this year. This great work will have required only four years to accomplish. The maps are lithographed, and will be ultimately engraved.

WE have already mentioned a publication issued by the Direction of Schools at Tiflis, in which the teachers of the Caucasus have the opportunity of publishing descriptions of the interesting but little known districts where they are compelled to stay, often deprived of any intercourse with the civilised world. We have now received the third volume of this publication, which contains several valuable papers. The chief of them is the first part of an interesting memoir, by M. Lavroff, on Ossetia and Ossetians, with a map. In this first part the author describes the country, its orography and hydrography, climate, flora, and fauna, leaving the purely ethnographical part for a second memoir. M. Gadovsky contributes valuable notes on the newly-annexed province of Kars: its geography, population, tenure of land, and the occupations of the inhabitants. The second part of this volume is devoted to the rich folk-lore of the Cossacks, Tartars, and Circassians, in which the ethnographer will find rich materials.

IN the "Untersuchungen aus dem botanischen Institut zu Tübingen" F. Schwarz discusses the structure and functions of the root-hairs of flowering plants. He finds that in maize the surface of a hairy root is 5·5 times greater than that of a root not covered with hairs; in the pea 12·4 times greater. The intimate contact of the root-hairs with particles of soil is effected by the conversion into mucilage of the outermost layer of the wall of the hair; the inner layer of the membrane is stained blue, the outer layer yellowish brown by zinc chloriodide. The greatest development of root-hairs accompanies the greatest energy of growth of the root. A medium degree of moisture is most favourable for their formation; with plants growing in water they are often altogether suppressed. Nutation promotes their production, especially at the point of curvature. Contact with dry solid bodies has no effect on their production. They are always formed in acropetal succession. They have not in most cases the same form in the same species, being considerably affected by conditions of growth. In many plants the root-hairs are branched.

THE annual prize of 25,000 francs, instituted by the King of the Belgians, will for 1885 be granted to the author of the best work on the means of popularising the study of geography and developing it in the different educational establishments. Foreigners may compete equally with Belgians. The works of the competitors must be sent to the Minister of the Interior before January 1, 1885.

WE understand that Messrs. Sanderson and Co. are about to issue a small volume on tall-chimney climbing and lightning-rod testing.

CAPT. A. E. BARLOW, Commander of the P. and O. steamer *Paramatta*, writes as follows to the *Times*:—"An unusual phenomenon was observed during the recent voyage of the P. and O. steamer *Paramatta* to Sydney, New South Wales, which may be of interest to some of your readers. On December 11 and the following day, about lat. 10° S. and long. 92° E., the surface of the sea was covered with lava and pumice, some being as fine as sawdust and of a yellowish colour, but several patches of large extent were passed through with masses of pumice from the size of a cocoanut to that of a hogshead; this extended over 5° of latitude, and probably much more of longitude, as the densest patches all ran in an easterly and westerly direction. The largest specimen of pumice which I picked up was about ten inches in diameter, and appeared only to have been a few days in the water, as there was no deposit on it. This would lead to the conclusion that a submarine upheaval must have taken place long after the great eruption of Krakatoa, in the Strait of Sunda, our nearest approach to which was over 800 miles. On the homeward voyage on February 1 the same phenomenon was observed, but in a much less degree, in lat. 4° S., long. 88° E., showing that the mass had drifted to the west-north-west about 500 miles in six weeks."

UNDER the title of "New Commercial Plants and Drugs, No. 7," Mr. Thos. Christy has recently issued a continuation of his notes on useful plants which come before him in the course of commerce. The demand for economic plants of every description has of late years considerably increased amongst planters not only in our own colonies but also in other parts of the world in consequence of the general desire for the greater dissemination of staple articles of cultivation that are acknowledged sources of revenue, and also the introduction of new staples where from long cultivation or the ravages of disease the older and better nown plants have ceased to be remunerative. The circulation amongst planters and colonists generally of such books as this is calculated to do a great deal of good even if it were only to let them know of the existence and properties of certain plants, for while there are many that have a knowledge of useful plants, there are also others who are content to go on growing the same crops that they have always been accustomed to, and though we may not expect full details of the uses of the plants enumerated, nor botanical descriptions of the plants themselves, sufficient is given in all cases to put the reader on the right track for further information. In some of the subjects, however, very voluminous abstracts are given from some of the best journals in which special articles have appeared. It will suffice to say that the present number of "New Commercial Plants and Drugs" contains very interesting articles on the Cacao (*Theobroma cacao*) and its preparation, the Siam benzoin tree, pepper and nutmeg cultivation, Liberian coffee, and numerous other economic plants of very varied uses.

THE Eleventh Annual Report of the National Health Society shows that the Society has carried on its work during the past year in a most practical manner. Hundreds of lectures on sanitary subjects have been delivered, not only all over the poorer parts of London, but in provincial towns, to large audiences of working men and women, classes of girls, district visitors, and others engaged in work amongst the poor. The Society is much encouraged by the practical results of the lectures on keeping the house healthy, rearing of infants, prevention of the spread of infectious diseases, preparation of food and kindred subjects, knowledge of which is so much needed in our crowded neighbourhoods. The questions of poisonous dyes in domestic fabrics, of smoke abatement, of dust collection, and the prevention of cholera have been investigated and reported upon by special committees appointed for the purpose. The Health Exhibition held by the Society last June was commented upon, and the Secretary stated that more than 100 members had joined the Society during the past year.

THE great interest manifested in the International Health Exhibition is shown by the fact that application has been made, by British exhibitors alone, for space five times as great as that actually at the disposal of the Executive Council. Information has recently been received that the French Government has appointed a Commission; and Italy—owing in a great measure to the individual exertions of a member of the Executive Council—will, it is hoped, take an active part. A portion of the Educational Section of the Exhibition will be located in the Central Institute of the City of London Technical Guilds, the handsome building in course of erection in the Exhibition Road, which has been kindly placed at the disposal of the Executive Council. The Royal Albert Hall with its musical attractions will now form an integral part of the Exhibition; and the Aquarium, a popular feature of the late Fisheries Exhibition, will continue as an important part of the Health Exhibition. In the Dress Section the most popular exhibit will probably prove to be a series which is being prepared illustrative of English dress of all ranks of life, from the time of the Conquest to George IV. An International Congress on Education will be held, and conferences and lectures will conduce to the elucidation of the subjects of the Exhibition. It is also proposed to have a library and reading-room in connection with the Exhibition, which will be open to all visitors, under proper regulations, while the Exhibition is open. The library will consist of books on various subjects comprised in the classification of the Exhibition, both English and foreign. Application has been addressed to foreign and colonial Governments, asking them for copies of reports and statistics on sanitary and educational matters, and a circular is being sent out to authors and publishers requesting them to contribute works of a similar character.

AT a meeting of the Society of Telegraph Engineers held on the 13th inst., a short paper, "Notes on a Train Lighting Experiment," was read by Mr. W. H. Massey of Twyford, who strongly advocated the use of a small engine and dynamo-machine placed on each locomotive for working incandescent lamps, by means of which railway carriages would be much better lighted than at present for less than is paid for gas. An interesting discussion took place, and the meeting was adjourned to the 27th inst., when Mr. Massey is expected to reply.

THE March number of *Petermann's Mittheilungen* contains a letter from Dr. Junker dated Sami, 6½° N. lat., 25° E. long., December 8, 1882, in which he gives a brief statement of the results of his journeys in the Upper Welle and Bomokandi, with notes on the various tribes that inhabit the region. Dr. Junker did some further exploring work to the south-west of his station in 1883; but his numerous cases of collections have been lost in a fire which consumed the building where they were stored.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mrs. Dundas; a Leopard (*Felis pardus*) from Africa, presented by Mr. S. Cresswell; a West Indian Rail (*Aramides cayennensis*) from South America, presented by Mrs. Edward Hairby; a Kestrel (*Tinnunculus alaudarius*), British, presented by Mr. F. E. Bann; a Common Viper (*Vipera berus*), British, presented by Mr. W. H. B. Pain; two Mute Swans (*Cygnus olor*), European, four Redshanks (*Totanus calidris*), British, purchased.

PHYSICAL NOTES

PROF. J. H. POYNTING has published in the *Proceedings of the Birmingham Philosophical Society* a note on a method of calculating the velocity of propagation of waves of longitudinal and transverse disturbances by the rate of transfer of energy. The paper discusses the two cases by the method originally propounded by Lord Rayleigh.

WE have received from Madame Plateau copies of three posthumous memoirs by her late husband, the lamented Prof. J. Plateau. Their titles are: "Quelques Expériences sur les lames liquides minces (deuxième note)"; "Sur l'Observations des Mouvements très rapides"; and "Bibliographie analytique des Principaux Phénomènes subjectifs de la Vision." The first of these *brochures* relates to the preservation of the glyceric fluid, to certain appearances in very thin films, and on the constitution of foam. In the second the writer contrasts four methods: the rotating mirror, the stroboscopic method, the intermittent illumination by electric sparks, and the process of multiple instantaneous photography. The third is a supplement for the years 1880–1882 to the well-known bibliography compiled by the deceased *savant*.

WE have also received the first instalment of vol. i. of the *Bulletin de la Société Internationale des Électriciens* (January 1, 1884), containing the laws of the new society, a list of founders, and one of the members already enrolled, now numbering about 1200, of whom only a few are Englishmen.

PROF. QUINCKE has lately read before the Berlin Academy a paper on the measurement of magnetic forces by hydrostatic pressure. He has examined the magnetic inductive capacity, or, as he calls it, the "di-magnetic constant" of a number of liquids, by observing their rise in an open-air manometer when subjected to a field of powerful, but known, intensity, the observed change of pressure being proportional to the square of the intensity of the field and to the difference between the magnetic inductive capacity of the substance and that of the air. A number of tables are given, with copious numerical data. The di-magnetic constant of such liquids as ether, alcohol, turpentine, nitric acid, bisulphide of carbon, glycerine, water, &c., showed small negative values; whilst the values were positive, and in many cases much more considerable for solutions of chloride of iron, chloride of manganese, sulphate of nickel, and of cobalt, and for solutions of magnetic salts in general.

A SLIGHT mistake occurred in a note on p. 276, in which Bunsen's estimation that in three years 5·135 cubic centimetres of carbonic dioxide was absorbed by a square metre of glass was stated as the absorption of one square centimetre.

THE CHEMICAL WORK OF WÖHLER[1]

IT seems fitting that these walls, which have vibrated in sympathy with that brilliant eulogy of Liebig which Prof. Hofmann pronounced some nine years ago should hear something of him whose life-long association with Liebig has exercised an undying influence on the development of scientific thought. The names of Frederick Wöhler and Justus Liebig will be linked together throughout all time. The work which they did in common makes an epoch in the history of chemistry. No truer indication of the singular strength and beauty of their relations could be given than is contained in a letter from Liebig to Wöhler, written on the last day of the year 1871. "I cannot let the year pass away," writes Liebig to Wöhler, "without giving thee one more sign of my existence, and again expressing my heartfelt wishes for thy welfare and the welfare of those that are dear to thee. We shall not for long be able to send each other New-Years' greetings, yet, when we are dead and mouldering, the ties which have united us in life will still hold us together in the memory of men as a not too frequent example of faithful workers who, without envy or jealousy, have zealously laboured in the same field, linked together in the closest friendship."

[1] A lecture delivered at the Royal Institution on Friday evening, February 15, 1884, by Prof. Thorpe, F.R.S.

And yet, bound as they were in the ties of a friendship the purity and warmth of which were but characteristic of the men, and although each influenced the other's walk and work in life to a degree which it is almost impossible to gauge, such was the strength of their individuality and such the force of their genius that, without a doubt, either would have been a great figure in the history of science if the other had not existed.

The conditions under which minds of the highest type arise and develop have on more than one occasion engaged the attention of this audience. Although there were circumstances in Wöhler's surroundings which in early life may have influenced the bent of his mind, it is not easy to see whence sprang that passionate love of nature which was so strikingly exhibited in the man. His father, August Anton Wöhler, was formerly an equerry in the service of the Elector William II. of Hesse; he afterwards came to live at Frankfort, and became a leading citizen of that town. His wise liberality and public spirit are commemorated in the Wöhler Foundation and Wöhler School, institutions known to every Frankforter. His mother was connected by marriage with the minister of Eschersheim, a village near Frankfort, and it was in the minister's house that Frederick Wöhler first saw the light, on July 31, 1800. Even in early youth his passion for experimenting and collecting manifested itself, to the neglect not unfrequently of the lessons of the gymnasium; indeed it would appear that during his school career Wöhler was not characterised by either special diligence or knowledge. The bent of his mind towards natural science was directed by Dr. Buch, a retired physician who had devoted himself to the study of chemistry and physics; and it was in the kitchen of his patron's house that he prepared the then newly-discovered element selenium, of which an account was afterwards sent by Dr. Buch to Gilbert's ***Annalen***, with Wöhler's name at the head of it. The elder Wöhler appears to have been a man of considerable artistic feeling, and under his direction the son was taught sketching and otherwise educated in that perception of natural beauty which comes out so strikingly in his after life; and he was encouraged to make himself familiar with the literature which the genius of Schiller and Goethe has ennobled. He had, moreover, to thank his father for that love of physical exercise and passion for outdoor life which reacted so beneficially upon his development, and contributed so largely to the uniformly good health which he enjoyed to within a few days of his death. Mainly, it would seem, because his father had been there before him, Wöhler, in his twentieth year, entered the University of Marburg. It was his own and the family's wish that he should study medicine, and he accordingly put his name down for the lectures of Bünger on Anatomy, Gerling on Physics and Mathematics, and Wenderoth on Botany. He found time also to attend Ullmann's classes on Mineralogy; and although he declined to hear Wurzer's lectures on Chemistry, he by no means neglected that science. He transformed his living-room into a laboratory, and to the great, and perhaps not undeserved, disgust of his landlady, occupied himself with the preparation and study of the properties of prussic acid, thiocyanic acid, and other cyanogen compounds. He discovered at that time, without knowing that Sir Humphry Davy had anticipated him, the beautifully crystalline but intensely poisonous iodide of cyanogen; and in the little paper on cyanogen compounds which his good friend Dr. Buch communicated to Gilbert's ***Annalen*** for him we have the first description of the remarkable behaviour of mercuric thiocyanate on heating, which has astonished and amused us in the so-called "Pharaoh's Serpent."

Wöhler, attracted by the fame of Leopold Gmelin, left Marburg for Heidelberg. His main idea was to hear the lectures of that distinguished man, but Gmelin declared this to be unnecessary and a waste of time. Wöhler in fact never attended any systematic lectures on chemistry; he had access, however, to the old cloisters which at that time constituted the Heidelberg laboratory, and there began the work on cyanic acid which some four or five years later was destined to culminate in the great discovery of the synthesis of urea. His association, at this time, with Tiedemann, who was engaged in physiological chemical investigation with Gmelin, had also considerable influence in determining the direction of much of his future work, whilst its immediate effect was the publication in Tiedemann's ***Zeitschrift für Physiologie*** of the results of an inquiry into the transformation experienced by various substances, organic and inorganic, in their passage through the organism. In 1823 Wöhler obtained his degree, when, on Gmelin's advice, he determined to follow his master's example, and abandon medicine for chemistry. At that time the great Swedish chemist Berzelius was at the summit of his fame: his masterly analytical skill, no less than his labours towards the development of chemical theory, had made him supreme among the chemists of Europe, and to Stockholm therefore, Wöhler, acting on the advice of Gmelin, determined to go. He was warmly welcomed by Berzelius, on whom his communications to Gilbert's ***Annalen*** had made a favourable impression, and with the offer of a place in the private laboratory of the illustrious Swede, Wöhler set out for the Scandinavian capital. Of his experiences with Berzelius his pupil has left us a delightful account. It is valuable not only as a charming character-sketch of the great teacher, but also from the side-light it throws upon the nature and disposition of Wöhler and himself. It is interesting, too, as an account of the mode in which Berzelius worked and taught, and as showing how the typical laboratory of that time contrasted with the temples which have since been reared by the disciples of Hermes.

"With a beating heart," says Wöhler, "I stood before Berzelius's door and rang the bell. It was opened by a well-clad, portly, vigorous-looking man. It was Berzelius himself. . . . As he led me into his laboratory I was as in a dream, doubting if I could really be in the classical place which was the object of my aspirations. . . . I was at that time the only one in the laboratory: before me were Mitscherlich and Heinrich and Gustav Rose: after me came Magnus. The laboratory consisted of two ordinary rooms furnished in the simplest possible way; there were no furnaces nor draught places; neither gas nor water service. In one of the rooms were two common deal tables; on one of these worked Berzelius, the other was intended for me. On the walls were a few cupboards for the reagents; in the middle was a mercury trough, whilst the glass-blower's lamp stood on the hearth. In addition was a sink, consisting of an earthenware cistern and tap, standing over a wooden tub, where the despotic Anna, the cook, had daily to clean the apparatus. In the other room were the balances, and some cupboards containing instruments: close to was a small workshop fitted with a lathe. In the neighbouring kitchen, in which Anna prepared the meals, was a small but seldom-used furnace and the never-cool sand-bath."

Wöhler's first exercises were in mineral analysis, in order that he might become acquainted with Berzelius's special methods and manipulative procedure. At that time he prepared, among other products, some new compounds of tungsten, notably the beautifully crystallised monoxychloride and the tungsten sodium-bronze ($Na_2W_3O_9$), which some twenty-five years later was introduced into the arts as a bronze powder. It was, however, with his investigation on cyanic acid that both he and Berzelius were mainly interested. In Berzelius's opinion the existence of this body was of importance from the light it seemed to him to throw upon the validity of the new chlorine theory. "I was surprised," says Wöhler, "to hear him, the hitherto steadfast upholder of the old notion, now always talk of *chlorine* instead of oxidised hydrochloric acid. Once, when Anna, in cleaning some vessel, remarked that it smelt strongly of oxymuriatic acid, Berzelius said, 'Hearest thou, Anna, thou must no longer speak of oxidised muriatic acid; thou must call it *chlorine*: that is better.'" With what feelings would Davy have listened to that colloquy between the Swedish philosopher and his factotum! Chlorine was discovered by Berzelius's illustrious countryman, Scheele, but its true nature was first demonstrated in the laboratory of the Royal Institution.

A couple of months were now spent in travel with Berzelius, in company with the two Brongniarts, Alexander the geologist and Adolph the botanist, during which they explored the greater portion of the geologically interesting parts of Southern Sweden and Norway, and collected rich stores of those wonderful minerals for which Scandinavia is famous. Scandinavia is no less famous for salmon and trout, and it was on his return from a fishing expedition in Norway that the travellers met with Davy, who, as readers of "Salmonia" know, handled his rod with great zest and zeal. Wöhler, who as a boy had learned the story from his friend Dr. Buch, of the isolation of the alkaline metals by Davy, and who, aided by his little sister, whose business it was to blow the bellows, had toiled, not unsuccessfully, to make potassium in the kitchen fire, was presented to the famous chemist.

On the return to Stockholm, Wöhler took leave of Berzelius and prepared to return to Germany. Of his association with this great man Wöhler had ever the kindliest memories. Although the outcome of much of his subsequent work, or at least much of that which he did in concert with Liebig, might be said to bring him in occasional conflict with Berzelius's cherished convictions on points of chemical theory, the master and pupil remained to the end bound together in the warmest friendship. Scarcely a month passed without an exchange of letters. Those from Berzelius were religiously preserved by Wöhler, who, after his master's death in 1848, presented them, to the extent of some hundreds, to the Swedish Academy of Sciences. We are told that in the later letters the "trauliche Du" appears in place of the more formal "Sie," and that "*Totus et tantus tuus*" is a not unfrequent signature.

Wöhler's gratitude and almost filial reverence are seen in the circumstance that even in the full tide of his vigour, and when time was doubly precious to him, he continued to charge himself with the yearly translation of Berzelius's *Jahresbericht* into German. It is easy to trace the influence of Wöhler's contact with Berzelius in his after work. To begin with, the men had much in common: their sympathies were as catholic as science itself, and they ranged at will over every department of chemical knowledge. Wöhler attacked the composition of a mineral with as much ardour as he did the preparation of an organic compound: to him the problems of physiological chemistry were not more important than the isolation of a rare earth or the perfection of some analytical method. The artificial barriers and fancied lines of demarcation in the science seemed to have no existence for Wöhler: indeed, it was the crowning triumph of his work to break down such barriers almost at a stroke, and to demonstrate the irrationality of these attempts to draw distinctions regardless of differences. The history of chemistry is indeed like that of the nation which has done so much to advance it: its unity to-day is as complete as that of Germany itself.

Wöhler was now to embark on his academic career, and under the advice of Gmelin and Tiedemann he prepared to settle in Heidelberg as *privat docent*. But to Heidelberg he was not destined to go. His work had already been gauged by such men as Leopold von Buch, Poggendorff, and Mitscherlich, and these, without his knowledge, had strongly recommended his election to the vacant teachership of chemistry in the newly-founded Trade School in Berlin. Berzelius advised him to accept the post, and to Berlin accordingly Wöhler went in 1825. He was now in possession of a laboratory which he could call his own, and he had to justify that possession by the use which he made of it. One of the problems which he now attacked was the isolation of *aluminium*, a metallic radicle more abundant and more widely diffused than any other of the fifty bodies we are accustomed to designate as metals. He succeeded in obtaining the body by the method which, nearly twenty years after, was worked out on a manufacturing scale by Sainte-Claire Deville. Deville caused the first bar of the metal thus procured to be struck as a medal, with the image of Napoleon III. on the one side, and the name Wöhler with the date 1827 on the other, and some time after the Emperor simultaneously designated the two chemists officers of the Legion of Honour.

But of the twenty-two memoirs and papers which Poggendorff's *Annalen* exhibits as the outcome of Wöhler's activity and power of work during his six years' stay in Berlin, that on the artificial formation of urea is by far the most important. No single chemical discovery of this century has exercised so great an influence on the development of scientific thought, and the words with which Wöhler closes his account of the molecular transformation of ammonium cyanate—a body of purely inorganic origin—into urea—a substance which of all that might be named is the most characteristic of the action of the so-called vital force—are full of meaning: "This unexpected result," he says, "is a remarkable fact, in so far as it presents an example of the artificial formation of an organic body, and indeed one of animal origin, out of inorganic materials." "The synthesis of urea," says Prof. Hofmann in his account of Wöhler's life-work, "was an epoch-making discovery in the real sense of that word. With it was opened out a new domain of investigation upon which the chemist instantly seized. The present generation, which is constantly gathering such rich harvests from the territory won for it by Wöhler, can only with difficulty transport itself back to that remote period in which the creation of an organic compound within the body of a plant or an animal appeared to be conditioned in some mysterious way by the vital force, and they can hardly realise the impresssion which the building up of urea from its elements then made upon men's minds. And yet it cannot be said that chemists were unprepared for this discovery. Men were long ago in the habit of perceiving that bodies of mineral origin were but the types of those met with in the animal and vegetable organism—in both classes there were the same differences in states of aggregation, the same mutual transformations, the same crystalline forms, the same constancy in combining relations, the same conjunction of the elements according to the weights of their atoms or in multiples of these, in both classes the appearance of the same species of compounds. But all attempts to build up organic compounds from their elements, as this for a large number of mineral substances had already been done, had hitherto been futile. The chemists of that period had nevertheless the presentiment that even this barrier must fall, and one can conceive the feeling of joy with which the gospel of a new unified chemistry was hailed by the intellect of that time. With the revolution thus effected in the ideas of men, science was directed into new paths and unto new goals. Who does not know with what zeal these paths have been trodden, and how many of these goals have been reached!"

But if at this time Wöhler made a great discovery for the world, he also, at about the same time, made a great discovery for himself: he discovered Liebig. The manner in which the two men were brought together is worth mentioning, for it would seem almost as if the hand of destiny was in it. At about the time that Wöhler was at Stockholm thinking and working on cyanic acid, Liebig was at Paris engaged with Gay Lussac on the study of the metallic compounds of an acid which, on account of their formidable explosive properties, has received the not inappropriate name of fulminic acid. Liebig, with rare skill and courage, had determined the composition of that acid, and had been rewarded by the honour of a waltz with Gay Lussac, it being the habit of that distinguished philosopher, as he explained to the astonished young German doctor, to express his ecstasy on the occasion of a new discovery in the poetry of motion. But the most extraordinary result of that investigation was to show that the terribly explosive fulminic acid and the innocuous cyanic acid were of identical composition. The idea that bodies could exist of identical ultimate composition—that is composed of the same elements united in the same proportion and yet possess essentially different properties, in other words be absolutely dissimilar things, was new to science; Berzelius, the great chemical lawgiver of his time, scouted the notion as absurd; to him it was impossible to conceive that identity in elementary composition should not result in identity of properties. And yet, later on, Berzelius was forced to realise the fact by the discovery by his pupil Wöhler of the molecular transformation of ammonium cyanate into urea, and to coin for us the word *isomerism*, by which that fact is denoted.

It was thus from the singular circumstance that Wöhler and Liebig were at the outset of their career engaged upon the elucidation of the nature of two bodies of identical composition, but of dissimilar origin, dissimilar relations, and very different properties, that they were brought into juxtaposition. They desired to know each other: they met in the house of a mutual friend at Frankfort, and the names of Liebig and Wöhler became henceforth linked together for all time.

The origin of that partnership, so fruitful in consequences for science, may be seen in the following characteristic letter:—

"FREDERICK WÖHLER TO JUSTUS LIEBIG

"*Sacrow, near Potsdam, June* 8, 1829

"DEAR PROFESSOR,—The content of your last letter to Poggendorff has been communicated to me by him, and I am glad that it affords me an opportunity of resuming the correspondence which we began last winter. It must surely be some wicked demon that again and again imperceptibly brings us into collision with our work, and tries to make the chemical public believe that we purposely seek as opponents these apples of discord. But I think he is not going to succeed. If you are so minded, we might, for the humour of it, undertake some chemical work together, in order that the result might be made known under our joint names. Of course, you would work in Giessen, and I in Berlin, after we were agreed upon the plan, and had communicated with each other from time to time as to its progress. I leave the choice of subject entirely to you.

"I am very glad that you have also determined the identity of pyrouric acid, and cyanic [cyanuric] acids. L. Gmelin would say: 'God be thanked, there is one acid the less!' . . .

"Yours, "WÖHLER"

Liebig acceded to the proposition at once, and suggested some problem on the chemical nature of nitrogen; this Wöhler found himself unable to undertake, as it involved the use of chlorine, to the action of which he was at all times extremely susceptible. On the other hand, he proposed to Liebig that they should continue in common a research on mellitic acid, which he himself had begun. Their joint investigation on this body made its appearance within the following year.

It would be quite impossible within the limits of an hour to attempt to give you anything approaching to a complete analysis of Wöhler's work. In all, he was the author of 275 memoirs and papers, and of these fifteen were published in concert with Liebig. I must therefore confine my selection from this vast amount of material to those papers which are of paramount importance from the influence which they have exerted on chemical theory or on the development of the chemical arts.

Very shortly after the publication of the work on mellitic acid Wöhler proposed to Liebig a joint investigation on cyanuric acid, in the course of which he observed the extraordinary transformation of that acid into cyanic acid, and the reconversion of the cyanic acid into cyanuric acid—one of the most remarkable instances of molecular rearrangement known to the chemist. The work progressed little for some months, owing to the demands made by Berzelius's *Jahresbericht* on Wöhler's time. "Wirf die Schreiberei zum Teufel," wrote Liebig, "und gehe in das Laboratorium, wohin Du gehörst." It was that functionary, doubtless, who in due time carried off the writing to his master, the printer. Wöhler went back to his laboratory, and in a few weeks the two investigators had obtained the clue to the puzzle. Liebig wrote to Wöhler: "Now that I have received your experiments the whole thing is cleared up, and with what satisfaction for us! The matter is now decided: the cyanic aid of Serullas is identical with that from urea. . . . Ich bin ganz närrisch vor Freude, dass unser Kindlein nun fehlerlos in die Welt gesetzt wird, ohne Buckel oder Klumpfuss."

[It had been suggested to attack the fulminic acid again.] "The fulminic acid we will allow to remain undisturbed. Like you, I have vowed to have nothing more to do with this stuff. Some time back I wanted, in connection with our work, to decompose some fulminating silver by means of ammonium sulphide; at the moment the first drop fell into the dish the mass exploded under my nose. I was thrown backwards, and was deaf for a fortnight, and became almost blind."

The work on cyanic acid appeared in Poggendorff's *Annalen* during the last month of 1830, and Wöhler was able to send the "Kind ein" "im neuen Kleide," as he says, with a New Year's greeting to his friend. Liebig had suggested fresh work, but at the moment Wöhler was in no humour to attack anything organic. The Swedish chemist, Sefström, had just announced the existence of a new element in the slag of certain iron ores, and this very substance had slipped through Wöhler's fingers unperceived. "I was an ass," he wrote to his friend, "not to have detected it two years ago in the lead ore from Zimapan in Mexico. I was busy with its analysis, and had found something strange in it, when I was laid up for some months in consequence of breathing hydrofluoric acid, and so the matter was allowed to rest. Meanwhile Berzelius sends me word of its discovery by Sefström in Swedish bar iron and in slag. It is very like chromium, and just as remarkable. Moreover, it is the same metal that Del Rio found in the Mexican lead ore, and called erythronium: Descotils, however, had declared this ore to be lead chromate."

Wöhler, no doubt, found a ready sympathiser in Liebig, to whom, not many years before, a similar experience had happened. We all know the story of the young chemist whose unscientific use of the imagination cost him the discovery of the element *bromine*. Wöhler had sent some of the substance to Stockholm, and Berzelius wrote as follows:—

"JACOB BERZELIUS TO FREDERICK WÖHLER

"*Stockholm, January* 22, 1831

"As to the small quantity of the body marked ? I will relate the following story:—'In the far north there lived in the olden time the goddess Vanadis, beautiful and gracious. One day there came a knock at her door. The goddess was in no hurry, and thought "They can knock again"; but there came no further knock, for he who knocked had passed on. The goddess, wondering who it could be that cared so little to be let in, ran to the window and recognised the departing one. "Ah!" said she to herself, "it is that lazy fellow, Wöhler! He richly deserves his name, since he cares so little to come in." Some days after, some one else knocked, repeatedly and loud. The goddess opened the door herself; it was Sefström who entered, and, as a consequence of their meeting, vanadium came to light.' Your specimen with the ? is, in fact, vanadium oxide.

"But he that has found the mode of artificially forming an organic body can well renounce the discovery of a new metal; indeed, one might have discovered ten unknown elements without as much skill as attaches to the masterly work which you and Liebig have carried out together and just communicated to the scientific world."

In 1831 Wöhler was called from Berlin to Cassel, and for some little time he was wholly engaged in the planning and erection of his new laboratory at the Gewerbe-Schule in that town. In the spring of the following year he was again ready for a new research; and this time it was to be the finest piece of work that the two investigators jointly engaged in. It was, in fact, to be the classical research on bitter almond oil. On May 16, 1832, Wöhler wrote to Liebig:—"Ich sehne mich nach einer ernsten Arbeit, sollten wir nicht die Confusion mit dem Bittermandelöl in's Reine bringen? Aber woher Material?" It must have been a *förscherblick* amounting to inspiration which led Wöhler to take up this subject; but neither he nor Liebig could have been wholly conscious of the consequences which were to follow from their work. To-day oil of bitter almonds is made artificially in Germany by the hundredweight: at that time the investigators could only obtain it in small quantities from Paris. They had indeed to thank Pelouze for the material with which they worked. Wöhler made this his greatest research under the cloud of a great sorrow: after barely two years of married life he lost his wife. Liebig, in the tenderest manner, brought him over to Giessen, and sought to win him from his grief and the sense of his loneliness by his company and the wholesome distraction of their joint work made side by side.

On August 30, 1832, Wöhler wrote to Liebig from Cassel:—

"I am here back again in my darkened solitude. I do not know how I shall thank you for the affection with which you received me and kept me by you for so long. How happy was I that we could work together face to face.

"I send you with this the memoir on bitter almond oil. The writing has taken me longer than I anticipated. I want you to read through the whole with the greatest care, and to notice particularly the numbers and formulæ. What does not please you, alter at once. I have often felt that there was something not quite right, without being able to find what was right."

I shall not attempt to dwell upon the outcome of this great work. The investigation on the radicle of benzoic acid will ever remain one of the greatest achievements in the history of organic chemistry: the work was indeed epoch-making in the far-reaching nature of its consequences. It was full of facts and rich in the promise of new material; a veritable mine from which subsequent workers like Cannizzaro, Fehling, Piria, Stas, and Hlasiwetz have dug rich treasure. The immediate effect of the paper was to establish the doctrine of organic radicles by demonstrating the existence of groups of bodies which had their analogues and prototypes in inorganic chemistry. The concluding words of the memoir strike, in fact, the keynote of the whole investigation. "In once more reviewing and connecting together the relations described in this memoir," so wrote Liebig and Wöhler, "we find that they may be grouped round a common nucleus which preserves intact its nature and composition in its associations with other bodies. This stability has induced us to regard this nucleus as a kind of compound element, and to propose for it the special name of 'benzoyl.'"

A significant feature in the memoir was that each of the substances described and correlated was the type of a distinct group of bodies, some of which were known, but of which the analogies and relations were unthought of; others of these bodies were yet to be discovered, a matter of little difficulty when the modes of their origin had been indicated. The effect of this memoir on the chemical world was instantaneous. Berzelius was delighted. "The facts put forward by you," he wrote to Wöhler and Liebig, "give rise to such considerations that they may well be regarded as the dawn of a new day in vegetal chemistry. On this account I would propose that this first-discovered radicle composed of more than two elements should be named *proin* (from πρωΐ, the beginning of day) or *orthrin* (ὄρθρος, daybreak), terms from which names like *proic acid*, *orthric acid*, *proic chloride*, *orthric chloride*, &c., could be readily derived."

Wöhler remained in Cassel for nearly five years. In the autumn of 1835 died Strömeyer, Professor of Chemistry in the University of Göttingen. Opinions were divided as to his successor; the choice lay between Liebig and Wöhler. Eventually Wöhler was selected, and entered on his work at Göttingen in the early part of 1836. He was succeeded at Cassel by Bunsen, who was at that time *privat docent* in Göttingen. In the October of that year Wöhler was again ready for fresh work. He writes to Liebig: "I am like a hen which has laid an egg and straightway sets up a great cackling. I have this morning found how oil of bitter almonds containing prussic acid may be obtained from amygdalin, and would propose that we jointly undertake the further investigation of the matter, as it is intimately related to the benzoyl research, and it would seem strange if either of us should work alone again in this field, denn es lässt sich gar nicht absehen wie weit es sich erstreckt, und ich glaube es ist gewiss fruchtbar, wenn es mit Deinem Mist gedüngt wird. . . ." In a couple of days afterwards Wöhler was ready with the fundamental facts for the research and had sketched out its plan. He writes:—

"I have just made a most remarkable discovery in relation to the amygdalin. Since it appeared that bitter almond oil might be obtained from amygdalin, it occurred to me that the one might be converted into the other by simply distilling almonds with water by an action similar to that of a ferment upon sugar, the change in this case being due in all probability to the albumen in the almonds. And this idea seems to be completely established. The facts are as follows:

"1. Amygdalin, dissolved in water and digested with a bruised sweet almond, begins almost immediately to smell of bitter almond oil, which after a time may be distilled off in such quantity that it would appear that the amygdalin was wholly transformed into it.

"2. A filtered emulsion of sweet almonds produces the same effect.

"3. A boiled emulsion of sweet almonds, in which, therefore, the albumen is coagulated, affords not the smallest trace of oil with amygdalin.

"4. Bruised sweet almonds, covered with alcohol, and freed therefrom by pressure, transform, as before, amygdalin into bitter almond oil.

"5. Bruised peas, or the albumen they contain, give no oil with amygdalin.

"There are three points, therefore, to be ascertained—

"*a.* What is the substance in bitter or sweet almonds which, in contact with amygdalin and water, forms bitter almond oil?

"*b.* Is the action by double decomposition or catalytic, like that of a ferment?

"*c.* What is the other product which in all probability is formed in addition to the oil and prussic acid?"

The merest tyro in organic chemistry to-day is familiar with the broad features of this investigation, and knows the answers which Liebig was able to give to his friend's interrogatories. The third substance Liebig discovered to be sugar. Under the influence of a nitrogenised ferment, termed by Liebig and Wöhler *emulsin*, amygdalin, in presence of water, is decomposed into benzaldehyde (bitter almond oil), prussic acid, and sugar (glucose), thus:—

$$\underset{\text{Amygdalin}}{C_{20}H_{27}NO_{11}} + \underset{\text{Water}}{2H_2O} = \underset{\text{Benzaldehyde}}{C_7H_6O} + \underset{\text{Prussic acid}}{CNH} + \underset{\text{Glucose}}{2C_6H_{12}O_6}.$$

It simply remains to explain why this reaction only occurs when the almonds are bruised and digested with water. Both the emulsin and the amygdalin exist together in the almonds, but are contained in separate cells, and are only brought into contact by the rupture of the cell-walls and the solvent action of the water. Amygdalin was the prototype of a large and important group of substances classed together as the glucosides.

At the instigation of Wöhler, the friends again returned to the question of the chemical nature of uric acid, and the memoir which they eventually published on the subject is of the profoundest interest, not only to the chemist, but also to the physiologist. Uric acid, originally discovered by Scheele, was shown in 1815, by William Prout, then a boy of nineteen, to be the main constituent of the solid excreta of reptiles; other chemists had succeeded in obtaining various derivatives from it, indeed Prout himself had prepared from it the so-called purpuric acid, a substance which years after as murexide obtained a transitory importance in the arts as a colouring matter. But nothing was known concerning the constitution of the body or of its relations to its derivatives until Wöhler and Liebig attacked the problem. The extraordinary mutability of uric acid, which had baffled and deceived previous investigators, was to Wöhler and Liebig the very clue to the labyrinth leading to a veritable treasure-house, and the wonderful insight and rare analytical skill of these two great men were never more clearly indicated than in the way in which they trod this intricate maze. No fewer than fifteen new bodies were added to the list of chemical compounds, and these were correlated with the same masterly lucidity that was so strikingly exhibited in the memoir on the radicle of benzoic acid. Some of the greatest triumphs of modern chemistry are seen in the synthesis of organic bodies. That organic chemistry was about to advance along this line was clearly foreseen by Wöhler and Liebig. In opening their account of this the last great work they did in common, they say:—"From this research, the philosophy of chemistry will draw the conclusion that the ultimate synthetical formation in our laboratories of all organic bodies, in so far as they are not organised (in so weit sie nicht mehr dem Organismus angehören), may be regarded as not only probable but as certain. Sugar, salicin, morphin will be artificially obtained. As yet we know nothing of the way by which this result is to be attained, inasmuch as the proximate materials for forming these bodies are unknown; but we shall come to know them."

Henceforth the friends worked but little in common. Liebig's energies were spent in other directions, and Wöhler turned his attention to inorganic chemistry. Time allows only the very briefest mention to be made of his more important discoveries in this department of the science. We have first his isolation of crystalline boron, and the preparation of the compounds of boron with aluminium and nitrogen, work done in concert with Sainte-Claire Deville. The readiness with which boron unites with nitrogen, and the mode in which the compound may be decomposed, led Wöhler to a conception of the origin of boric acid and borax in the volcanic waters in which they are frequently found. In collaboration with Buff he discovered the spontaneously inflammable hydride of silicon, the analogue of marsh gas, the simplest of the hydrides of carbon, and thereby laid the foundation-stone of a superstructure, which in time to come may only be less imposing than that built up of the compounds of carbon. Many years ago Wollaston noted the presence of beautiful lustrous copper-coloured cubes in the slags from the iron blast-furnaces, which he assumed to be metallic titanium; Wöhler proved this substance to be a compound of carbon, nitrogen, and titanium, and showed how it might be obtained. Of all the elements known to the chemist up to the period of Wöhler's cessation from work, it may be safely averred that there was not one but had passed through his hands in some form or other. Now he was busy with chromium, then with cerium, next with uranium and the platinum metals; titanium, tantalum, thorium, thallium, tungsten—all came in for some share of his attention. Of the minerals and meteorites he analysed, the number is legion; indeed, as Prof. Hofmann says, whoever sent him a piece of meteoric iron gained his heart. His restless activity was a source of continual wonder to his friends. "How happy art thou in thy work!" wrote Liebig on one occasion; "thou art like the man in the Indian fable, who when he laughed dropped roses from his mouth."

The names of Liebig and Wöhler are now so closely intertwined in the history of chemistry that it is hardly possible to avoid comparing the men. Such a comparison has already been drawn by one who of all others is most fitted to draw it. "Liebig," says Dr. Hofmann, "fiery and impetuous, seizing a new thought with enthusiasm, and giving to it the reins of his fancy, tenacious of his convictions, but open to the recognition of error, sincerely grateful, indeed, when made conscious of it,—Wöhler, calm and deliberate, entering upon a fresh problem after full reflection, guarding himself against each rash conclusion, and only after the most rigorous testing, by which every chance of error seemed to be excluded, giving expression to his opinion—but both following the path of inquiry in their several ways, and both animated by the same intense love of truth! Liebig, irritable and quick to take offence, hot-tempered, hardly master of his emotions, which not unfrequently found vent in bitter words, involving him in long and painful quarrels,—Wöhler, unimpassioned, meeting even the most malignant provocation with an immovable equanimity, disarming the bitterest opponent by the sobriety of his speech, a firm enemy to strife and contention—and yet both men penetrated by the same unswerving sense of rectitude! Can we marvel that between two such natures, so differently ordered, and yet so complementary, there should ripen a friendship which both should reckon as the greatest gain of their lives?"

Who can fully gauge the influence of such a nature as Wöhler's? How it was exerted on Liebig is indicated in the following letter:—

"FREDERICK WÖHLER TO JUSTUS LIEBIG

"*Göttingen, March* 9, 1843

"To make war against Marchand, or, indeed, against anybody else, brings no contentment with it, and is of little use to science. . . . Imagine that it is the year 1900, when we are both dissolved into carbonic acid, water, and ammonia, and our ashes, it may be, are part of the bones of some dog which has despoiled our graves—who cares then whether we have lived in peace or anger; who thinks then of thy polemics, of the sacrifice of thy health and rest for science?—Nobody. But thy good ideas, the new facts which thou hast discovered, these, sifted from all that is immaterial, will be known and remembered to all time. But how comes it that I should advise the lion to eat sugar!"

It was thus in philosophic contentment, happy in his work, in his home life, and in his friendships, that Wöhler lived out his fourscore years and two. He made Göttingen famous as a school of chemistry; at the time of the one-and-twentieth year of his connection with the university it was found that upwards of 8000 students had listened to his lectures or worked in his laboratory. He was a man whom the world has delighted to honour; and there was hardly an academy of science or a learned society which has not in some way or other recognised his services to science. He was made a Foreign Member of the Royal Society in 1854, a Corresponding Member of the Berlin Academy in 1855, Foreign Associate of the Institute of France in 1864, and in 1872 he received the Copley Medal from the Royal Society. On September 23, 1882—

"He gave his honours to the world again,
His blessed part to heaven, and slept in peace."

METEORIC DUST

SIR WILLIAM THOMSON has sent us the following communication for publication:—

"*Portkil, Kilcreggan, March* 13, 1884

"DEAR SIR WILLIAM THOMSON,—Herewith I inclose some of the meteoric dust collected on a cotton filter, and both ignited at a red heat. The change of colour is interesting.

"On Saturday, March 1, the snow lay 5½ inches deep at 8 a.m., pure and white. At 9.15 a.m., when I next noticed it, it was sooty looking, the blackish appearance penetrating half an inch only. The sky was clear and calm, any tendency to movement of the air being from the south-east.

"I carefully measured a superficial foot on an outlying field sloping to the south-west at a spot bisected by the 200-foot line of the Ordnance Survey, and collected the snow into two bowls of white delft, half into each. After evaporating the snow water, thoroughly drying the residue, I collected and weighed it, that from one giving 1⅝ grains, and the other 2⅜ grains, or 4 grains to the square foot exactly.

"I can personally vouch for the dust being all over the Roseneath peninsula, as I trudged through the snow to Coulport on Loch Long, and found it the same all the way north, also on the top of the Gallow-hill (414 feet). I have since seen those who noticed it at Garelochhead, so that on this peninsula alone, taking 4 grains as an average, there has fallen over 100 tons.

"From hearsay it appears to have been noticed from Kippen on the north to Largs on the south, and from Hamilton on the east to Dunoon on the west, or over an area (in round numbers) of 810 square miles, and admitting the former estimate, we have the astonishing aggregate of say 5760 tons! A weighty gift to Mother Earth, surely of some value.

"I should mention that every crack, scratch, or depression in the glaze of the bowls was filled with the finely divided matter; it was impossible, therefore, to collect it *all* for weighing, consequently 4 grains per square foot is under rather than over the probable average. The observer at Kippen, too, mentions that the snow was permeated there for one inch by the sooty appearance.

"On Monday (March 3), after snow had fallen to the depth of an additional 8 inches, I watched for a recurrence of the phenomenon, and on the sky clearing about midnight I fetched in a dish that I had left outside and found a little had fallen in small flakes; these had melted their way through the snow, leaving little tunnels about the size of crow-quills. The quantity, however, was exceedingly small. Tendency to movement of the air as before from the south-east. Barometer had risen from 29·4 at 2 p.m. to 29·6, steady at midnight, thermometer 42°. On Saturday previous barometer stood at 30·05 (90 feet above sea-level, aneroid), thermometer 44°, 12 noon. The dust I left with you previously contains a little organic matter (grassy fibre), though what I had under the microscope appeared entirely metallic.

"The snow had melted a good deal before I recognised the importance of obtaining a fair sample. My children, however, had rolled a huge snowball down the slope, at the top of which the cottage stands, and this had increased as it rolled until it was something like 6 feet in diameter, and so formed a mine from which to collect the dust. There is still some of the black water in process of evaporation; should you require it more of the dust is at your service.

"One of the older inhabitants remembers a similar occurrence here in 1828 on the 20th or 22nd of March, when the snow, he says, fell in black or sooty flakes.

"Perhaps it is well to mention that the goats suffered somewhat from influenza on Sunday and Monday, and that I myself had a sharp attack followed by severe headache for a day, caused probably by inhaling a minute quantity of the dust snuff fashion. It might have been from something else, only the coincidence is suggestive of caution.

"I am, yours faithfully,
"LEWIS P. MUIRHEAD

"Professor Sir William Thomson, Glasgow University"

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Boards for Medicine, Physics and Chemistry, and Biology and Geology, after joint deliberation, have recommended an important change in the appointments of Natural Science Examiners. It has been a regulation of the Natural Science Tripos that all answers shall be looked over by two examiners out of the eight, but it has become increasingly difficult to find examiners with the requisite extent of knowledge. Thus it practically happens that each examiner is sole examiner in a single subject, and the places of candidates are often practically dependent on the judgment of a single examiner to an extent unknown in the other Triposes. It is now recommended that two examiners shall be appointed in each subject of Natural Science, to undertake all the University Examinations in that subject, and thus the Natural Sciences Tripos, the Special Examinations for the ordinary B.A., and portions of the M.B. Examinations, will be brought into one system. The examiners should never both be changed at the same time. The payments recommended are—for each examiner in Physics and in Chemistry, 50*l.*; in Botany, Zoology, Human Anatomy, and Physiology, 40*l.*; in Geology, 20*l.*; and Mineralogy, 10*l.*

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 697, January.—W. Dennis Marks, note on the losses per horse-power by condensation of steam in pipes and cylinders of engines.—De Volson Wood, the cheapest point of cut-off.—Prof. R. H. Thurston, the theory of turbines. This is the conclusion of a very valuable mathematical paper given in a very full abstract.—B. N. Clark, water-line defence and gun-shields for cruisers.—W. Dennis Marks, economy of compound engines.—Prof. E. J. Houston, the Delany synchronous-multiplex system of telegraphy. This invention is founded on La Cour's phonic wheel, and bids fair to supersede harmonic multiple telegraphs.

Annalen der Physik und Chemie, xxi. January.—O. Fröhlich, measurements of sun-heat. Describes amongst other matters a new pyrheliometer with a special thermopile arrangement.—A. W. Velten, the specific heat of water. The results confirm Regnault's values.—E. Pirani, on galvanic polarisation. The values are estimated by a compensation method.—W. Hittorf, on electric conductivity of gases (first part).—A. Oberbeck, on electric oscillations and on phenomena of polarisation caused thereby.—A. Toepler, on the estimation of horizontal magnetic intensity by use of the balance.—W. von Bezold, a simple experiment on the connection between the temperature of an incandescent wire and the composition of the light emitted by it. A platinum wire is stretched horizontally through the tip of a Bunsen burner and examined in a spectroscope with horizontal slit.—E. Ketteler, reply to Herr Voigt's criticisms.

No. 2, February.—S. Czapski, on the thermal variation of the electromotive force of galvanic batteries, and its relation to their free energy.—J. Kollert, on the properties of flame in their electrical relation. Confirms the previous measurements of Elster and Geitel.—F. Fuchs, on a compensation-method for estimation of the resistance of unpolarisable elements. A modification of Poggendorff's well-known method.—E. Budde, on the theory of thermo-electric forces.—H. Lorberg, on electrostriction. A discussion of Quincke's results.—B. Weinstein, on the calculation of the potential of coils. A mathematical paper.—A. von Waltenhofen, on an instructive experiment which may be made with asymmetrical thermopiles. On passing an independent current through the thermopile certain non-reversible phenomena of polarisation are observed arising from the asymmetry of the junctions that are heated.—C. Christiansen, on the emission of heat from uneven surfaces.—A. Tschirch, researches on chlorophyll and some of its derivatives.—W. Holtz, a lecture experiment in proof of the law that the velocity of rotation increases as the rotating masses approach the axis.

Journal de Physique, tome iii. No. 2, February.—G. Lippmann, physical definition and determination of absolute temperatures. This is the first part of a communication in which the author seeks to find stricter thermodynamic definitions of temperature. He attributes to Carnot the discovery of the scale of absolnte temperature!—D. Gernez, researches on the duration of the solidification of sulphur, and on a new variety of sulphur. The crystallisation in octahedra takes from 25 to 100 times as long as the crystallisation in rhombic prisms. The new crystalline kind obtained by M. Gernez is in the form of very elongated prisms of a nacreous texture. They are produced by rubbing the side of the test-tube containing the surfused sulphur with the end of a platinum wire or glass rod. When these crystals are introduced into surfused sulphur, they determine a growth of similar crystals throughout the mass; and the formation is much more rapid than that of either of the previously known forms.—E. Mathieu, suspension of a liquid by a capillary vertical tube.—E. Mathieu, modification of the pressure of a liquid by capillary forces.

Rendiconti del R. Istituto Lombardo, Milan, January 24.—Biographical memoir of Emilio Cornalia (1824–1883), by Prof. Leopoldo Maggi.—Necrological notice of the late Camillo Hajech.—*Résumé* of the meteorological observations made at the Brera Observatory, Milan, during the year 1883, by E. Pini.—Some applications of Cournot's principle of least effort to the equilibrium of linked systems (theoretical mechanics), by Prof. G. Bardelli.—Meteorological observations made at the Brera Observatory during the month of January, 1884.

SOCIETIES AND ACADEMIES

London

Mathematical Society, March 13.—Prof. Henrici, F.R.S., president, and subsequently Mr. S. Roberts, F.R.S., vice-president, in the chair.—The Rev. A. C. E. Blomfield, Messrs. J. Chevallier, E. H. Hayes, R. S. Heath, and Prof. J. Larmor were elected Members.—Mr. Tucker read a paper by Prof. M. J. M. Hill on the closed funicular polygons belonging to a system of coplanar forces having a single resultant; and communicated a paper by Prof. J. Larmor, on the direct application of the principle of least action to dynamical analogues.—Mr. J. W. L. Glaisher, F.R.S., read a paper on the square of Euler's series.—Mr. J. J. Walker, F.R.S., communicated a note by Mr. J. Griffiths, further results from a theory of transformation of elliptic functions.—Mr. S. Roberts, F.R.S., read a note concerning the Pellian equation.

Physical Society, March 8.—Prof. Guthrie, president, in the chair.—Lord Rayleigh read a paper on the electro-chemical equivalent of silver. The determination was made by a method described to the last meeting of the British Association at Southampton, which consists in using two fixed coils and a movable coil suspended between these from one end of a balanced beam. These coils are in circuit with the current and voltameter. The current is reversed in the fixed coils at intervals of five minutes, and the weight required to bring the balance even is noted. The calculation of the effect by this method is independent of the precise measurement of the coils. Two or more silver voltameters were in circuit, nitrate of silver being the solution used. Careful precautions of various kinds were taken, and the result was that unit C.G.S. current deposits $1 \cdot 118 \times 10^{-2}$. It follows that 1 ampere will deposit 4·025 grm. of silver per hour.—Lord Rayleigh also read a paper on the absolute electromotive force of Clark's cell. Experiments made at the Cavendish Laboratory gave the electromotive force of this cell as 1·453 volts. The accepted value is 1·457 volts. If the B.A. unit (as Lord Rayleigh believes) is about ·9867 of a true ohm, the result, 1·453, becomes 1·434 volts.—Lord Rayleigh also mentioned that he had been making experiments on the rotation of the plane of polarised light in bisulphide of carbon, and obtained a result agreeing more nearly with Gordon's than with Becquerel's.—Profs. Guthrie and Ayrton spoke on the papers, the former eliciting the reply that electro-corrosion was less satisfactory than electro-deposition for determining the equivalent; and the latter that silver was better than copper for accurate results in the voltameter.—Mr. Shelford Bidwell, M.A., read a paper on some experiments illustrating an explanation of Hall's phenomenon. By these experiments Mr. Bidwell sought to explain Hall's effect through a combination of mechanical stress and the well-known Peltier effect on the thin metal plate which is placed between the poles of the magnet. He repeated many of the experiments, and showed how he had obtained the same results as Hall, except in the case of aluminium, which he found to be + like iron, whereas Hall made it −. Mr. Bidwell reversed the effect by cutting two slits in the strip of metal, thereby altering the stress on it. Righi's effect was also explained on the same grounds. Mr. Walter Browne said that difference in the quality of the aluminium might explain the anomaly with this metal. Prof. Perry criticised the explanation of the slitted plate, and Prof. G. C. Foster suggested that results in absolute measure should be obtained.

Edinburgh

Royal Society, February 18.—Sheriff Forbes Irvine, vice-president, in the chair.—Prof. Tait read a paper on radiation, in which he called attention to Stewart's papers of 1858 as containing, so far as it has yet been developed, the theory of exchanges. Yet, in the most recent authoritative treatise on the subject, the name of Stewart is not even once mentioned. The basis of the whole theory is Carnot's principle, and therefore no demonstration can be considered absolutely rigorous. Thus it is probable that as there are very hot particles in a gas at ordinary temperatures, so there may be feeble radiation of high wave-lengths from a black body at ordinary temperatures.—Mr. Sang read a paper on the need for decimal subdivisions in astronomy, trigonometry, and navigation, in which he pointed out the inconvenience of the sexagesimal system, and estimated it as doubling the labour of calculation. The decimal division of the second, used throughout the *Nautical Almanac*, was appealed to as evidence of the need for a change. The paper was accompanied by a number of tables suited to the decimal division of the quadrant, or useful therefor.—Prof. Ewing communicated a paper by A. Tanakadaté on an electromagnetic declinometer.—Prof. Tait showed that when one polygon has its corners at the middle points of the sides of another, the condition that the first, second, or *n*th derived polygon shall be similar to the original, involves a singular equation in quaternion differences.—Prof. Tait also made some remarks on the basis of the theory of vortex atoms, pointing out that there is not necessarily any direct action between vortices in a perfect fluid; the present theory, which indicates such action, being based upon the assumed continuity of motion throughout the fluid.

Paris

Academy of Sciences, March 10.—M. Rolland in the chair.—The election of M. G. Darboux was announced, as successor to the late M. Puiseux in the Section of Geometry.—On the forms presented by the nucleus of the Pons-Brooks comet on January 13 and 19 (one illustration), by M. Faye. The author rejects the explanation of these remarkable forms proposed by Bessel, who attributed to the nucleus a polarity like that of the magnetic forces. In virtue of this polarity the nucleus and anterior nuclear emission are supposed to oscillate in presence of the sun like the needle of a compass in presence of a magnet. But M. Faye sees in these changes nothing but the effect of a rotatory motion powerfully affected by solar attraction. Under these conditions the rotation may acquire irregular pendulant vibrations without having recourse to the intervention of polar forces. —Explosive gaseous mixtures; calculation of their temperatures and specific heat at the moment of explosion (continued), by MM. Berthelot and Vieille. Tables of the results of these experiments are appended for the oxyhydric and oxycarbonic mixtures, for cyanogen, and the carburets of hydrogen.—Note on a letter of the astronomer Méchain in connection with the completion of the triangulation of Spain and the extension of the meridian to the Balearic Isles, by M. J. Lefort.—On a differential equation of the third order, by M. E. Gonrsat.—On the decomposition of polynomes which admit only of primary divisors of a determined form, by M. Lefébure.—On the remarkable variation of the nucleus of the Pons-Brooks comet (one illustration, by M. Ch. Trépied.—On the barometric oscillations produced by the Krakatoa eruption, by M. P. Tacchini.—On the crepuscular and auroral lights observed at Morges, in Switzerland, during the winter of 1883–84, by M. Ch. Dufour.—On a method for measuring the coefficient of cubic expansion of solid substances in the form of minute particles, by M. J. Thoulet. To determine the coefficients of these bodies the author employs a solution of iodide of mercury in iodide of potassium. The extreme delicacy of the process is shown by its application to quartz, which yields a coefficient of 0·0000357 compared with M. Fizeau's 0·00003619. —On the action of two consecutive parts of the same electric current, by M. A. Buguet.—On the spectrum of absorption of water; preliminary studies connected with the spectral analysis of the rays transmitted through a more or less dense layer of water, by MM. J. L. Soret and Ed. Sarasin.—Action of electric effluvia on oxygen and nitrogen in the presence of chlorine, by MM. P. Hautefeuille and J. Chappuis.—Observations on the formula of some sal ammoniacs, by M. R. Engel.—Observation relative to a note of M. Calmels on the poison of Batrachians, by MM. A. Gautier and Étard.—On the Malpighian vessels of the Lepidoptera, by M. Cholodkovsky.—On an aberrant form of the phylum Sporozoa, by M. J. Kunstler.—On the presence of manganese in the white cipoline marbles of Carrara, Paros, and the Pyrenees; geological deductions, by M. Dieulafait.

BERLIN

Physical Society, February 22.—Prof. Landolt produced a cylinder of solid carbonic acid he had prepared about an hour before the sitting, and described the mode of its formation. From a Natterer compressing vessel a stream of liquid carbonic acid was made to penetrate into a conical cloth bag. The bag speedily got filled with a loose snow of carbonic acid, which was then, by means of a stamper, hammered together in a cylindrical vessel into a solid cylinder. Compact carbonic acid cylinders of this kind could be touched gently with the hand, and possessed the hardness of chalk, which, too, they resembled in appearance, and on account of their brittleness did not readily admit of being cut with a knife. The specific gravity of solid hammered carbonic acid was found to be 1·2.—Prof. Schwalbe showed on a beech twig the ice-swellings he had described at the last sitting. These were produced in a moderately freezing mixture, their formation failing in a strongly freezing mixture. A twig which by way of experiment had been completely dried entirely lost the capability it previously possessed in a high degree of forming ice protuberances.—Prof. Erdmann related an observation he had made some time ago, and had since very frequently repeated. In a perfectly dark room he was able only by indirect vision to perceive an object which reflected light very faintly, while, on endeavouring to look at it fixedly, the object completely disappeared. This phenomenon he observed only in the evening in going to bed, after he had been working for a considerable time in a brightly illuminated room. On the other hand, when he awoke in the night he perceived the faintly lucent object quite as well by direct as by indirect vision. He was of opinion that this phenomenon was connected with the lassitude of the middle parts of the retina, while Prof. von Helmholtz explained it by the inferior sensitiveness to light of the yellow spot in comparison with its surroundings.—Dr. Kœnig reported at length the experiments which in common with Dr. Dietrici he had instituted with a view to determining the colour-sensitiveness of normal eyes. Exhibiting the apparatus he had made use of, Dr. Kœnig explained its construction and the procedure he had followed in the experiment. Towards one angle of a prism was directed an observing telescope, which, instead of an eye-piece, had a diaphragm provided with a slit, on which the spectrum fell, so that it was possible to observe sections of any degree of minuteness whatsoever. Towards each of the two other angles of the prism was placed a collimator, which in the focus of its lens had a slit for the entrance of the light, which was polarised by means of a Nicol prism. Behind the slit was a double refracting prism, by varying the position of which in the collimator the slit-image could be doubled at pleasure. Through the slit of the objective were seen close beside each other the spectrum of the light which had passed through one collimator, and the spectrum of light which had passed through the other. While one collimator was now kept fixed, the other, by means of micrometers, was displaced till the point was reached at which the observer found the colours in both spectra alike. The wave-lengths in both spectral stripes were then measured, and their difference was the standard of colour-sensitiveness in the single regions. For each wave-length fifty readings were in this way made by each of the two observers, and the mean difference calculated of the wave-lengths in the two spectral ranges, which were perceived to be equal. These experiments extended from the wave-length of 640 millionths of a millimetre to the wave-length of 430, and were made from each 10 millionths of a millimetre, each particular spot being examined under two different intensities of light. From the results of these measurements it was established that the colour-sensitiveness of normal eyes ranged from more than 1 to about 0·2 millionths of a millimetre. The difference of the D-lines in the solar spectrum amounted to 0·6 millionths of a millimetre. Altogether three maxima of sensitiveness were found. The first maximum appeared with the wave-length of 570 near the D-line. A second greater maximum approached the F-line with a wave-length of about 490 to 470. Finally, a third smaller maximum was found with a wave-length of 450 to 440. The place of the maximum changed with the intensity in such a manner that, the greater the intensity was, the more the maximum shifted towards the more refrangible part of the spectrum. Beyond the wave-lengths of 640 and 430 these experiments could not be carried out, because, at the red end especially, no differences of colour, but only differences of brightness, were perceived. From the colour sensibility thus found, it was calculated that within the range of the normal spectrum the healthy eye was able to perceive about 300 differences of colour. Dr. Kœnig hoped to be able to set forth on a future occasion further experiments in conjunction with the measurements here communicated, and the consequences resulting therefrom in respect of the theory of the perception of colour.

CONTENTS

THURSDAY, MARCH 27, 1884

THE CHOLERA BACILLUS

IN his capacity as chief of the German Cholera Commission Dr. Koch has issued a further—his sixth—report, and it is one which must become historic in connection with inquiries as to the etiology of that disease. Hitherto Dr. Koch has almost entirely confined himself to reporting facts as they were elicited, and whenever he has referred to any inferences which might be drawn from them, it has only been to show how many sources of error stood in the way of all attempts to arrive at trustworthy conclusions. This attitude of Dr. Koch has naturally tended to increase the confidence in which he is held as a scientific worker, and it has an important bearing on the character of the present report, in which the reserve hitherto maintained is thrown off, and Dr. Koch announces that the bacilli he has discovered are altogether peculiar to cholera, and further, that they are the actual cause of cholera.

The further investigations which have been made relate to the cultivation of the bacilli in question, to their behaviour in the bodies of patients during the various stages of the disease, and to the examination of additional bodies of persons dying both of cholera and of other diseases. The result is that what are now termed the cholera bacilli can be found in no bodies except those of cholera patients; that at certain stages of the cholera disease they are invariably found in the bodies of the patients, whether these have lived and died in Egypt or in a country so far distant from it as India; that these organisms confine themselves to the organ which is the seat of the disease, namely, the bowel; and that they behave exactly as do other pathogenic bacteria, their first appearance coinciding with the commencement of the disease, their increase being proportional to its advance, and their disappearance corresponding with its decline. Certain incidental studies have also tended to confirm the correctness of the hypothesis that these bacilli are the cause of cholera. It is well known that the linen of cholera patients, has conveyed the infection of that disease. Now Dr. Koch has repeatedly observed that such linen, when soiled by the alvine discharges and kept moist for a period of twenty-four hours, has been the seat of an extraordinary multiplication of the special organisms; and in connection with these experiments it was found that precisely the same result took place whenever cholera dejections, or the contents of the intestines of persons having died of cholera, were spread upon such substances as moist linen or blotting paper. And further, a thin layer of the same discharges, when placed on a moist soil, was found within twenty-four hours to have been converted into a thick mass of cholera bacilli. This latter discovery is one of extreme importance in connection with the observations so frequently made as to the spread of cholera in India by means of water-sources, the soil around which is so often befouled by the natives.

From one point of view the report gives special promise. Some bacilli of disease will, in certain stages, withstand almost every form of maltreatment; they may be dried, frozen, and otherwise dealt with, and yet they remain as potent as ever for mischief. But Dr. Koch's cholera bacilli die off rapidly when dried, all vestige of life apparently disappearing after three hours' desiccation. And not only so, but these bacilli will only grow in alkaline solutions, a very small quantity of a free acid standing in the way of their development. To these two circumstances we may in all probability to a large extent attribute the frequency with which those who are directly associated with the sick and their discharges escape infection; and the fact that the healthy stomach contains a sufficient amount of acid to destroy the bacilli may possibly lead to the discovery of some therapeutic or other measure of prevention which may be generally adopted. Directly gastric disturbance steps in and the gastric juices give a different reaction, we are probably face to face with conditions specially favourable to the reception of the poison, and in this respect it is noteworthy that cholera so often attacks those persons who have suffered, or are suffering, from diarrhœa and other gastric disorders.

In one respect Dr. Koch's experiments have failed. He has not succeeded in producing cholera artificially in any of the lower animals. As we have already pointed out, cholera is not the only specific disease to which man alone appears to be susceptible; and it is possible that the fact of cholera discharges and portions of diseased intestines having been given as food to the lower animals with impunity may find much of its explanation in the absence, in the stomachs of those animals, of the needed alkaline cultivation fluid.

At one point of the report our confidence in the correctness of Dr. Koch's inferences is weakened. It is where he, in maintaining his view that the bacillus he has discovered is the actual cause of cholera, refers to its resemblance in one respect to the bacillus of enteric fever. Now, leading micro-pathologists in this country have hitherto declined to regard it as proved that any such specific bacillus has been discovered. Dr. Koch's views have therefore still to stand the test of scientific criticism by his fellow workers, who will doubtless, as occasion offers, repeat his experiments.

THE SCIENCE OF THE EXAMINATION-ROOM

THOSE persons whose unhappy lot it is to have much to do with examinations must often feel that there is some fundamental common factor dropped out in the relation between examiner and examinees. A straightforward paper is set in a subject, say A, in which we will suppose there is no attempt to "catch" or perplex the student, but simply to sample, as it were, the ordinary commonplace knowledge which average industry might acquire. There returns to the examiner in due time a mass of manuscript, evidently written with pains and labour, mostly quite seriously meant, but which does not deal with the subject A, but with something which, though apparently related, is evidently quite different, and which we may call A′. After a little while he begins to wonder whether the whole thing is not a nightmare. The form is apparently rational, and yet the details are hopelessly incongruous and absurd. Or, to put the thing in another shape, it is as if one set a paper in solid geometry and got answers from Prof. Sylvester's infinitely thin book-worm.

If the examination-system is to be maintained without being on the one hand hopelessly discredited, or on the other lapsing into a kind of ceremonial observance like academic dress or a Guy Fawkes celebration, something must seriously be done to ascertain the real relation between A and A′. It is generally presumed that the object of "plucking" a candidate is to indicate to him his imperfect knowledge. But though the student of the subject called A′ is usually plucked by the examiner in A it is not clear that what may be called the moral result is in any way satisfactory. The examiner is disgusted equally with the candidate who has likely enough done his very best, just as the infinitely thin book-worm might do his best. The candidate grinds away at his A′ with more assiduity than ever if he is modest enough to think his ignorance to be in fault; but this only makes his subsequent failures with the examiner in A more assured, because the radical incommensurability of A and A′ becomes more intensified.

There is really reason to think that underneath the rational fabric of science as understood by intelligent persons of common sense there is a vast substratum of something altogether different, but with which a large number of individuals are quite seriously occupied. A′ is only a term in fact of a very considerable series. Every now and then in the pages of this journal strong evidences crop up of the existence of this singular body of knowledge. This existence, however, is scarcely really grasped by the scientific world proper, and it might be compared to a sort of inverse of Prof. Tait's unseen universe.

The present state of things can hardly go on. It is quite certain that, whatever intrinsic interest science of the A′ type may possess, it is of no kind of practical use to ordinary human beings. If it cannot be displaced by the real thing of which it is a kind of phantom, it is a serious question whether the struggle of the examination-room had better not be for a time suspended.

In the meantime it is very important to investigate the true nature of this phantom science. A little work, of which the second edition has been lately sent to this journal for review, appears to belong to its literature, which there is reason to think is rather copious. This particular publication is part of the "Students' Aids Series," bears the motto, "*Mens sana corpore sano*," and deals with botany.[1] It is impossible to seriously criticise it; indeed, from the point of view of what has been said above it would not be easy to do so. We may content ourselves with reproducing textually from its pages the *entire account* given of a well-known and very characteristic group of Thallophytes :—

THE OLIVE SEAWEEDS.

These weeds vary in general appearance from small tufted filaments to immense stalks terminated by a branched thallus.

In the higher forms a shrubby aspect, a kind of root, and an epidermal layer are observed. Their colour is not bright green, but in general olive.

The zoospores originate in **Oosporangia**, situated at ends or joints of the frond, or in each of the cells of a filamentous body called a **Trichosporangium**; they resemble those of the Green Algæ.

The zoospores from the Trichosporangium have been mistaken for spermatozoids.

The spores reside in sacs termed **Perispores**, having a lining membrane, the **Epispore**.

The perispores or sporangia are either scattered or are arranged in **Sori** or groups on the frond's surface, or in cavities, **Scaphidia** or conceptacula, communicating by a pore with its surface.

The scaphidia may appear as club-shaped masses or receptacula at the edges of the frond.

The antheridia are ovate sacs which contain **Antherozoa** or **Phytozoa** (two ciliated spermatozoids), and appear on slender filaments in the same or other plants, and in the same or other conceptacles as the spores. If on the same plant, they are called **Monœcious**; if on different, **Diœcious**. When in the same conceptacles with the spores, they are Hermaphrodite. To the slender filaments destitute of antheridia the name of Paraphyses is given.

We must leave to our botanical readers to notice for themselves where this instructive specimen of A′ science differs from the kind of lesson which an ordinarily constituted teacher of real botany would try to communicate to his pupils. At any rate we may ask, would any one having learnt all this by rote (for there is reason to think that such is the method insisted upon) be secure in recognising a piece of bladder wrack when shown to him, or certain of any single fact in its life-history.

A curious point about the A′ science is the copiousness and more or less unintelligibility of its terminology. There is no doubt, however, that this is very generally mastered, however repulsive such a task might seem at first sight. But the problem is still unsolved as to what is the end gained. With the same effort it is probable that the rudiments of an Oriental language might be acquired—say Arabic—and the question arises whether in every way this would not be more profitable.

[1] "Aids to Botany." By Armand Semple, B.A., M.B., Cantab.; L.S.A., M.R.C.P., Lond., Physician North-Eastern Hospital for Children, Hackney, Physician to the Royal Society of Musicians, late Senior Examiner in Arts at Apothecaries' Hall, late Medical Clinical Assistant and Surgical Registrar at the London Hospital, author of the "Essential Features of Diseases of Children," "Aids to Chemistry" (Inorganic and Organic), "Aids to Materia Medica" (Inorganic and Organic), "Tablets of Materia Medica," "Aids to Medicine." (Double Part.) Third Thousand. (London: Baillière, Tindall, and Cox, King William Street, Strand. Dublin: Fannin and Co., Grafton Street. Edinburgh: MacLachlan and Stewart, South Bridge. Glasgow: A. and W. Stenhouse, College Gate. New York: Putnam and Sons, 1883.)

LEFROY'S MAGNETIC SURVEY IN CANADA

Diary of a Magnetic Survey of a Portion of the Dominion of Canada, chiefly in the North-Western Territories. Executed in the Years 1842-44. By Lieut. Lefroy, R.A., now General Sir J. H. Lefroy, C.B., F.R.S., &c. (London: Longmans and Co., 1883.)

THIS record of magnetical work performed forty years ago by Lieut. Lefroy of the Royal Artillery—now General Sir J. Henry Lefroy—is a contribution of interest to the science of terrestrial magnetism.

The Magnetic Survey of the British Possessions in North America authorised by Her Majesty's Government in the year 1841 at the recommendation of the Royal Society, and in great part executed in 1843 and 1844 under the supervision of the late Sir Edward Sabine, had for its primary objects the determination of the regular and irregular changes of the magnetic elements, especially that of the horary variation of the declination; this variation being then known as subject to wide differences in the high magnetic latitudes of the northern hemisphere as compared with those observed in middle latitudes, both in respect of the turning hours and in the direction of the movement at the same local time. Furthermore, investigation of observations made by Polar voyagers and Arctic travellers had shown that the northern part of these British possessions was a region of peculiar interest as comprising in its area the most powerful of the two foci of magnetic intensity in the northern hemisphere, and also the locus of vertical dip commonly recognised as the North Magnetic Pole.

To Lieut. Lefroy—furnished with transportable magnetometers—was assigned the arduous and responsible duty of traversing this region of such striking magnetical interest, to determine the absolute values of the declination, inclination, and intensity at available stations; and at one or more fixed winter residences in high latitudes to make hourly and term day observations of those regular and irregular fluctuations in the movements of the needle presumed to exist in values of more than ordinary magnitude.

Sir Henry Lefroy's present volume contains the diary of his journeys—these latter extending to 5480 geographical miles—in which is given in more or less detail the magnetical elements determined at three hundred and fourteen stations, combined with such astronomical observations as were necessary, in the then imperfect state of the maps of the region traversed, to approximately assign the geographical positions of the places of observation.

The extended series of hourly and term day magnetical and meteorological observations made at the fixed winter and spring residences [1843-44] of Fort Chipewyan on Lake Athabasca (lat. 58° 43′ N., long. 111° 19′ W.), and at Fort Simpson on Mackenzie River (lat. 61° 51′ N., long. 121° 25′ W.), with their very complete and able discussion by Capt. Lefroy, were printed by order of Her Majesty's Government in 1855. This masterly work is well known to those interested in the science of terrestrial magnetism. The Diary now for the first time published is a fitting sequel to the earlier work; and is not the less valuable from what may appear to be its tardy production. The author's preface—which conveys a graceful tribute to his old chief—in a few words clears up the seeming anomaly. He says:—

"The renewed attention directed to the distribution and periodical changes of the earth's magnetism in the North Polar region, suggests an endeavour on my part to present the observations of my magnetical survey of 1843-44 with fuller explanation, and in a form more convenient for reference than that in which they were originally published" [Sabine's 'Contributions to Terrestrial Magnetism,' No. vii. *Philosophical Transactions*, 1846, and No. xiii. *Philosophical Transactions*, 1872]; "and being still the principal authority for the received position of the focus or pole of greatest magnetic intensity, as well as for the lines of equal magnetic force, equal inclination, and equal variation over a large part of the continent of North America, it is certain that whenever they come to be repeated, the observer of the future will inquire for particulars not contained in, and not suitable for, the *Philosophical Transactions*."

Apart from the value of a full record of the observations made over so great an extent of continental America, is the consideration of the graphical treatment of the isoclinal and isodynamic lines, as embodied on maps accompanying the Diary. The author dwells on the difference in rendering the mapped results on the system followed by Sabine—as given in the *Philosophical Transactions*—and on that adopted by himself. Sabine's aim was to present, over the vast area he was dealing with, the normal values of the magnetical elements, free—so far as his judgment permitted—from the local disturbances experienced at individual stations, depending on geological conditions; and stations at which the disturbances obviously affected the assumed normal values were designedly rejected. Lefroy's treatment includes every station at which he set up his instruments, rejecting no observation because of its anomaly where there was no internal appearance of error. By the one investigator we are thus presented with a harmonious mapped system of regular lines or curves indicating equal values of the magnetic elements; by the other the equivalent lines of equal values are more or less sinuous, in some places much distorted, and losing the semblance of regularity.

In the case of the isoclinal lines as so developed, the author partly infers that their greater inflections bear some relation to the courses of the rivers; and he further draws attention to his isodynamic lines or curves, differing both in form and position from those of Sabine.

In a discussion as to the appositeness of either of the systems pursued, it must be borne in mind that, at numerous well-known points on the earth's surface, a movement made by the observer of the magnetic needle a foot or two vertically, or a few feet horizontally, either way, considerably affects the observations. This is notably the case at many oceanic islands, and a marked example is to be found on our own coasts at Canna near the island of Skye. Sir H. Lefroy's experiences in this direction are well marked at Stations LII. and CXXI., where the total force observed was 15·26 and 15·38 respectively; the normal value undoubtedly was about 14·10 and 14·15; the disturbance from a local geological cause thus increased the total force by 1/14th. It is therefore certain that, unless we have some fairly approximate knowledge of the normal value of the magnetic elements at the disturbed station, we should remain in ignorance of the extent of the disturbance.

In the present state of our knowledge of the distribution of magnetism in the several determinate values of declination, inclination, and intensity over the earth's surface—limited in the best explored regions to a very small number of points of observation compared with the great areas of land and water which they represent—it appears premature to give interpretation to local disturbances as being connected with topographical features rather than geological. On general grounds we must consider the delineation of the normal lines in any region as a primary need, whether in a theoretical or a practical direction.

Local magnetic disturbances demand a special study; this has been given effect to in a theoretical direction by Lamont in Germany ("Researches on the Direction and Intensity of Terrestrial Magnetism in Northern Germany, Belgium, Holland, and Denmark in the Year 1858," Munich, 1859), and practically is being now worked out in the United States; it is understood a special magnetic survey of the State of Missouri is nearly complete.

As magnetical observations multiply over large areas of land, it is possible that the normal lines may be found to lose symmetry by disturbing causes which may extend over many square degrees of surface, as distinct from local irregularities. Lamont's observations in continental Europe point to this. A first essay on a large scale has been lately made by the able and diligent magnetician, C. A. Schott, to chart the distribution of the magnetic declination of the United States for the epoch January 1885. In this work distinct notice is taken of all local disturbances in the direction of the magnetic needle, the number of observing stations being 2359. This valuable essay is published as an Appendix to the Report for 1882 of the United States Coast and Geodetic Survey.

It should be observed that in Sir Henry Lefroy's maps the lines of magnetic declination are reproduced as given by Sabine; in Mr. Schott's paper this is the only element discussed, doubtless from the more ample material at his command, and possibly from its practical value for topographical, geological, or mining purposes.

Whenever the time arrives for undertaking a magnetic survey of the British possessions in North America, Sir Henry Lefroy's Diary will be invaluable as a pioneer work. At the present time his early published magnetical and meteorological observations at Lake Athabasca and Fort Simpson are of great interest in connection with those recently made in a neighbouring region by Capt. Dawson, R.A., at the International Circumpolar Station, Fort Rae.

F. J. EVANS

EXCURSIONS OF AN EVOLUTIONIST

Excursions of an Evolutionist. By John Fiske. (London: Macmillan and Co., 1884.)

MR. FISKE is certainly one of the most successful of the writers who have undertaken the task of popularising the many new ideas which have been originated by the theory of evolution. He has not himself added anything of any importance to these ideas; but, having accepted them with enthusiasm, he represents them to the public with so much force and clearness, as well as grace of literary style, that while reading his pages we feel how the function of a really good expositor is scarcely of less value in the world than that of an originator. The applicability of these remarks to his earlier works will, we think, be generally recognised by the readers of this journal; and, if so, they are certainly no less applicable to the series of essays which we have now to consider.

The first essay is on "Europe before the Arrival of Man," and it gives an exceedingly clear and well-condensed *résumé* of the present standing of the question as to the probable date of man's appearance in geological time. Next in logical order we have three essays on "The Arrival of Man in Europe," "Our Aryan Forefathers," and "What we learn from Old Aryan Words." Within the compass of the pages allotted to them we do not think that it would be possible to give a more instructive and entertaining history than is presented by these chapters. The fifth essay is on the question, "Was there a Primitive Mother-Tongue?" which is very conclusively answered in the negative. "Sociology and Hero-Worship" is devoted to arguing the relations that subsist between a genius and the age or society in which he lives; this is appropriately followed by the essay on "Heroes of Industry," which is a kind of historical sketch of the philosophical principles that govern the possibilities of invention. A new point of departure is taken in the next three essays on "The Causes of Persecution," "The Origins of Protestantism," and "The True Lesson of Protestantism." Here the main argument is that the rise of Protestantism and the decline of the persecuting spirit are due to an increasing recognition of the right of private judgment, coupled with an increasing refinement of moral feeling. The theory of corporate responsibility, which is more or less essential to the integrity of the social state in the earlier stages of its development, becomes gradually superseded by the theory that the individual is alone responsible for his beliefs and actions; hence the growing recognition of the right of private judgment. "The Meaning of Infancy" is a brief restatement of the author's views already published in his "Cosmic Philosophy." These are the views which deserve to be regarded as perhaps the most original that Mr. Fiske has enunciated. The general fact that the protracted period of infancy among the anthropoid apes (and therefore presumably among the brutal ancestry of man) must have had a large share in determining the evolution of man is a fact which could scarcely escape the observation of any attentive evolutionist; but Mr. Fiske is the only writer, so far as we are aware, who has treated this fact with the consideration that it deserves. Of the remaining essays, "Evolution and Religion" is an after-dinner eulogium on Mr. Herbert Spencer, "A Universe of Mind-Stuff" is an exposition of Clifford's essay upon this subject, and "In Memoriam: Charles Darwin," is a well-written obituary review of Mr. Darwin's life and work.

As we have not detected any errors on matters of fact, the only criticisms we have to make pertain to matters of opinion. In particular, it appears to us that, in his anxiety to raise the cosmic theory of evolution into a religion of cosmism (or, as he terms it, in his earlier work, "Cosmic Theism"), Mr. Fiske entirely loses the clearness of view and precision of statement which elsewhere characterise his work. Although no friend or admirer of Comte, with a strange inconsistency he follows implicitly the method of the French philosopher in blindfolding judgment with metaphor, and then, without rein or bridle, running away upon a wild enthusiasm. We have here no space to justify this general statement, but we feel sure that no sober-minded man can read the after-dinner speech or eulogy on Mr. Spencer without feeling that its extravagance runs into absurdity. We have no wish to deprive Mr. Fiske of any happiness that he may derive either from his "religion" or from his "hero-worship"; but we cannot review his essays without observing that in neither of these respects is he likely to meet with much sympathy among "men of science," to whose opinion he habitually professes so much deference.

GEORGE J. ROMANES

OUR BOOK SHELF

The Zoological Record for 1882. Being Vol. XIX. of the Record of Zoological Literature. Edited by Edward Caldwell Rye, F.Z.S., &c. (London: Van Voorst, 1883.)

ALMOST before the shadow of 1883 had passed away, the "Record of the Zoological Literature of the Year 1882" made its appearance, and the circumstances attending its publication are, as the editor informs us, without precedent in the nineteen years during which this important and most valuable annual has been issued. The sudden death on the Niger of Mr. W. A. Forbes, the late recorder of the literature relating to the mammals, was soon followed by the loss of the help of Mr. Howard Saunders in the arduous work concerning the recording of the literature of the birds. These severe losses have been supplied by Mr. Oldfield Thomas and Mr. R. B. Sharpe. In the records of the fishes Mr. Boulenger has had the assistance of Mr. R. Ogilvie-Grant. Mr. Ridley has handed the recording of the Protozoa over to Mr. W. Saville Kent, and the Myriapod literature has fallen to Mr. I. D. Gibson-Carmichael. It thus happens that of the recorders who, just twenty years ago, assisted Dr. Günther in the arduous undertaking of bringing out the first volume of this work, but one, Dr. E. von Martens, still responds to the editor's call, though happily all of the first recorders still survive to overlook and appreciate the labours of their successors.

The editor apologises for some slight delay in the appearance of the volume, owing to the mechanical difficulties brought about by all these changes, difficulties only to be thoroughly understood by those who have experienced them, and which we trust will not trouble the editor again. It is not without interest to note that nearly two-thirds of this volume is compiled by officers of the Natural History Department of the British Museum; indeed, if we include Dr. E. von Martens' work, and remember that he occupies the position of assistant in the Natural History Museum of Berlin, it would appear that over 600 out of 700 pages have been compiled by writers whose lives are devoted to the subjects about which they write.

The editor has again to thank the British Association for the Advancement of Science and the Government Grant Committee of the Royal Society for kindly aid in assistance of the publication. The number of new genera and sub-genera recorded in this volume is 1015 as against 1438 in the last volume, and it will be remembered that this latter number included 483 new genera made by Haeckel.

Each recorder seems to have executed his share of the work well and painstakingly. The special treatment of the literature of each group is on the lines of that followed in the later volumes of the series. We warmly congratulate the Zoological Record Association on the result of their editor's labours.

Sketches of North-Western Mongolia. Vol. IV.—*Ethnographical Materials.* By G. N. Potanin. 1025 pages, with 26 Plates (Russian). (St. Petersburg: Published by the Russian Geographical Society.)

THE first two volumes of this important work contained the results of the journeys by the author in 1876 and 1877. The third, which is in print, will contain the geographical materials collected during the journey of 1879, and the volume we have before us deals with the ethnographical part of the same journey. It begins with an enumeration of the Turkish and Mongolian peoples who inhabit the region: Tartars, Uryankhays, Kirghiz, Durbuts, Darkhats, and Buryats, with the legends current about their origin. There is no general sketch of the populations dealt with; the aim of the author seems to have been to give in this volume a collection of materials, rather than to enter the field of general conclusions. With regard to the former, the present volume is a most valuable one. We find in it interesting facts as to the family, social, and religious life of the inhabitants; a list of names of stars, plants, and animals, together with the beliefs about them, and finally, their legends and folk-lore. Of these, no less than 200 are given, containing a rich and new source of information. On almost every one of the 500 pages occupied by these legends and tales one is attracted either by their poetical beauty or by the light they throw on the mythology and popular conceptions of the inhabitants of this border region of Central Asia; while M. Potanin's name is the best warrant for the accuracy of the transcription of the legends reported. However rich this material, one hesitates to say which of the two is more valuable, the folk-lore published, or the annotations which follow them. These last cover 300 pages of small type, and we find there, philological explanations, comparisons with the legends of other Finnish tribes, most valuable materials for comparative mythology, and so on, all being the result of a thorough study of nearly the whole of the Russian literature of the subject, disseminated through periodicals of the most various descriptions. While perusing these invaluable materials one only regrets that the author has not yet been brought to summarise his wide studies and to draw therefrom some conclusions which may enter into the domain of science. In any case a careful index of all matter mentioned in the volume would much facilitate the researches. The plates represent mostly the pictured tambourines of the shamans and the *ongons* (holy pictures and idols) of the Tartars, Uryankhays, and Buryats.

P. K.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Quintino Sella

IT is proposed to place a bronze wreath on the tomb of the distinguished Italian geologist and statesman, Quintino Sella. English geologists are invited to express their sympathy with their Italian fellow-workers by sending in their names with a small subscription. I have been requested to bring the matter before their notice, and to collect the subscriptions in this country.

THOS. M'KENNY HUGHES

Woodwardian Museum, Cambridge, March 25

Electrostatic Measurement of E.M.F.

PERHAPS you will allow me to make known through your columns to those who have from time to time made inquiries concerning my Absolute Sine Electrometer, that, after many months' work, I have satisfactorily concluded a series of experiments with the instrument which was made for Prof. Anthony. When this instrument was finished last year, I made some observations with it which were so unsatisfactory that I did not feel justified in allowing it to be sent to America. I have now, however, removed all the difficulties connected with it, and I uniformly obtain results perfectly consistent one with another. Indeed my difficulties during the last six weeks were due to the fact of my employing cells which were not sufficiently constant, and not to any fault of the electrometer, a fact which I did not realise for some time.

I hope to publish in a few days a full report on the various points connected with the instrument and on the experimental results obtained.

GEORGE M. MINCHIN

Royal Indian Engineering College, Cooper's Hill, March 24

Pons' Comet

THIS comet has been visible here some time. I first saw it at 9 p.m. on January 15, but only for two or three minutes, through the clouds. On the following evening (January 16) I saw it well. To the naked eye it looked like a star of the first magnitude seen through a haze; the tail was visible, but not at all conspicuous. In the telescope (4-inch) the head was large, but appeared wholly nebulous, with a bright central condensation; the tail broad, but faint. I could only trace it some 2° or 3°. The brightness of the nucleus must have been considerable, as when close to the horizon I could see it through a pretty thick cloud. Subsequently the nucleus has seemed to me decidedly more disk-like, I suppose from being better seen. I may add that the sunset-glows and the unusually cloudy weather we are having have interfered greatly with satisfactory observation.

Nelson, N.Z., February 1 A. S. ATKINSON

The Access to Mountains and Moorlands Bill

I AM glad to observe that you have called the attention of scientific men to the importance of Mr. Bryce's Bill. Perhaps nothing can better show the need of such a measure than certain facts in regard to the Clova district in Forfarshire, which is classic ground to the botanist; indeed, I think I may venture to say that it is the richest ground in the British Islands. From time immemorial a right of way existed through Glen Dale, and, I can remember the time when botanists could ascend any of the hills in that district without being subjected to the tender, though somewhat embarrassing attention of gamekeepers. I have good reason to believe that the case is somewhat altered in recent years, and that, after a man has gone hundreds of miles in order to see *Oxytropis campestris* growing in its only British station, he may find himself turned back just within sight of the goal. The thing can still be done by taking advantage of a curious fact in natural history, viz. that two gamekeepers cannot remain long in loving converse with three men: by keeping this fact in mind, one out of three may still study the botany of Clova. After having gone pretty well over Scotland I am glad to say that there are many places in which there is no need for Mr. Bryce's Bill. In most cases in which it is needed it is where "new men" usurp a power which the old lords of the soil never dreamt they possessed. A. CRAIG-CHRISTIE

Edinburgh, March 24

A Sixth Sense

IN the valuable address given by Sir William Thomson at the Midland Institute, Birmingham, on October 3, and reported so fully in the columns of NATURE, it is implied that Dr. Thomas Reid of Glasgow brought out the distinction of a sixth or muscular sense. I cannot find any satisfactory evidence of this, although Reid came very near it indeed when he stated in his "Inquiry into the Human Mind," chap. v. section 1:—"By touch we perceive not one quality only, but many, and those of very different kinds;" and again:—"There is, no doubt, a sensation by which we perceive a body to be hard or soft;" and again, further on he even speaks of its being strange that this sense should "be so much unknown as never to have been made an object of thought or reflection nor to have been honoured with a name in any language."

But on the other hand, while I cannot detect any attempt whatever to refer this sensation to the muscles as its peripheral origin, while speaking of our conception of the hardness of bodies, Dr. Reid says (p. 121, ed. of 1846):—"We have no way of coming at this conception and belief, but by means of a certain sensation of touch;" and again, "I see nothing left but to conclude that, by an original principle of our constitution, a certain sensation of touch both suggests to the mind the conception of hardness and creates a belief of it." Reid, in short, like his eminent predecessor Hutcheson in the same chair, was dissatisfied with the ordinary division of the senses, and really felt disposed to split up the varied phenomena bundled up under the term "touch" into two or more divisions; but it was reserved for Dr. Thomas Brown, a good physiologist according to the light of the times, and Professor of Moral Philosophy in Edinburgh (1810-2), explicitly to complete the distinction hinted at by Reid, and to refer our conception of resistance or tension (as we find in estimating weights by the hand) to a distinct sixth or muscular sense. Thus in his twenty-second lecture he says:—"The feeling of resistance is, I conceive, to be ascribed, not to an organ of touch, but to our muscular frame, to which I have already more than once directed your attention, as forming a distinct organ of sense." In the lecture which follows that, Brown admits the frequent mingling of mere tactual sensation with that of muscular effort:—"But it is not of this mere tactual feeling we think when we term bodies hard or soft—it is of the greater or less resistance which they afford to our muscular contraction."

It is remarkable that the teaching of this eminent psychologist, the preceptor of James Mill, should so early have been forgotten in Scotland. HENRY FAULDS

Laurel Bank, Shawlands, Glasgow, March 18

MR. FAULDS, in the preceding letter, is no doubt quite correct in remarking that the distinction pointed out and insisted on (not merely hinted at) by Thomas Reid, a little more than a hundred years ago, in the Moral Philosophy Chair of the University of Glasgow, was more clearly and fully defined by his eminent successor in Edinburgh, Thomas Brown. But I cannot agree with his last sentence, implying that Thomas Brown is forgotten in Scotland. In fact, my mind was so full of Reid and Brown, from my recollections of the teachings of the Professors of Moral Philosophy and Logic in this University, that, in giving my address at Birmingham, I said Thomas Brown, meaning Thomas Reid, but feeling the names of Reid and Brown both thoroughly mixed up with all I had ever learned of this subject. WILLIAM THOMSON

The University, Glasgow, March 20

Earthworms

THE theory of the formation of vegetable mould through the action of earthworms, by Darwin, received little attention when published from people who had been accustomed to examine the soils of various countries. That the vegetable soil had been formed as he states seemed to have been accepted by his followers without hesitation. In your columns, however, of late, letters have appeared from Messrs. R. M. Christy and T. E. Wilcox, showing that earthworms do not exist in the prairies in the north-west of Canada or in the United States, in those of Kansas, the Indian Territory, or in Idaho and Washington Territory. This is simply what may be expected. Notwithstanding the keenness of observation of Darwin and his width of observation, there seem vast regions where earthworms have had little to do with the formation of the vegetable soil. In many parts of Australia, and also in the moister climate of New Zealand, the soil affords few indications that earthworms ever passed it through their bodies. In a section of soil I brought from the Mataura plain, South Island of New Zealand, nothing could be seen to indicate that worms had ever swallowed it. That vegetable soil forms a fit habitation for earthworms is undoubted. Darwin admits "that a layer, though a thin one, of fine earth, which probably long retains some moisture, is in all cases necessary for their existence." Before this thin layer existed, how could they—the worms—form vegetable soil? This thin layer must have been formed in some other way; Darwin does not say how. It is not necessary to call in the aid of earthworms to do so. The very name which has been universally applied to the thin upper covering, the exterior film enveloping the surface of the deposits underneath, viz. vegetable soil, speaks to its origin in the decay of vegetation. Take for instance the boulder-clays of this part of the Lothians in Scotland, with their tough, stony texture, their pebbles as finely striated as when the ice squeezed them into the pasty mass of crushed shales out of which they appear to have been partly formed. While these surfaces could have afforded none of the conditions required by Darwin, or indeed supply any other save inorganic food, the slow growth on their surfaces of the more simple forms of vegetable life, and their decay, would in the lapse of ages supply the thin film which Darwin requires. It surely, then, is attempting too much to ascribe to the earthworm the formation of the vegetable soil. The earthworm is not the only occupant of the material which the growth and decay of vegetation supplies as a surface covering. The earthworm is not the only drainer. The roots of many plants not only descend deeply into the subsoils, but also fetch up from depths where worms could not reach supplies of material to mix with the superficial covering; and so do the various insects which have their habitat in the soil, burrowing as they go, and casting, like the mole, the stuff behind them or upwards as they descend.

So far as I have examined soils, I am inclined to think that the earthworm is far more plentiful when animal matter in a decaying state is applied to soils near the dwellings of man, or when his deposits are laid over those of the larger animals. As against the views of Hutton and Playfair, and as stated by Darwin, that the vegetable soil or mould is always diminishing, I have to say it seems entirely the reverse; it seems to have had a beginning, is increasing, and shall increase so long as vegetable and animal life covers the surface of the earth. This is not the case where vegetation ceases to cover the surface, and the sun and wind get direct access to the surface; any soil that may have been formed there soon disappears. In such situations, until vegetation has again spread itself, all the earthworms that could congregate there would only add to the decaying animal matter, as live they could not, there being no food for them in the absence of vegetation and other animal matter.

Bonnington, Midlothian JAMES MELVIN

I INCLOSE an excerpt from NATURE of January 3 (p. 213), which I saw in one of our daily newspapers. The observation there made is correct as to the absence of earthworms in the region mentioned, but the reason assigned is, I think, incorrect. It is well known to settlers on virgin soils in this country that in the first tillage of the ground they will see no earthworms. This is equally the case whether they settle upon prairie land which has been swept annually by fires, or upon wood land which has been cleared for cultivation and which has never been burned over. Even in the natural meadows called "beaver meadows," which one will chance upon in an otherwise completely forest-covered region, one will at first find no sign of the earthworm. Some sluggish stream is dammed by a colony of beavers, and the land flooded is cleared of trees by them. Alluvial deposits accumulate, and when the beavers have been killed or driven away the dam is destroyed by freshets, and the little stream regains its former dimensions, while the flooded ground, drained naturally, becomes a meadow covered with wild grasses nourished by rich depths of soil. But, until settlement and tillage by man, there is no trace of earthworms even in these most favourable localities. At first they are found about the stableyard, then in portions of ground enriched by stable manure, garden or meadow, till at length they may be found in all soils, either those cultivated or those pastured by domesticated animals.

For years I have been accustomed to go to Mukoka, in the Canadian Dominion, for shooting and fishing. This section is a wooded wilderness with numerous lakes and streams. It is still Governmental wild land, and in part unsurveyed for settlement. The frontier settlers there tell me that until a place has been inhabited for five years it is useless to search for the earthworm. HY. F. WALKER

8, East Thirtieth Street, New York City, U.S.A., March 5

The Remarkable Sunsets

THE following extract from a letter written at Auspaki, province of Vitebsk, Russia, may be of interest:—

"*February* 26 (Old Style), *March* 9

"February has been the coldest and the pleasantest month this winter, particularly the latter part of it; frost from 5° to 12° Reaumur; bright sunshine. Now we have been able to see the roseate sunsets, which for at least three months have been hidden by clouds. We are, however, so accustomed to brilliant sunsets here, that we might not have remarked them if our attention had not been directed to them. Here, generally, when the sky is clear and the frost severe, the eastern horizon is a misty blue, above which is a rosy streak melting away into the clear blue above. But these latter sunsets have differed from that in a great measure. The west has often been blood-red. and the eastern horizon has been rosy, not so much in a streak but in patches, which have sometimes been visible over head. At the beginning of the month I was in Riga, and found the river open below bridge; indeed, the navigation has not been closed the whole winter. Snow there was none in Riga, and I saw them carting the most miserable ice for the ice-cellars; I think it was little more than six inches thick. We have been favoured here; we have retained our snow, and have had, and still have, good sledge roads. We filled the ice-cellar the day before yesterday, and the ice was more than a foot in thickness. . . ." J. M. HAYWARD

Sidmouth, March 24

THOUGH we are no longer favoured with the gorgeous sunsets which marked the autumn and early winter, yet two phenomena are still frequently visible which seem referable to the same cause as those splendid displays.

The first is the unusual *white glow* in the western sky before sunset which was an almost constant precursor of the brilliant and long-continued colouring of the past months. It was very marked on November 8, the occasion of the first remarkable sunset, and it is still to be seen on almost any fine evening before the sun sets, though it is no longer followed by the more striking phenomena.

The second is a decidedly unusual *pink tinge* occasionally visible for some ten to twenty degrees round the sun when shining in a somewhat hazy sky, the colour being brought out with great distinctness if light cumulus cloud happens to be passing across it. I first observed it about 1 p.m. on Sunday, March 2, and it was very marked last Thursday (20th) between 10 and 11 a.m., and again on Friday (21st) between 1 and 2 p.m., as well as on one or two other days which I have not specially noted.

May not both be due to the gradual subsidence to a lower level in our atmosphere of the particles which at a higher elevation caused the wonderful colouring of the past months?

Hampstead, March 24 B. W. S.

P.S.—Since first writing the above, I see in NATURE that it was from March 1 to 3 that the fall of dust was noticed at Kilcreggan. Writing from the neighbourhood of London, it may be as well to say that the appearance is wholly different from any effect of London smoke (with which I have been familiar for nearly fifty years) both in colour and in being produced at a higher level than that of ordinary clouds.

"Curious Habit of a Brazilian Moth"

IN NATURE for May 17, 1883 (p. 55), appeared a letter entitled as above, by Mr. E. Dukinfield Jones, in which the author stated that he had observed a kind of moth in Brazil engaged in sucking up water in large quantity through its proboscis. I may say that this strange habit is not confined to *Panthera apardalaria*, as I have observed the same thing in two species of butterfly (*Papilio orizabus*, B., and *Appias saba*, F.), and imagine that the phenomenon is by no means rare. These two butterflies are very common by the sides of streams and damp places on the Ankay plain in Madagascar.

One morning while sitting by the side of one of these streams I noticed the Papilio, which is an insect measuring about four inches from tip to tip of its wings, resting on the wet bank; and wishing to procure it as a specimen, I approached it as gently as possible, the creature being apparently so absorbed in what it was about as to be totally unconscious of my proximity to it. Noticing strange and unaccountable movements—sundry jerks and probings with its proboscis—I quietly sat down near it to watch it more closely. I observed that every second or two a drop of pure liquid was squirted (not exuded merely) from the tip of its abdomen. I picked up a leaf that was lying near, and inserted the edge of it between the insect's body and the ground so as to catch the liquid. Unfortunately I had no watch with me at the time, nor means of measuring liquids; but I reckoned that about thirty drops were emitted per minute. I held the leaf for about five minutes—as nearly so as I could reckon—and at the end of that time there was caught in it about a saltspoon full of what seemed to be pure water, without either taste or colour. After watching the butterfly for a time, I seized it by the wings between my thumb and fingers with the greatest ease, so utterly lost did it appear to be to what was going on near it.

In another spot I saw as many as sixteen of these large butterflies within the space of a square foot, all engaged in the same strange action. Some of them emitted the liquid more frequently and in greater quantity than others; and one of them squirted the liquid so as to drop fully a quarter or a third of an inch beyond the point on the ground perpendicular with the end of its body. It was at this spot that I saw the second of the butterflies alluded to also engaged in the same curious proceeding.

Antananarivo, Madagascar, January 3 R. BARON

Representation of Students

THE students in residence at Girton College are indirectly represented by the members elected by the "certificated students," but cannot themselves, whilst they are in the condition of undergraduates, elect a representative on the governing body.

The College Hall of Residence has advanced one step further in the same direction by offering direct representation to students *in residence*, and it is this new departure which was mentioned in NATURE (vol. xxix. p. 388).

Ever since the establishment of Girton College, students in residence have valued their prospective right to have a voice in the management more dearly than would generally be credited, and have held that Girton stood first among colleges for women partly because it conferred this dignity upon its students.

But the dignity conferred by the actual enjoyment of a privilege exceeds that conferred by a prospective right to the same privilege. ANOTHER CERTIFICATED STUDENT OF GIRTON COLLEGE

"Suicide" of Black Snakes

IN NATURE, March 13, p. 452, Mr. Edward Hardman, Government Geologist of Perth, West Australia, mentions an instance of the suicide, by its own venom, of a black snake. The snake had been wounded, and, the wounded part having been attacked by black ants, "it instantly turned short round and hit itself twice on the neck with seeming determination; in less than one minute it was dead." Mr. Hardman believed the death to be due to its own venom.

He records further instances, *which, though he had not witnessed himself*, had been *related* to him by those who had witnessed the facts.

I believe it to be a generally accepted opinion among thanatophidiologists that, from what is known of the virulent properties of snake-poison, though fatal to man and other living beings, it is innoxious in its effects to serpents of like nature. Sir Joseph Fayrer, a great authority upon this question, has said: "Strange to say—and this to me is one of its greatest mysteries—a snake cannot poison itself or one of its own species, scarcely its own congeners, and only slightly any other genus of venomous snake, but it kills innocent snakes quickly" (address on "The Nature of Snake-Poison," delivered at a meeting of the Medical Society of London, January 28).

The glands which secrete such venom draw their secretion from the blood; that blood, therefore, must have within itself, as part of itself, the elements which constitute its virulence, and cannot therefore be injuriously affected by a further introduction of these elements. Their presence in the blood gives to this vital fluid a power whereby an immunity is obtained, somewhat similar to that which vaccination and syphilisation give to human beings, and which the vaccination of the cultivated virus of anthrax, of rinderpest, of foot-and-mouth disease, gives to animals.

It may, however, happen that the climate of Australia has a special action producing effects different from those observed in India, and, if so, requiring close investigation and study.

The question becomes an interesting one, and, if philosophically prosecuted, may elicit facts which would give to this instance of venom envenoming itself a significance and an established position in the history of natural science.

JAMES DONNET

Unconscious Bias in Walking

THIRTY or more tests in walking, with closed eyes, on a nearly level lawn lightly covered with newly-fallen snow, gave the following results:—My natural gait, in which I step a half to three-quarters of an inch further with my right foot than with my left, always produced a sharp curve to the right. Whenever the step made by either foot was about three inches greater than that made by the other my course was substantially straight. A curve to the left always resulted when either foot stepped more than three inches further than the other. Unnatural toeing out of either foot did not change the result. My right arm is three-quarters of an inch longer than my left, but my legs are of equal length. Both limbs on my right side are stronger and more skilful than those on the left. When but a single action is required, it is my right arm or my right leg that prefers to perform it. When two actions are necessary, the right side chooses that requiring the greater skill, leaving to the left the plainer work, regardless of the power demanded by it. Thus, in mounting a horse, or leaping across a ditch in the ordinary manner, I spring from the left foot; yet if I am to land on the foot from which I start, I can hop higher and farther with my right leg. I can also lift a greater weight with it; and can lower myself to, and raise myself from, a kneeling position with the right leg alone—a feat impossible for me to perform with the left. In my case, at least, the division of labour is decided by skill, and not by strength. These facts, considered in connection with the further observation that in walking the foot which for the time being supports the person does not rock into a pushing position until the other foot has completed its forward motion and is ready to drop to the ground, incline me to the opinion that walking is a reaching rather than a pushing process. Perhaps photography may help to decide this point. J. E. SMITH

New York, March 10

Recent Weather in North America

THE ice-storm, as we call it, which we have lately experienced, seems to call for a permanent record. It began at about 4 p.m. on the 7th inst., and until 12 noon of the following day there was a constant drizzle or rain, the thermometer being a few degrees below the freezing-point. The amount of the rainfall at the surface of the ground was 1·10 inches. As the rain fell upon the trees it soon formed a coating of ice upon every exposed branch and twig, and this grew thicker and heavier until saplings were bent to the ground and large branches were broken from many trees over a wide area of country. The wind blowing gently from the north, the coating of ice was much thicker on that side of each twig or branch. Fences were decorated with long icicles hanging at a decided angle towards the south. Telegraph wires were so heavily loaded that many fell, and some of them, besides the coating of ice, had a most curious decoration in the shape of little icicles hanging about two inches apart, some of them appearing horizontal, and some (it is said) actually pointing upwards. The storm is reported as having extended over an area of some 20,000 square miles. It was not immediately followed by a thaw, which might have relieved the trees of their load; a gentle precipitation, partly of snow and partly of sleet, took place at intervals from 5 p.m. on the 8th till early in the morning of the 10th, the temperature remaining below freezing. The view on the 10th, when the clouds broke away and the sun shone on the trees, was beautiful beyond description, but the most remarkable effect was that produced by the moonlight on the evening of that day.

In order to gain something like an accurate idea of the amount of ice which had frozen on the trees, I made measurements of a number of twigs taken from the extremities of branches, in order to compare their diameter in their natural state with that they had when covered with ice. Some of the figures may be of interest. One twig ·11 of an inch in diameter was enlarged to ·73; another of the same size to ·84; one of ·12 inch diameter measured ·84 with its ice-covering, and another of ·12 inch measured 1·03; one of ·18 diameter had become 1·21, and one of ·21 had become 1·07. The largest ratio of increase which I found on a tree was in the case of a twig ·09 of an inch in diameter, which had attained to ·97, having gained nearly nine times its original diameter. But some upright stalks of weeds standing about eighteen inches above the ground gave still larger proportional measurements. One 5/100 of an inch in diameter now measured ·87, and another of 4/100 of an inch measured ·85, having increased its diameter by more than twenty times.

I made another estimate of the quantity of ice on the trees by breaking the ends of some branches from an apple-tree and weighing them with and without the ice that coated them. It appeared that wood which weighed ten ounces was carrying ice which weighed sixty-nine ounces.

Perhaps it should be noted that the ice did not freeze on the twigs or stalks so that the cross-sections would be exactly circular, and that the measurements made were those of the largest diameters in the several instances.

Prof. Brocklesby writes to the papers of a similar storm many years ago, when a piece of branch weighing four ounces carried four pounds of ice. SAMUEL HART

Trinity College, Hartford, Conn., March 11

EDUCATION IN THE UNITED STATES[1]

A SUCCESSFUL effort made to meet a strong desire that this Report should be brought out sooner enables us to call attention to it in less than twelve months after the last, but, as in material food so in the case of the many reports embodied here, thorough digestion has been essential.

[1] "United States Report of the Commissioner of Education for the Year 1881." (Washington: Government Printing Office, 1883.)

An additional interest, moreover, is lent to this Report by the working up of the information supplied by a Compendium of the Census of 1880. Here are given very full particulars of the changes in distribution of population during the last ten years, and of the amount of education still required by its various classes.

As to the former we may mention in passing that the Report calculates that more than half the English-speaking people of the earth live now in the United States, which in size and population has become the fourth nation of the world. Rather more than one-eighth, six and a half out of fifty millions, of its inhabitants are immigrants; and a singularly similar proportion exists between the coloured and the white population. Emigration is a stream westwards, not only across the Atlantic but across the continent of America. While 1,211,000 of the population of the State of New York were immigrants to it, 882,000 had emigrated from it. Nearly 10,000,000 out of 43,000,000 of natives had moved from the States of their birth to other States. It would seem to an Englishman in his own land that this "unsettled" state of the country must loosen all the feeling of attachment to the soil suggested by the word "home"; but it must, as the Report describes, tend immensely to consolidate the widespread territories; and it certainly suggests the fairness of the great work of education being made a national and not a State function.

Of the emigrants from Europe there were twice as many from Ireland as from Great Britain, but the Irish were equalled in number by the Germans alone, and the total Teutonic immigration in proportion to that of Irish was as 40 to 18. "The preponderance, therefore, of Celtic methods and ideas among our immigrant population is at an end, at least for the present. The German, Scandinavian, and British elements will exert an ever-increasing Teutonic influence, and will form a strong, steady, and sensible influence to counterbalance the volatile and brilliant qualities of the Irish blood. Not the least among the attractions which have drawn to America the Swedes, Danes, and Norwegians whose steady industry and stalwart vigour is felt with immense effect along the northern border States and Territories, are the schools, to which they give their hearty support. In these schools they find less of class education in America even than in Germany, where the children are separated, the high from the low, the rich from the poor, at the entrance into the school-room; instead of the social intercourse, the common interest, the mutual enjoyment which may be the result of the American public school." Nor is all the advantage to the immigrant only. "The influence of the Germans has been exercised in behalf of better methods of primary instruction, thorough training, and high standards in the intermediate and higher grades, the introduction of the German language into the schools, and science training, especially as related to the development of our internal resources." Much do we want more of a similar element in England! Much information is condensed in sixteen diagrams or outline maps showing at a glance various results of the census.

A list is given of 251 "cities," towns, that is, containing over 7500 inhabitants. Belonging to these are—

17	per cent.	of the	population;
26	,,	,,	daily attendance;
33	,,	,,	annual school income;
49	,,	,,	school property.

Nothing can speak more strongly than the above figures of the advantage to education afforded by the concentration of population such as is the case in England. Even in a country where the rural population forms five-sixths of the whole, and is felt to be of vastly greater importance than it is in England, only one-half of the school property and two-thirds of the income is devoted to them; whereas, to secure equal advantage to the scholars, these proportions ought to be more than reversed. As it is, a rural school and an ungraded school are almost synonymous, and more exact reports from each State of their efficiency and means are strongly urged, and their want of trained teachers regretted. But even in the cities the population keeps ahead of the provision of "sittings," till New York already requires over 50,000, and Brooklyn and Chicago over 30,000, more than their present supply. The latter has been driven to the certainly unhealthy practice of "double divisions," teaching, that is, one set of children after another within twenty-four hours. Very far, therefore, are these large cities from carrying out the suggestion here quoted from the London School Board, of providing schools beforehand for increasing population.

The excess of female over male teachers has become a national characteristic, and our Report accounts for it not only by the superior attractions of pioneer life for the men, for it is the case even in States where men largely preponderate; but also by the industry and intelligence which have become the inherited tendencies of the women of the Northern States. In the colleges, accordingly, we note that just over ten thousand women are being co-educated with men, and "the experience of these institutions shows that co-education is entirely practicable, and is recommended by their officers upon considerations of economy, its agreement with the conditions of family life, and its practical results." The equal capacity of women with men for higher education, our Report asserts, has been conceded both in Europe and the United States; and it quotes elsewhere the large increase of female pupil-teachers in England compared with the corresponding increase in males. Extra care has been given to the reports on this subject, both on account of the attention directed from other countries upon the United States and also because it may well form a standard of social progress. But the "meagre wages" of which the Report speaks are illustrated by the fact that even in Pennsylvania, where excellent provision is made for the examination and appointment of teachers, the average salaries for men were about 40*l.* for the six months' teaching required in the year, and 33*l.* for women, while in Alabama the average was only 20*l.* A large increase in the number of female students at the normal colleges shows, however, that these wages are not to be spurned, if they do not attract the highest talent desirable. All Bills introduced into Congress agree in providing that a large part of the national aid proposed shall be applied to the increase of teachers' salaries. It would seem, however, that the difficulty of the thinness and dispersion of the population causing schools to be small, and therefore education per head costly as well as inefficient, is rather increased by an unwise feeling of independence which objects to be joined with neighbouring districts, even where distance allows it. To gratify this same feeling, also, the State Government, after laying down wise and complete rules, has left in some cases to the school authorities and to the people themselves in each city or town, the whole practical control of the work. It is like passing an Act of Parliament without making it the duty of any body of men to see that it is enforced. A State supervision is a step towards centralisation, which is, no doubt wisely, recommended strongly by our Report.

The desirability that curriculums should be laid down by the central authority is quoted as the experience of the world, and of Belgium particularly, where, whenever the schools have followed definite programmes, progress has been marked, while in schools in which the whole matter has been left to the teachers routine has prevented it.

The long recesses, caused in a new country by the scarcity of labour during harvest times, so shorten the educational year that while on the one hand it is felt that not enough is provided for in the curriculum of most schools, on the other hand, time is too short to allow the effective teaching of what is already there. The Report remarks that it is impossible to examine the various courses without being struck with the general neglect of elementary science; adding that "the rural schools would seem to be favourably situated for the study of nature in some of her varied aspects. The well-known effect of such study upon the mind, its value as a resource to the individual, and its relation to the tendency of modern thought, are so many reasons for its introduction into these courses."

The higher classes, we are told, are working harder at the schools, but the key to the reports from so many States in which population as well as cost and efficiency are said to have increased while attendance has not, evidently is that a class is rapidly increasing in America now who make no demand for education and do not appreciate it. The chief of the four recommendations with which the Report ends is the appropriation of more national land for the purposes of education in impoverished portions of the country. Yet the special reports of New York and Connecticut show that ignorance is not caused by want only: for the reduced attendance is accounted for by commercial prosperity and demand for labour, during which a hard-struggling population is tempted to forsake school in order to earn money.

Maryland reports great illiteracy among both blacks and whites, and shows a decrease in everything except expenditure. North Carolina is much more satisfactory, partly through the help of religious bodies, who are making great efforts for the benefit of the negro, whose education remains the difficult question of the United States. More than half as many more black children are uneducated in the whole Union than white children. From the Report it is evident that many of the Northern States feel that they are already heavily taxed for the support of their own schools. Yet their wealth is immense compared with that of the Southern States; the Report quotes personal property and real estate as two and a half times greater per head in the three States of New York, New Jersey, and Pennsylvania than it is in the south. Again, it is a small class in the north that does not appreciate education, but in the south not only is the negro himself careless about it, but there is often to be found among the whites a bitter hatred of the educated black. It is absurd to leave a difficult and costly matter like his education in the hands of his late masters, and expect them to both do it and pay for it; and the only practical method is, as our Report recommends, for the nation to establish and maintain good schools in the face even of hostility. In some places where the Peabody Fund is pushing the work on, the negro is better cared for than the white child, but its administrators cannot undertake the education of a whole people.

The endeavour to make elementary science a feature of the higher grade schools has revealed the same difficulty as has been pointed out at home, viz. the lack of teachers prepared to give the instruction. "The lifeless routine of memorised recitations is worse than useless in science. It paralyses the faculties by which the facts of science are apprehended, and renders true progress impossible. This is a matter demanding attention in normal schools." In a few cities special means have been provided for meeting the emergency. In Boston, courses of lectures were given successfully by the professors of the Institute of Technology upon different branches of natural science, designed to meet the want of teachers; and a similar course before the Teachers' School of Science, on physics, zoology, botany, and geology, were well illustrated by experiments and specimens, and attended by 400 teachers, the entire expense being borne by two ladies. The Lawrence Scientific School, Harvard University, teaches all the principal sciences experimentally, students being assisted also by scholarships. Many women in the normal colleges are now giving special attention to them. A branch specially recommended to be taught there is the laws of health. Of all agencies these normal schools can do most to promote the systematic training of the body. A gymnasium, the study of physiology, hygiene, and sanitation are urged as invaluable to teachers, and it is to them that we must look in some measure for the diffusion of knowledge with reference to the laws of health. A quotation from Dr. Schrodt is made, almost equal to saying that every boy when he leaves school "ought to be either a fool or a physician"! The laws of health should be made as familiar to the minds of children as the rudiments of language and numbers. We are glad to note in Prof. Hitchcock's report on college hygiene that he recommends simultaneous care of the digestive organs with relaxation of mental effort, rather than violent exercise, for students. A larger number of the training schools report laboratories, museums, &c., and the Bureau urges the usefulness of an educational museum from which it would circulate illustrations of the most improved appliances.

Passing to more specialised education, hardly any schools have increased in every way more than commercial and business colleges; there were one-fourth more establishments and scholars than in the previous year.

Kindergarten schools had more than 60 per cent. more scholars. They may well be supported if they carry out all that their programme lays down, which includes, and indeed places foremost all that ought to be the work of home, and uses the word education in its very widest sense. The training described in the normal kindergarten schools surely must wonderfully assist all the students in their future duties as mothers; and an orphan in the care of one of these schools, many of which are carried on as charities, is hardly to be pitied!

Two fewer colleges, but more property and greater teaching power, with 3000 more students, shows that the multitude of these institutions in the United States is being checked by natural selection, while greater efficiency is found among the surviving fittest. Much interchange of the inhabitants of the various States to the Universities of others takes place. There is happily hardly any local feeling in favour of attending a college in the student's native State, and there could hardly be a more unifying action upon a population like that of the United States than this of students meeting from all points to disperse again and take influential positions in all quarters.

At Harvard College the President remarks that the scientific turn of mind is comparatively rare among the young men who enter the college, a large majority of the students preferring languages, metaphysics, history, and political economy to mathematics, physics, zoology, and botany—perhaps the result of the training in the secondary schools. But studies made to a great extent elective have not led to the choice of those requiring least effort. Many more selected scientific subjects in their senior than in their junior years. At Columbia College geology was elected by every member of the class, and astronomy by all but one. About three-fifths selected chemistry, two-fifths philosophy, and one-fifth political economy. Studies are thus selected in harmony with tastes and proclivities, and pursued with interest and satisfaction. "The mental discipline incident to the study of chemistry especially entitles the science to take a place among advanced courses of study, a truth recognised by many collegiate institutions, both by giving the science increased attention in fixed courses, and also by placing it on an equality with classical and mathematical studies when the elective system has been adopted."

Well worthy of the attention of all friends of technical education in England are the numerous efforts to carry out the same desirable ends in the United States. A school of applied science has been organised at Cleveland, Ohio, for this purpose. "The course of study will be four years in length. One half the time will be spent in a careful study of mathematics, chemistry, physics, modern languages, and the methods of scientific research, the other half in professional studies in some department of applied science, as mechanics, in which are unfolded the laws of natural forces underlying processes and existing in materials. Mathematics has given the rules of calculation; drawing, a skill of eye and hand; and shop-practice, familiarity with actual labour accurately performed." Fourteen similar institutions during the last ten or twelve years have been started, but in all of them, as may be expected in a new country like America, the great demand is for knowledge in the arts of working wood and iron; the former is taught from felling the tree to cabinet-making, and since little of such work can be done without the aid of the companion art of working metals up into tools and machinery, they are, in varying proportions, taught together in nearly all. Several schools report that the time—in some cases two afternoons a week—assigned for shop-work did not diminish the intellectual tasks required. Rather less ambitious in its aims, but excellently practical, is the Worcester County Free Institute, founded by some gentlemen of wealth for the training of boys for the duties of an active life, "broader and brighter than the popular method of learning a trade, and more simple and direct than the so-called liberal education." The education there is based on mathematics, living languages, physical sciences, and drawing, but the distinguishing feature is the method and amount of practice in a machine-shop. A manual training school also at Boston and a school for miners and mechanics of a little lower grade still at Drifton, Pa., are schools in each of which an increasing proportion of time is devoted to technical subjects, in the latter entirely free.

On the whole, nevertheless, with seven and a half million dollars bequeathed for educational purposes during 1881, our Report regretfully remarks this year that the "claims of science do not seem to be sufficiently regarded by the benefactors of learning." While these various schools of science have increased in number slightly, and teachers and pupils by about one-tenth, schools of theology, though similarly increased in number, have lost one-tenth of their pupils.

Like the higher colleges, the schools of law have fallen off in number, but they contain more pupils. The influence of their work as affecting all future legislation in the States, and therefore the importance of their pupils being grounded in the science of legislation and not learning it in offices only by the rule of thumb, is wisely urged. Here it is history which is chiefly required to underlie "technical" training. Still more must every one feel the necessity for a high moral as well as mental standard in a profession that has in these days gathered such despotic powers to itself.

Many weighty remarks, similar to those we referred to last year, on the insufficiency of the medical course of study, are to be found in this Report. The necessity of elevating the standard of medical education is universally admitted, and a general improvement to some extent is noted. It is evidently entirely in the hands of the Universities, for themselves report that, where the standard has been raised, students have by no means fallen off, but the reverse; and medical men know well that where diplomas differ in standard, the highest are well worth working for. The importance of the degree to this profession is also shown by more being taken in medicine than in anything else, and more in medicine and science together than in letters, law, and all other subjects.

On no point does England show to such disadvantage by the side of the United States as in the matter of free libraries. It is the more inexplicable because the marvellously, not to say unfairly, cheap literature there, together with the scattered habitations, would each tend to every man's house being his library; while in England the exactly reverse conditions of costly books and closely packed population must make free libraries a most convenient arrangement. Yet in the United States seventy-one additional libraries with 178,000 volumes were started in 1881, making up nearly 4000 libraries with 13,000,000 volumes. "The true aim in the administration of these libraries should be to make the books in them accessible and useful to the greatest number of readers. The time has passed when the preservation of a library was the chief end of its economy. Methods of arranging, classifying, numbering, and charging books affect materially the usefulness of any collection." It well deserves consideration what an influence for good or for evil 4000 librarians guiding the tastes of their readers to one or other class of literature may have. A further step also is being taken in many places. Librarians and the trustees of libraries generally are trying to cooperate with teachers and parents both in selecting and supplying literature for the young; the librarian and the schoolmaster together choosing a number of volumes from the main library to be circulated at the discretion of the latter among his scholars.

An interesting matter for discussion is the principle again laid down by this Report in its remarks upon the defective classes, that those deficient in natural powers, as the deaf, the blind, have as good a right to their education as those with a sound mind in a sound body; that it is a duty and not a charity to educate them effectually. The necessity of a "technical" education also, in their case, *i.e.* teaching them a trade as well as "letters" is clearly urged. This is carried also with success in some cases as far as a college education, and the late President Garfield complimented the authorities of the Deaf-mute College at Washington upon their presenting so many more capable men to the State. This is, in bare fact, true of the college's work; but, like the view taken of much benevolent work, it seems to forget that the same amount of power bestowed upon better material would have done much more for the State, and that this better material is never scarce. It is taking much safer ground to base it upon benevolence which, like the "quality of mercy," will bring a blessing also to the giver.

There are fourteen institutions for the benefit of feeble-minded youth. Our Report pleads for them that money spent on their education will be more productive than that spent on lunatics. The census of 1880 reports 76,895 idiots and 91,997 insane. Inquiry into the cause of such large numbers in a country where overcrowding ought not to be necessary, and the fact that 14 per cent of them had a weak-minded parent and 20 per cent. a weak-minded relative, raises a doubt as to the good in the long run of relaxing the natural check to the survival of the unfit. That 33 per cent. of the parents are addicted to drink is, alas, a too natural explanation to us in England. There can be no doubt that it would be not only wise State economy, but it would bring very valuable scientific evidence upon the most home-reaching of subjects "to attach to all appropriations for charitable purposes an enabling clause that institutions disbursing this charity should contribute to the commonwealth, in as precise a form as possible, statistics of the origin of the evils they affect to relieve."

Reform schools on the excellent plan of the celebrated Michigan one at Coldwater are increasing in number, and one for females also has been opened in this State at Adrian; and while the argument from benevolence is even stronger for their inmates than for the weakminded, the economical objection is far weaker, as the morality of colonies like Botany Bay shows that moral infirmities, when not carefully cultivated in gaols and prisons, are not so deeply set. Again, while natural checks have a tendency to eradicate *weak* mental powers, they act much more slowly, if at all, in crowded cities against diseased morality. It is therefore the more necessary to expend money and labour upon the victims of the latter, as is the special aim of the New Jersey State Reform School. The high aim of the Female Industrial School in this State is "to make it such a home that any parent having a wayward daughter may with confidence have her committed for reformation with the assurance that her surroundings will be of an elevating character." The risk of putting a premium upon vice is easily guarded against where private feeling is not allowed to rule.

The system of public instruction in Ontario (Canada) is so highly approved and has been so successful that a detailed account of its principles and organisation is given here; and the lucid, concise *résumé* of the work of other countries supplied in this United States Report would be valuable to many a reader in Europe who has not the time or the taste to go through the more lengthy documents published in his own country. W. O.

PATHOLOGICAL ANTHROPOLOGY

A NEW and important departure in anthropological studies is taken by Prof. Klebs of Zurich in a paper "On the transformations of the human race as a result mainly of pathological influences," read at the recent meeting of the Swiss Scientific Association at Freiburg, and of which we give the leading points. Hitherto pathology can scarcely be said to have been seriously considered at all in the speculations of anthropologists on the evolution of the fundamental human types. Monogenists especially, deriving all from one primeval stock, have sought an explanation of present varieties mainly in *outward* causes, such as diet, social habits, climate—in a word, the environment. Now the learned Zurich professor attempts to refer existing varieties rather to *inward* causes, without of course pretending to deny that these may themselves ultimately to a large extent depend on external conditions.

Prof. Klebs starts with the assumption that the form of the human body cannot be endowed with greater elements of persistence than other varieties of animal species, which may be modified either naturally or artificially, as, for instance, by stock-breeders. Thus, by the laws of heredity, individual characteristics may be blended together, and give rise to new forms within the several specific groups. The intermingling of races amongst civilised peoples tends in this way, not to universal uniformity, but rather to an endless multiplication of forms. But, besides heredity, these results may be brought about by other influences which make themselves felt, especially during the period of growth, and in a less degree in later years. Such are the deformities associated with certain pursuits, the typical and special characters of certain social circles, the aristocratic, agricultural, and other types, familiar examples of which are offered by the lettered, labouring, and criminal classes.

It may be concluded from this decided tendency to variation that the bodily forms, like all other phenomena of the organised world, are subject to continual modification, that they are essentially plastic, sensitive to, and perpetuating the traces of all external influences. Thus the Danish anatomist, Schmidt, finds that the numerous crania recovered from the prehistoric graves in Jutland and the neighbouring islands present the most varied anthropological types, ranging from that of the Neanderthal skull to those of foreign races, which can scarcely be supposed to have had any direct contact with the Danish aborigines.

But amongst the causes producing structural change, none, according to Prof. Klebs, are more effective than pathological affections. It is now well ascertained that the most prevalent ailments, and especially those of an infectious character, are of a parasitic nature, so that their diffusion takes the character of a struggle for existence between two organisms. Henceforth it becomes possible to study the action of these phenomena on racial and specific transformation.

But modern anthropology has approached this question only from one point. It recognises that within a given population, limited to a definite territory, typical features may be produced, such as those observed by Virchow amongst the Frisians and by Ranke amongst the Bavarians. Yet the former refuses to attribute to rachitis the flat shape of the East Frisian skull, although analogous deviations from the normal German skull are elsewhere also produced by rachitis. A whole series, however, of pathological phenomena have been determined which place in the clearest light the connection between structural change and internal affections.

Cretinism at once suggests itself, the domain and nature of which are best defined by describing it as a malady spread over the Central European highlands, and probably connected with the action of certain upland waters on the production of goitre. It has been found that in Bavaria, Switzerland, and Austria these waters contain certain minute infusoria, which, when introduced into the waters of disaffected localities, produce like effects on the inhabitants.

The bodily structure of cretins, resulting from a premature arrest of the growth of bone, recalls in the most vivid manner the descriptions of dwarfs handed down by popular traditions. Hence it seems not improbable that this degeneracy may at a given point have resulted in the formation of a definite, although possibly not permanently fixed, type. A slight general influence of cretinism may still be detected in many places, as in Salzburg, and especially in Pinzgau and Pongau, where the natives present a striking contrast to those of their kindred, who have been driven by priestly intolerance to quit their homes and settle in the North German lowlands.

The opposite deformity, that is, excessive growth of structure, is also met in upland regions, where its presence recalls the legends of giants who usually dwelt in the same districts as the dwarfs. In fact the greatest irregularity in the length of the body occurs in the highlands, although mountaineers are, on the whole, of shorter stature than lowlanders. Thus the natives of Hasle, in the Bernese Oberland, and those of Elm, in the Canton of Glaris, are above the average height. This has suggested the theory of foreign immigration, a theory, however, supported only by a few local geographical terms of somewhat doubtful origin. In reality this deformity may also depend on pathological causes. At Elm a case has occurred of gigantic growth setting in at the late age of thirty-six and continuing till the death of the subject in his forty-second year. Although we may be still ignorant of the first and true cause of this disorder, the existence of analogous cases in the same locality, the unusual size of the inhabitants, and the established fact of gigantic growth in highland regions, all seem to point at some subtle relation between such pathological phenomena and the nature of the soil. They should perhaps be regarded as due to the action of organisms in the system, as has been shown to be the case with cretinism.

Another series of pathological symptoms is associated with the development of the pigments, which have hitherto been considered as a salient characteristic of races. A distinct relation has already been established between pigmentation under certain pathological conditions, such as the so-called "bronze-skin," and a morbid state of the supra-renal capsules. Since then special attention has been directed to these organs, which would appear to be the chief centre of pigmentary development. It is now found that in the dark races, as among swarthy individuals of the fair races, the medullar portion of the supra-renal capsules is always pigmented. From this remarkable coincidence it may be concluded that to the functional activity or sluggishness of these vascular glands are due the changes so frequently occurring in the colour of the hair and of the other cutaneous organs. Here also the pathologic action passes step by step from its most aggravated forms to its lightest phases, merging at last in simple physiological functions. The dark races, notably the Negroes, have had their origin in malarious regions, whose influence generates in serious cases a deposit of pigment or melanosis, occasionally manifested under the form of black tumours. The observations made by Prof. Klebs and others in the Pontine Marshes and Roman Campagna, show that the malaria is caused by a certain bacillus developed in the soil of those districts. Hence it may in this case be admitted that pathological actions of a comparatively mild form may exercise a modifying influence on the structural development of man. They should perhaps even be regarded as the true causes of the evolution of human types.

However crude and even unsatisfactory these views, they will doubtless serve a useful purpose by directing attention to a hitherto neglected field of research. They at all events reopen the whole question of the origin of human varieties, a question which cannot be considered as closed until monogenists and polygenists have reconciled their differences. The author's theory seems so far to support the monogenist school, inasmuch as it tends to account for present diversity by natural causes, without the necessity of having recourse to several independent centres of human evolution. The weak point of the theory seems to be that these natural causes are themselves confessedly of an exceptional character. It requires us to believe that the human varieties were evolved under morbid, that is, abnormal, conditions. Before that conclusion can be accepted, it will be necessary to show that the normal conditions of climate, diet, and so forth, were inadequate for the purpose. Unless this is done, the normal will probably continue to be regarded as, *cæteris paribus*, more efficacious than the abnormal causes.

A. H. KEANE

THE GERMAN EXPEDITION TO SOUTH GEORGIA

THE following is an abstract of the report of the German Meteorological Expedition which was despatched under the international scheme to South Georgia Island, in lat. 54° S. and long. 37° W.

The Expedition, which was chosen by a Commission appointed by the German Government, consisted of the following members:—Dr. C. Schrader, chief, observer of the Hamburg Observatory; Dr. P. Vogel, sub chief, mathematical instructor in Munich; Dr. C. von der Steinen, physician and zoologist, physician at the Charité Hospital in Berlin; Dr. H. Will, botanist, of the Forest Academy; Dr. O. Claus, mathematician; Herren E. Mosthoff, engineer, and A. Zschau, assistant; and a few sailors.

The object of the Expedition was to effect meteorological and magnetic observations, and to study the physical condition and the flora and fauna of the island, as well, as far as permissible, to observe the transit of Venus on December 6, 1882.

The Expedition arrived at Monte Video on July 4, 1882, by one of the Hamburg liners, and left that place on the 23rd on board the German man-of-war *Moltke*, after having adjusted their instruments and obtained a few domestic animals.

After twenty days' sailing the island was sighted; on August 20 the ship reached Royal Bay on the east coast. On the shore preparations were at once begun for removing the metre-deep snow, and erecting the dwelling house, 11 × 8 metres, two smaller houses for the magnetic observations, an astronomical observatory, and a small tower. A house was also built for the cattle.

All the scientific members, with the exception of those on the watch for reading the meteorological and magnetic instruments, met daily in the work-room from 9 a.m. to 12 noon, and from 2 to 6 p.m., to execute the scientific labours.

The instruments were read every hour, while the watches of the twenty-four hours were divided so that two members were on duty, the one from 3 to 9 a.m., and from 3 to 9 p.m., and the other from 9 a.m. to 3 p.m., and again from 9 p.m. to 3 a.m., and in this manner each member had two days' watch in the week. On the 1st and 15th of every month magnetic observations were effected every fifth minute, and for one hour on these days every twentieth second. But the labour was not found to be at all too heavy.

The lowest temperature registered was − 14° C., and the highest on one single occasion 18° C., but the thermometer varied generally in all seasons between − 5° and + 7° C., so that the difference between winter and summer consisted chiefly in the length of the days. Once during the winter—in August—the phenomenon occurred of the thermometer during, with a heavy westerly gale, to 14° C. The westerly and partly south-westerly winds were, during the winter, the warmest, which was ascribed to the circumstance that these passed over mountains some 2000 metres in height protecting the station on one side, which made them "Föhn-like."

The barometer readings varied between 715 and 770 mm. The lowest readings were never attended by violent storms; these occurred always quite unexpectedly when the glass stood at "fair." The force of the storms, which generally lasted twelve to twenty-four hours, and reaching the island seven to eight times a month, was calculated by a splendid Racknagel anemometer. The tide was carefully measured by ebb and flood gauges.

Falls of rain or snow were very rare during the year, and the plateau surrounding Royal Bay was already, in August, free from snow, and became first in April, when the ground was frozen, covered with snow. It snowed, however, several times in the middle of the summer, as, for instance, at Christmas.

The most frequent winds were those from west and south-west; the northerly ones always brought fog. In the summer the weather was nearly always thick and hazy, which greatly impeded excursions. Such were, nevertheless, undertaken several times, and the highest peaks of the arms—about 700 m.—of the chain of mountains running through the island were ascended. The central mountains range from 2000 m. to 3000 m. The climbing of the slate rocks was very difficult and fatiguing, and in spite of every effort the greatest distance covered was only about a German geographical mile, and the task of exploring the island was impossible of accomplishment, as the glaciers could not be passed by the small force at disposal. The mountains fell often abruptly into the sea, and the highest tops were about 15 km. from the station. The peaks of the above-mentioned arms were free from snow in the summer, and then covered with various kinds of moss.

The only rock found was clay-slate, in some places interspersed with varieties of quartz. Even the blocks carried down by the glaciers from the central part of the island—which was not reached—were of the same nature. No metals were found, but the slate rock contained a little iron; the quantity was, however, so small that it hardly affected the needle.

No land mammalia were found on the island, and of maritime mammals only the sea-elephant (*Phoca proboscidea*) and the sea-leopard, the latter in very small numbers. They did not breed in the bay. Of birds there were several. Two kinds of penguins (König and Esel) visited the island in great numbers, making their nests there, which always faced the sun. The eggs were very delicious. During the pairing-season large quantities of *Procellaria gigantea* came to the island, whose eggs were also very good. *Procellaria capensis*—the Cape Pigeon—was a summer visitor only, but was found in great numbers, hatching in little holes under the turf. This bird was so persecuted by a kind of gull that it only left its nest after dark. Another specimen of Procellaria also visited the island in the summer. It was named "Equinoxalis." There was only one kind of duck, and this became very scarce through shooting. The number of cormorants was very small, while the albatross (Diomedea) remained during the summer only, when it made its nest hanging from the rocks. They had magnificent brown feathers. Of the white albatross only two specimens were seen, but the white Dominican gull was common. Some few of the *Chionis alba*—the Antarctic Pigeon—which were eaten, remained during the whole year, as well as a singing-bird of the size of a lark.

The insects found were few, viz. only a species of land-beetle without wings, about one centimetre long, resembling the common German *Lauf-käfer*, and a water-beetle of the same size. A kind of red spider was caught under big stones. Of lower maritime invertebrates a good collection was made, which has, however, not yet been classified. The greatest part of this was, however, obtained when the tide was out and no boat was necessary, and the dredging was unsatisfactory.

In the summer two species of fish were caught in calm weather, varying from 5 to 20 cm. in length. But none were caught during the winter. The Expedition collected only about forty species of land and water plants, among the former of which were several varieties of the Tussack grass, two kinds of moss, two kinds of fern, and a little shrub with leaves and red blossoms. The grass was ravenously consumed by the cattle and the goats, but the sheep preferred this little shrub. Dr. Will is under the impression that he has discovered some new varieties.

The transit of Venus was seen in perfect weather, although a severe storm raged at the time. The ingress and egress were clearly observed, as well as the progress over the sun's disk, but no photographs were taken, as the Expedition was not furnished with suitable apparatus.

The island possessed, in spite of its desolateness, a beautiful Alpine nature, the tranquillity of which was only broken by the constant thunder of avalanches. The dwelling-house was comfortable, although it would have been more so if each member had had a separate room instead of its being shared with another. The provisions furnished to the Expedition left, however, much to be desired. The tinned Australian meat was tasteless, and the vegetables bad. The milk (in tins) only lasted six months, while the salt meat and fish, although good, were not sufficient. No fresh potatoes were furnished, the claret was bad, and the beer was soon consumed. The cook did wonders, however, in the way of culinary achievements. There was no case of scurvy, neither any serious case of illness. Some experiments were made during the summer to cultivate beans, peas, and potatoes, but they failed, as the shoots were destroyed by cold as soon as above the ground.

The Expedition left the island on September 5, 1883, in the German corvette *Marie*, but all the houses were left intact.

Four of the members of the Expedition returned home, but Dr. Vogel spent a couple of months in travelling in the Argentine Republic, while Messrs. Will and Claus are negotiating with the Argentine Government about taking the command of an expedition for exploring the course of the River Pilcomayo, in which the celebrated explorer Creveaux lost his life. Should their negotiations fail, these gentlemen intend to undertake a journey to the Brazilian province of Matto Grosso, and thence make an exploration of Central Bolivia (Santa Cruz de la Sierra), and eventually follow the watercourses of Mamore and Madeira into the Amazon River, and then the latter to its mouth.

ALLEN THOMSON

BORN in Edinburgh, April 2, 1809, Allen Thomson had nearly completed his seventy-fifth year when he died on the evening of Friday last, March 21. He was the son of John Thomson, a distinguished physician, who was the first occupant of the Chairs of Military Surgery and of Pathology in the University of Edinburgh, and it is remarkable that both chairs were founded on his own recommendation. Allen Thomson graduated as M.D. at the University of Edinburgh in 1830, and in 1831 he became a Fellow of the Royal College of Surgeons of Edinburgh. Soon after graduation he became an extra-mural Lecturer on Anatomy along with William Sharpey. The atmosphere of the Edinburgh school at this time was highly charged. A number of men, afterwards famous, were either students or extra-mural teachers. It is sufficient to mention the names of John Reid, John Goodsir, Martin Barry, Edward Forbes, William B. Carpenter, and John Hughes Bennett. All of these became distinguished in biological science, and amongst them in these days there was the clash of intellect and the rivalry of a noble ambition. None of these remain except Dr. Carpenter, who must feel that the death of his friend Allen Thomson is the severance of another link connecting him with what was undoubtedly a brilliant epoch in the history of the Edinburgh medical school.

Dr. Thomson filled the Chair of Anatomy in Marischal College, Aberdeen, from 1839 to 1841, when he was appointed to the Chair of Physiology in Edinburgh. He held this office for six years, when he was transplanted to the Anatomical Chair in the University of Glasgow, which he occupied till 1877. Since then he has resided in London. Of his scientific honours it is unnecessary to say more than that they came without stint; but probably the crowning honour of this kind was when he filled the Presidential Chair of the British Association at the Plymouth meeting in 1877.

Allen Thomson had a double career to a greater extent than most scientific men. He was not merely, by his own researches and by his well-known exhaustless stores of knowledge, one of the leading living authorities in the department of embryology, but he was an eminent public man, interested and influential in many matters of social and scientific politics. In Glasgow for many years he rendered the city and the University invaluable service. By his energy and tact he contributed more than probably any other man to the great work of building the new University on Gilmore Hill.

But with all his public work he was a busy man in his own department. His early work brought him reputation as an embryologist, and he kept it up by many important papers in the same department of science. In addition he wrote on physiological optics, especially on the mechanism of accommodation, and on the sensibility of the skin. His writings were not characterised so much by brilliant originality as by facility of interpretation of the writings of others, and by a running commentary of his own, showing that he had repeated the observations he was narrating with the effect of adding a few facts here and cutting out what he believed to be erroneous there. His method of thought and literary style were both severe. He was always sceptical until convinced, and he strove to get from himself and from others accuracy in detail. Hence he was inclined to be severe on new discoveries or theories, and whilst ready to listen was rather apt to quench the enthusiasm of a tyro by a douche of cold praise. But still his mind was open and receptive, and in not a few instances he changed his opinions under pressure of argument, which cannot be always asserted even of scientific men. Dr. Thomson always had a greater interest in embryological science than in any other department of biology, and none hailed with more delight the rise of the modern British school, no-deplored more deeply the loss of its leader, F. M. Balfour. As an embryologist his fame will depend chiefly on the clear interpretation he gave to some of the descriptions of the German school, and to the application he made of these to human embryology. An adept with his pencil as with his pen, he gave expression to his views in diagrams that probably for many a day will help the bewildered reader. Thus, though his name will not be associated with any one great discovery, Dr. Thomson will be recognised as a potent force in biological science during this century. His own work, his judicious criticisms, his personal influence, his encouragement to workers, all had an important part in moulding the present state of scientific thought on biological questions.

As to the man himself, those who knew him can testify to the kindly courtesy, to the simplicity of address, to the indescribable charm of his manner, to the warmth of his friendship. He was wise in counsel and adroit in reconciling differences amongst men. To this he owed much of his social power. His finely-moulded and venerable face will be much missed, but not more so than his wise advice at the council board or to the yonng man who has chosen a scientific career. JOHN G. MCKENDRICK

QUINTINO SELLA

BY the death of Signor Quintino Sella, to which we briefly referred last week, Italian science loses one of her strongest supporters and most earnest students. Although some of the best years of his life were devoted to statesmanship, his early writings on mineralogy were of sufficient solidity to establish for their author a very high reputation. These mineralogical memoirs, contributed chiefly to the Royal Academy of Sciences of Turin, were distinguished by a profound knowledge of crystallography. When the Geological Survey of Italy was about to be established, Signor Sella was commissioned to visit most of the European countries where Surveys were in operation, and in 1861 he presented to Signor Cordova, then Minister of Agriculture, Industry, and Commerce, a valuable report, "Sul Modo di fare la Carta Geologica del Regno d'Italia." In collecting materials for that report he spent some time in this country, and took the warmest interest in the work of the Geological Survey. Ten years later he prepared an elaborate report on the mineral wealth of Sardinia. When the International Geological Congress was held at Bologna in 1881, Signor Sella, as one of the most representative scientific men in Italy, was selected to act as the president; and those who had the advantage of attending that meeting carried away with them the most pleasant recollections of his courtesy. Signor Sella died at Biella in Piedmont on the 14th inst.

We direct attention to the letter from Prof. Hughes in connection with a memorial to the Italian *savant*.

NOTES

AT the final meeting, on Saturday last, of the General Committee of the International Fisheries Exhibition, the balance of the funds was disposed of. The surplus amounts to over 15,000*l*., and of this 10,000*l*. were allotted to alleviate the distress of widows and orphans of sea fishermen, while 3000*l*. were voted as an endowment to a society which is to be called "The Royal Fisheries Society," whose functions will be somewhat similar to those of the Royal Agricultural Society; the remaining 2000*l*. are kept in reserve.

PROFESSORS MARTENS, Mendeléeff, and Minaieff are to attend the jubilee of Edinburgh University, as delegates from the University of St. Petersburg, and Prof. Rokhmaninoff as delegate from the University of Kieff.

THE great gold medal of the Paris Geographical Society has been awarded to the Deep-Sea Expeditions of the *Talisman* and *Travailleur*; a gold medal to M. Arthur Thouar, for his journey across the desert of the Northern Chaco in search of the remains of the Crevaux Expedition; a gold medal to M. Désiré Charnay, for his Central American explorations, and especially his researches in Yucatan.

A MEETING of the Governors of the City and Guilds of London Institute for the Advancement of Technical Education was held last week for the purpose of receiving the Annual Report of the Council. The chair was occupied by the Lord Chancellor. The Chairman, in moving the adoption of the Report, said that the Institution had arrived at a critical point of time, at a point of time at which he might remind them of the progress which things had made, but one, nevertheless, at which it became necessary that they should recognise the importance of proceeding energetically. With respect to the Central Institution, the buildings were nearly completed, and it was expected that the public opening of those buildings might take place in June of this year. It was proposed that four professors should be appointed to the Central Institution—viz. Professors of Chemistry, of Engineering, of Mechanics and Mathematics, and of Physics, the whole being superintended by a Board of Studies. There would be laboratories properly fitted up, and workshops and drawing offices, all with a view to supplying instruction which would combine the elements of those fundamental studies which underlay practical art. It was hoped that, as time went on, the number of exhibitions and scholarships, which would enable poor and meritorious students to obtain the benefits of the Institution, might increase. It was estimated that 9000*l*. a year would be available for the maintenance of the Institution, and that the fees of the students would amount to 2000*l*. That would give 11,000*l*. as an expected present income. When the grant amounted to 10,000*l*., and the students numbered from 150 to 200, paying in fees 5000*l*., the income would be 15,000*l*., and it was estimated that that amount would be required for maintaining the Institute in full working order. Passing from the Central Institution to Finsbury College, the Chairman said that the progress of that branch had been very satisfactory. During the past year it had instructed 799 persons, of whom 100 had been day students and the rest students attending the evening classes. The day students had to pass a preliminary examination in elementary mechanics, and there were six free scholars. The South London School had an attendance of 300 students. The candidates presented for examination this year were 2397, being an increase over the former year of 425, and the passes were 1498, showing an increase over the former year of 276. They came from 104 centres, showing an increase of seven centres; and they were examined, as in the former year, in thirty-seven subjects. What was still more remarkable was the rapid extension of the desire to have the benefit of these examinations, for there were now preparing for them 5862 students, being an increase over those who were under similar preparation in the former year of no less than 1814. He recognised with gratitude the liberality with which they had been supported by the City Guilds and other bodies, and he could not but think that those who had helped them so far would help them still further. Since the report had been written, the Skinners' Company had increased their subscription for the year 1884 from 500*l*. to 1000*l*., and their donation to the building fund from 2000*l*. to 3000*l*.

A CORRESPONDENT sends us the following:—"The new scheme for examinations for admission to Sandhurst which has been agreed upon (it appears) by the War Office and the Civil Service Commissioners must, if unmodified, work serious mischief to scientific education in public schools in which any proportion of the pupils are looking forward to the army as a profession. This will be seen from the following scale of marks, which has been communicated to the Committee of the Head Masters' Conference :—

		Marks
Obligatory Subjects (*Three* out of the four to be taken up by every candidate)	Mathematics	3000
	Latin	3000
	French	3000
	German	3000
Optional Subjects (*One* only to be taken up)	Higher Mathematics	2000
	Greek	2000
	Chemistry	1500
	Electricity and Magnetism ...	1500
	Geology and Physical Geography	1500
	English History	1500

A glance at this table is sufficient to show that the authorities are holding out a *distinct bribe* to candidates to eschew the experimental sciences altogether; and whatever their intention may be, the result will be the reduction of scientific knowledge among future officers of Her Majesty's army to the lowest possible minimum. This is surely a retrograde step in these late decades of the nineteenth century. Nor must it be forgotten that the application of the same scheme to examinations for admission to Woolwich is contemplated. Not only will every candidate be induced, if he can do so, to take up simply the four subjects in the first category, but, more than this, the scientific subjects (exclusive of mere mathematics) will only hereafter be taken up by those candidates whose performances in the more highly rewarded subjects are hopeless—the scientific subjects, in other words, will become simply a *refuge for mediocrity and incompetency*. Men who are spending the best years of their lives in combating the traditional prejudices which exist in this country in favour of the older studies will not only feel that they have to complain of the tardy and grudging recognition which is given to the 'new learning'—they will feel now, and justly so, that they have been betrayed by those from whom, on every ground, they ought to be able to look for more encouragement."

The Worshipful Company of Clothworkers, who have already given 3500*l*. to the Bradford Technical School, have also promised an annual subscription of 500*l*. towards the working expenses of the school.

Dr. Doberck writes from Hong Kong Observatory, February 17:—"The building of the Hong Kong Observatory was begun in June 1883, but only the foundations had been laid at the end of July, when I arrived. The main building, the architectural details of which do credit to the Surveyor-General's department, was so far finished by January 1 that I could take up my residence there, and tridiurnal eye-observations were commenced. Before the middle of the month the magnetic hut was ready, and I lost no time in making a complete set of magnetic observations. I expect that it will be possible to start the self-recording apparatus by March 1. I get telegraphic weather information from the Treaty Ports, Nagasaki, Vladivostock, and Manilla, and publish weather reports, which, as you will see from one of the three newspapers which publish them (sent herewith) also indicate winds to be expected from the gradients."

The Belgian Royal Academy proposes for public competition the subjoined subjects in the mathematical and physical sciences:—1. To resume and coordinate the researches hitherto made on the integration of linear equations of the second order with two variables, and to complete this theory, or at least advance it by further original research. 2. To establish by fresh experiments the theory of the reaction of bodies in the so-called nascent state. 3. Fresh spectroscopic researches with a view to ascertain especially whether the sun contains or not the essential constituent principles of organic compounds. 4. A complete exposition of the theory of deviations from the vertical, and verifying whether it applies to existing observations. 5. Fresh researches on the nutritive deposits in cereals, and especially on the transformations experienced by them during germination. 6. Fresh researches on the development of the Trematodes, from the histogenetic and organogenetic standpoint. 7. A study of the influence of compressed oxygen on the vital phenomena. Medals of the intrinsic value of 32*l*. and 24*l*. are offered respectively for the best papers on the first three and last four subjects. The papers must be legibly written in French, Flemish, or Latin, and forwarded prepaid to M. Liagre, Permanent Secretary, Palais des Académies, Brussels. They are to be signed by a motto, which is to be repeated in a sealed note containing the authors' names and addresses.

In the *American Journal of Science and Arts*, vol. xxiii. 2nd series, p. 276, a letter from Rev. George Jones, U.S.N., to Prof. Silliman, written at Quito, Ecuador, December 13, 1856, describes a fall of ashes from Cotopaxi, which was thirty miles distant, in which a purple sky was noted. The paragraph in which the mention is made runs as follows:—"Yesterday morning we noticed that at the south the sky had an unusual appearance, being of a purple colour for about 90° along the horizon, and so up to about 45° in height, the edge of this being mixed up with patches of white. About 12 o'clock ashes began to fall, first in small quantities; but by 8 o'clock the fall had got to be so considerable as to powder the clothes quickly, on our going out; and people coming into a house would look as we do at home when coming in from a snowstorm."

The exploring expedition, under the direction of M. Regel, the naturalist, has again left for Bokhara on its way to Chardshui, Kelif Kabadian, and Baldshuat, whence it will proceed *via* the Pamir plateau as far as the Kashgar frontier. M. Schwartz, the astronomer, accompanies the expedition.

Prof. Osborne Reynolds will give a discourse at the Royal Institution to-morrow (Friday, March 28) on the Two Manners of Motion of Water shown by Experiments; and Prof. T. G. Bonney, the President of the Geological Society, will give a discourse on Friday (April 4) on the Building of the Alps.

On Monday, at 9 p.m., a violent shock of earthquake, accompanied by a loud subterranean rumbling, was felt at Fünfkirchen, in Southern Hungary. It was also felt in Essegg and all over Slavonia. It is reported from Vierno that a shock of earthquake was felt there as well as at Karakul and in the Issyk-Kul district on the 13th inst.

At one of the last meetings of the Russian Chemical Society, Prof. Mendeléeff made the following interesting communication with regard to solutions:—It would be easy to prove, with the data of Gerlach, Marignac, Cremers, and Schiff, that the volume of a given amount of a salt in its solutions (for instance, of a molecule) varies with the variations of temperature and the degree of concentration of the solutions. It increases as both increase; and it might be concluded therefrom that the force on which solution depends varies with the degree of concentration. Still, another conclusion can be arrived at, if Grassy's measurements of the decrease of volumes of NaCl and $CaCl_2$ be taken into account. Interpolation shows that these solutions are reduced in volume, by pressure, as the amount of the dissolved salt varies; and the reduction of volume which accompanies the solution enables us to calculate the corresponding pressure. It appears that to each molecule of NaCl dissolved in 100 parts of water corresponds a nearly permanent pressure of about 120 atmospheres, whatever be the degree of concentration. For $CaCl_2$ the pressure also remains constant, but is nearly three times the above. Thus, if the tendency towards solution be measured by pressure, it results, for the two salts above mentioned, that the first amounts of salt dissolved exercise the same pressure as the last which bring the solution near to saturation. Prof. Mendeléeff points out that researches pursued in the direction just mentioned could throw some light on the internal forces which are active in solutions and other chemical compounds.

It appears from the annual report of the Russian Chemical and Physical Society that the chemical section has now 162 members; its income, including several grants, reached 5734 roubles (about 570*l*.), and its capital 13,932 roubles, of which 7894 roubles were devoted to premiums. The physical section has 103 members; its income reached 1851 roubles, and its capital 16,000 roubles.

At the annual general meeting of the Hackney Microscopical and Natural History Society held on March 19 at the Morley Hall, Hackney, a valuable microscope was presented to the honorary secretary by the members. The president, Dr. M. C. Cooke, in presenting the testimonial, made some highly eulogistic remarks upon the energy and unremitting attention given by the honorary secretary during the seven years of the existence of the Society, to which he ascribed its present flourishing condition. A silver plate bearing the following inscription was attached to the instrument:—"Presented to Collis Willmott, Esq., by members of the Hackney Microscopical and Natural History Society in appreciation of his services as Hon. Secretary, 19th March, 1884."

We have received from the Direction of Schools at Tiflis its annual report, and we are glad to recognise that education in the Caucasus—which is perhaps more independent of the Ministry of Public Instruction than other parts of Russia—is spreading more rapidly than might have been supposed. On January 1, 1883, there were no less than 1168 schools under the supervision of the Ministry, with an aggregate of 80,838 scholars, of whom 15,036 are girls. If the 60 Jewish and 1920 Mussulman schools at synagogues and mosques be added—however low the degree of education given to their 18,647 scholars—as also 31 schools of various descriptions, military, theological, and lower medical, the aggregate number of scholars would reach 102,728. There is thus (excepting the Jewish and Mussulman schools) one school for each 4880 inhabitants, surely still a very low figure; but it is a little higher in the more densely peopled Northern Caucasus (1 to 3060 in Kubau). Of the 1168 schools above mentioned there were 1055 primary schools, with 52,251 scholars, one-fifth of whom are girls; 33 higher primary schools, with 5213 scholars; 5 schools for teachers, with 500 scholars; 8 technical schools, or *Realschulen*, with 2312, and 10 lyceums, or half-lyceums, with 3555 scholars. We see with pleasure that there were also 6 lyceums and 6 half-lyceums for girls, with the high figure of 3127 scholars. The distribution of education among different nationalities is very interesting. Of the above-mentioned 80,838 scholars, 46 per cent. per cent. were Russians, 25 per cent. Armenians, 17 Georgians, and 5·2 Tartars and Circassians. With regard to the population, the proportion of Armenians receiving instruction is 1 to 41, while it is only 1 to 44 with the Russians, 1 to 75 with the Georgians, 1 to 350 with the Circassians, 1 to 851 with the Tartars, 1 to 33 with Jews, and 1 to 7 with the Western Europeans settled in the Caucasus. Even in lyceums the Armenians (1 to 858) come first after the Jews (1 to 210) and before the Russians (1 to 866), while only 1 to 11,237 Circassians, 1 to 9352 Tartars, and 1 to 1246 Georgians, enter the lyceums. The Russians like the technical schools better, and the daughters of the functionaries take the lead in the lyceums for girls. Altogether the tendency towards education is well felt in Northern Caucasus, and it is agreeable to see that in secondary schools—male and female—11 to 12 per cent of the scholars are children of peasants and Cossacks. The number of these schools is even too small, and in 1882 no less than 441 boys were refused admission to lyceums on account of want of room. One may be sure that this tendency would be still greater were it not for the want of sympathy displayed throughout Russia with the so-called classical lyceums, where a mechanical study of Latin takes the place of sound instruction in natural sciences. We must notice also a beautiful educational map of the Caucasus which accompanies the Report for 1880. Owing to a system of coloured signs of different shapes, one sees at a glance the number of schools of different descriptions, male and female, spread throughout the Caucasus, as well as who pays for them—the State, the municipalities, the village communes, or private persons; while a number of coloured plates on the borders of the map show the tendency towards instruction in different provinces, the nationalities of the scholars, and so on.

We are informed that Mr. Robert Hunt's (the Keeper of Mining Records) large and comprehensive work on the history, discovery, practical development, and future prospects of metalliferous mines in the United Kingdom, under the title of "British Mining," will be published early next month by Messrs. Crosby Lockwood and Co.

AN IMPROVED THERMO-ELECTRIC PILE FOR MEASURING SMALL ELECTROMOTIVE FORCES[1]

This paper contains a description, illustrated by sketches, of a new and convenient form of thermo-electric apparatus for measuring small electromotive forces by the method of opposition, and of the method of constructing and using the apparatus.

The apparatus consists essentially of a series of about 300 pairs of horizontal, slender, parallel wires of iron and German silver, the former alone being covered with cotton. The wires are about 8 inches long, fixed side by side in close mutual contact, though insulated from each other, as a continuous flat layer about 16 inches long, in a wooden frame, and soldered end to end in single continuous series. About 1½ inch in length of the opposite ends of the wires are bent downwards to a vertical position, so as to enable them to dip into two liquids of different temperatures contained in two long, narrow troughs. The liquids employed are non-conductors; this was found to be necessary. The one for the hot junctions is melted paraffin kept at a temperature of 120° C., and the one for the cold ones is non-volatile petroleum, known by the name of "thin machinery oil." The ends of the wires are immersed about one-fourth of an inch in the liquids.

The maximum power of the instrument is of course limited by the amount of difference of temperature of the two liquids, and of the two series of ends of wires immersed in them. Any lower degree of electromotive force is obtained by attaching a copper wire to one end of the series, and sliding the free end of the other terminal wire across the middle part of the upper surface of the wires, from that end of the series towards the other; the German silver wires being bare permit metallic contact.

An apparatus as above described, consisting of 295 pairs of wires, had a resistance of 95·6 ohms at 16° C., and by a difference of 100° C. of temperature of the two baths, gave a current having an electromotive force of ·7729 volt, or with a difference of 130° C., 1·005 volt. Each element therefore equalled ·0000262 volt for each C. degree difference of temperature.

After having been verified with a standard voltaic cell, such an apparatus (or any fraction of it) may itself be employed as a standard. It is capable of producing and measuring as small a degree of electromotive force as a 34861st part of a volt. When the potential of the currents to be measured exceeded one volt, either an additional pile or a standard voltaic cell was employed with it.

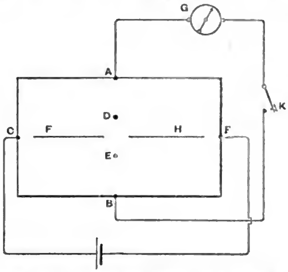
Several apparatus of this kind have been constructed, and a large number of determinations of electromotive force have been made with them. Fifteen determinations per hour have frequently been made; the rate of working, however, depends upon the steadiness of the current to be measured.

[1] Abstract of a paper read before the Birmingham Philosophical Society February 14, by Dr. G. Gore, F.R.S.

THE REVERSAL OF HALL'S PHENOMENON

In a recent communication to the Physical Society I mentioned among other things that I had succeeded in reversing the direction of the Hall effect in iron. It was, however, found to be so exceedingly difficult to keep the two points where the galvanometer connections were made at the same potential, even for a few seconds, that the extent of the deflections due to the Hall effect could only be roughly guessed at, and the experiment was hardly a satisfactory one. I believe this inconvenience arose from the fact that the iron, being a strongly magnetic metal, was slightly displaced whenever the polarity of the electromagnet was reversed, thus shifting the points of contact with the galvanometer wires. I have since repeated the experiment with gold, which turns out to be perfectly easy to work with, and altogether more suitable for the purpose. The following is an account of four experiments:—

Experiment 1.—A piece of nearly pure gold foil 5 cm. long and 3·5 cm. broad was cemented to a plate of glass and the whole placed between the flat pole pieces of an electromagnet. The middle points, A, B (see figure) of the longer sides of the foil were connected to a galvanometer, G, and the middle points, C, F, of the shorter sides to a battery. A current was passed through the metal from left to right, and the electromagnet



excited so that a south pole was beneath the glass and a north pole above it. The galvanometer was immediately deflected, indicating a current flowing in the direction B G A. If either the polarity of the magnet or the direction of the current through the foil was reversed, the transverse current was also reversed and flowed in the direction A G B. This is the ordinary "Hall effect," and the direction of the transverse currents agrees with that mentioned by Mr. Hall for gold. The extent of the deflections varied from about 50 to 70 scale divisions on each side of zero. Similar but smaller deflections occurred when the galvanometer was connected with points nearer to the middle of the plate.

Experiment 2.—Two longitudinal slits, F, H, about ¼ mm. wide, were then cut along the middle of the foil, leaving a connection 4 mm. wide between the two halves of the sheet, and the former experiment was repeated. The following are the details; and to understand them it must be remembered that the galvanometer is affected by two causes besides the transverse current: (1) by the direct action of the electromagnet upon the galvanometer needle, though 13 feet away from it; (2) by a small permanent current due to the fact that, however carefully adjusted, A and B are never (or hardly ever) at exactly the same potential.

The image of the galvanometer wire was brought as nearly as possible to zero of the scale before beginning the experiment, and the connections were made so that a current in the direction A G B caused a deflection to the left (−), and a current in the direction B G A caused a deflection to the right (+).

Upper pole of magnet north:—

Galvanometer key, K, raised, deflection + 25 divs.[1]
" " depressed, " + 102 divs.[2]

[1] Due solely to the action of the magnet upon the galvanometer needle.
[2] Due partly to the action of the magnet on the galvanometer needle, partly to the permanent current above referred to, and partly to the transverse current resulting from magnetisation.

Upper pole of magnet south:—

Galvanometer key raised, deflection − 24 divs.
" " depressed, " − 42 divs.

Net deflections due to current (subtracting effect of the magnet on the galvanometer needle):—

Upper pole north (102 − 25 =) + 77 divs.
" south (−42 + 24 =) − 18 divs.

Sum of opposite deflections due to transverse current, (77 + 18 =) 95, or deflection on each side of zero = 47·5 divs.

The slits therefore had the effect of reducing the amount of the Hall deflections; the direction was unaffected.

Experiment 3.—The galvanometer contacts were now moved from the edges to the points D, E, about 5 mm. from the middle line, and the experiment was repeated with the following result:—

Upper pole of magnet north:—

Key raised, deflection + 18 divs.
" depressed, " + 165 divs.

Upper pole south:—

Key raised, deflection − 35 divs.
" depressed, " + 180 divs.

Net deflections due to current:—

Upper pole north (165 − 18 =) + 147 divs.
" south (180 + 35 =) + 215 divs.

Sum of deflections due to transverse current (215 − 147 =) 68.
Deflection on each side of zero = 34 divs.

Thus when the galvanometer contacts were near the middle of the plate the deflections were almost as great as when the galvanometer was connected to the edges. *But they were in the opposite direction*, showing that the Hall effect was reversed.

Experiment 4.—A repetition of the last.

Upper pole north:—

Key raised, deflection + 28 divs.
" depressed, " + 170 divs.

Upper pole south:—

Key raised, deflection − 24 divs.
" depressed, " + 170 divs.

Net deflections due to current:—

Upper pole north (170 − 28 =) 132 divs.
" south (170 + 24 =) 194 divs.

Sum of deflections due to transverse current, (194 − 132 =) 62.
Deflection on each side of zero = 31 divs.

These results, curious as they are, were of course not unexpected, the experiment having been in fact devised for the purpose of testing in an absolutely conclusive manner the sufficiency of the explanation of Hall's phenomenon by strains and Peltier effects which I have recently proposed (see NATURE, p. 467).

Supposing the magnet and the battery to be so arranged that before the slits were made the points A and D were in stretched districts, and B and E in compressed districts of the metallic sheet, then the effect of cutting the slits will be practically to divide the plate into two independent plates, each of which undergoes strains similar to those originally existing in the whole. A and B therefore will still be in regions which are respectively stretched and compressed, while on the other hand the region in which D is will now be compressed, and that in which E is will be stretched. Thus as regards the points D and E the result of making the slits is to reverse the strain, and in consequence the Peltier effects and the galvanometer deflections. If Mr. Hall's own theory were correct, the existence of the slits should make no appreciable difference of any kind. That they should have the effect of *reversing* the action of the magnet upon the current is altogether inconceivable.

SHELFORD BIDWELL

DR. FEUSSNER'S NEW POLARISING PRISM

In a recent number of the *Zeitschrift für Instrumentenkunde* (iv. 42–50, February 1884), Dr. K. Feussner of Karlsruhe has given a detailed description of a polarising prism lately devised by him, which presents several points of novelty, and for which certain advantages are claimed. The paper also contains an account, although not an exhaustive one, of the various polarising prisms which have from time to time been constructed by means of different combinations of Iceland spar. The literature of this subject is scattered and somewhat difficult of accesand moreover only a small part of it has hitherto been translated into English; and it would appear therefore that a brief abstract of the paper may not be without service to those amongst the readers of NATURE who may be unacquainted with the original memoirs, or who may not have the necessary references at hand.

Following the order adopted by Dr. Feussner, the subject may be divided into two parts:—

I.—Older Forms of Polarising Prisms

In comparing the various forms of polarising prisms, the main points which need attention are:—the angular extent of the field of view, the direction of the emergent polarised ray, whether it is shifted to one side of or remains symmetrical to the long axis of the prism; the proportion which the length of the prism bears to its breadth; and lastly, the position of the terminal faces, whether perpendicular or inclined to the long axis. These requirements are fulfilled in different degrees by the following methods of construction.

Fig. 1.

Fig. 2.

Fig. 3.

1. *The Nicol Prism* (*Edin. New Phil. Journal*, 1828, vi. 83).—This (Fig. 1), as is well known, is constructed from a rhombohedron of Iceland spar, the length of which must be fully three times as great as the width. The end faces are cut off in such a manner that the angle of 72° which they originally form with the lateral edge of the rhombohedron, is reduced to 68°. The prism is then cut in two in a plane perpendicular to the new end surfaces, the section being carried obliquely from one obtuse corner of the prism to the other, in the direction of its length. The surfaces of this section, after having been carefully polished, are cemented together again by means of Canada balsam. A ray of light, on entering the prism, is separated by the double refraction of the calc-spar into an ordinary and an extraordinary ray: the former undergoes total reflection at the layer of balsam at an incidence which allows the extraordinary ray to be transmitted; the latter, therefore, passes through unchanged. This principle of obtaining a single polarised ray by means of total reflection of the other is common to all the forms of prism now to be described.

Dr. Feussner gives a mathematical analysis of the paths taken by the two polarised rays within the Nicol prism, and finds that the emergent extraordinary ray can include an angular field of 29°, but that this extreme value holds good only for rays incident upon that portion of the end surface which is near to the obtuse corner, and that from thence it gradually decreases until the field includes an angle of only about half the previous amount. He finds, moreover, that, although of course the ray emerges parallel to its direction of incidence, yet that the zone of polarised light is shifted to one side of the central line. Also that the great length of the Nicol—3·28 times its breadth—is not only an inconvenience, but, owing to the large pieces of spar thus required for its construction, prisms of any but small size become very expensive. To this it may be added that there is a considerable loss of light by reflection from the first surface, owing to its inclined position in regard to the long axis of the prism.

It is with the view of obviating these defects that the modifications represented in Figs. 2 to 6 have been devised.

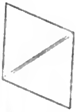


Fig. 4.

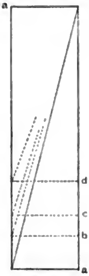


Fig. 5.

Fig. 6.

2. *The Shortened Nicol Prism.*—This arrangement of the Nicol prism is constructed by Dr. Steeg and Reuter of Homburg v. d. H. For the sake of facility of manufacture, the end surfaces are cleavage planes, and the oblique cut, instead of being perpendicular, makes with these an angle of about 84°. By this alteration the prism becomes shorter, and is now only 2·83 times its breadth; but if Canada balsam is still used as the cement, the field will occupy a very unsymmetrical position in regard to the long axis. If balsam of copaiba is made use of, the index of refraction of which is 1·50, a symmetrical field of about 24° will be obtained. A prism of this kind has also been designed by Prof. B. Hasert of Eisenach (*Pogg. Ann.* cxiii. 189), but its performance appears to be inferior to the above.

3. *The Nicol Prism with Perpendicular Ends.*—The terminal surfaces in this prism are perpendicular to the long axis, and the sectional cut makes with them an angle of about 75°. The length of the prism is 3·75 times its breadth, and if the cement has an index of refraction of 1·525, the field is symmetrically disposed, and includes an angle of 27°. Prisms of this kind have been manufactured by Dr. Steeg, by Mr. C. D. Ahrens, and others.

4. *The Foucault Prism* (*Comptes Rendus*, 1857, xlv. 238).—This construction differs from all those hitherto mentioned, in that a film of air is employed between the two cut surfaces as the totally reflecting medium instead of a layer of cement. The two halves of the prism are kept in position, without touching each other, by means of the mounting. The length of the prism is in this way much reduced, and amounts to only 1·528 times its breadth. The end surfaces are cleavage planes, and the sectional cut makes with them an angle of 59°. The field, however, includes not more than about 8°, so that this prism can be used only in the case of nearly parallel rays; and in addition to this the pictures which may be seen through it are to some extent veiled and indistinct, owing to repeated internal reflection.

5. *The Hartnack Prism* (*Ann. de Ch. et de Physique*, ser. iv. vii. 181).—This form of prism was devised in 1866 by MM. Hartnack and Prazmowski; the original memoir is a valuable one; a translation of it, with some additions, has lately been published (*Journ. of the R. Microscopical Soc.*, June, 1883, 428). It is considered by Dr. Feussner to be the most perfect prism capable of being prepared from calc-spar. The ends of the prism are perpendicular to its length; the section carried through it is in a plane perpendicular to the principal axis of the crystal. The cementing medium is linseed oil, the index of refraction of which is 1·485. This form of prism is certainly not so well known in this country as it deserves to be: a very excellent one supplied to the present writer by Dr. Steeg is of rectangular form throughout, the terminal surfaces are 19 × 15 mm., and the length 41 mm. The lateral shifting of the field is scarcely perceptible, the prism is perfectly colourless and transparent, and its performance is far superior to that of the ordinary Nicol. The field of view afforded by this construction depends upon

the cementing substance used, and also upon the inclination of the sectional cut in regard to the ends of the prism; it may vary from 20° to 41°. If the utmost extent of field is not required, the prism may be shortened by lessening the angle of the section, at the expense however of interfering with the symmetrical disposition of the field.

6. *The Glan Prism* (Carl's "Repertorium," xvi. 570, and xvii. 195).—This is a modification of the Foucault, and in a similar manner includes a film of air between the sectional surfaces. The end surfaces and also the cut carried through the prism are parallel to the principal axis of the calc spar. The ends are normal to the length, and the field includes about 8°. This prism is very short, and may indeed be even shorter than it is broad. It is subject to the same defect as that mentioned in the case of the Foucault, although perhaps not quite to the same extent.

II.—The New Polarising Prism

This prism differs very considerably from the preceding forms, and consists of a thin plate of a doubly refracting crystal cemented between two wedge-shaped pieces of glass, the terminal faces of which are normal to the length. The external form of the prism may thus be similar to the Hartnack, the calc-spar being replaced by glass. The indices of refraction of the glass and of the cementing medium should correspond with the greater index of refraction of the crystal, and the directions of greatest and least elasticity in the latter must stand in a plane perpendicular to the direction of the section. One of the advantages claimed for the new prism is that it dispenses with the large and valuable pieces of spar hitherto found necessary; a further advantage being that other crystalline substances may be used in this prism instead of calc-spar. The latter advantage, however, occurs only when the difference between the indices of refraction for the ordinary and extraordinary rays in the particular crystal made use of is greater than in calc-spar. When this is the case, the field becomes enlarged, and the length of the prism is reduced.

The substance which Dr. Feussner has employed as being most suitable for the separating crystal plate is nitrate of soda (*natronsalpeter*), in which the above-mentioned values are $\omega = 1\cdot587$ and $\epsilon = 1\cdot336$. It crystallises in similar form to calcite, and in both cases thin plates obtained by cleavage may be used.

As the cementing substance for the nitrate of soda, a mixture of gum dammar with monobromonaphthalene was used, which afforded an index of refraction of 1·58. In the case of thin plates of calcite, a solid cementing substance of sufficiently high refractive power was not available, and a fluid medium was therefore employed. For this purpose the whole prism was inclosed in a short glass tube with air-tight ends, which was filled with monobromonaphthalene. In an experimental prism a mixture of balsam of tolu was made use of, giving a cement with an index

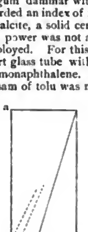


Fig. 7.

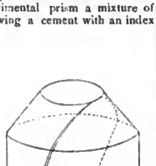


Fig. 8.

of refraction of 1·62, but the low refractive power resulted in a very considerable reduction of the field. The extent and disposition of the field may be varied by altering the inclination at which the crystal lamina is inserted (Fig. 7), and thereby reducing the length of the prism, as in the case of the Hartnack.

In order to obviate the effects of reflection from the internal side surfaces of the prism, the wedge-shaped blocks of glass of which it is built up may be made much broader than would otherwise be necessary; the edges of this extra width are cut obliquely, and suitably blackened.

The accompanying diagram (Fig. 8) represents a prism of cylindrical external form constructed in this manner, the lower surface being that of the incident light. In this the field amounts to 30°, and the breadth is about double the length.

Dr. Feussner remarks that a prism similar in some respects to his new arrangement was devised in 1869 by M. Jamin (*Comptes Rendus*, lxviii. 221), who used a thin plate of calc-spar inclosed in a cell filled with bisulphide of carbon; and also by Dr. Zenker, who replaced the liquid in M. Jamin's construction by wedges of flint glass.

Amongst others, the carefully considered modifications of the Nicol prism which have recently been devised by Prof. S. P. Thompson (*Phil. Mag.*, November, 1881, 349; and *Journ. R. Micros. Soc.*, August, 1883, 575), and by Mr. R. T. Glazebrook (*Phil. Mag.*, May, 1883, 352), do not appear to have been known to Dr. Feussner.

The following tabular view of different forms of polarising prisms is taken from the conclusion of Dr. Feussner's paper:—

	Field	Inclination of section in regard to long axis	Ratio of length to clear width	Fe[illegible]
I. The Old Polarising Prisms	°	°		
1. Nicol's prism	29	22	3·25	[illegible]
2. Shortened Nicol prism—				
a. Cemented with Canada balsam	13	25	2·83	[illegible]
b. ,, ,, copaiba ..	24	25	2·83	[illegible]
3. Nicol with perpendicular ends—				
a. With Canada balsam	20	15	3·73	[illegible]
b. With cement of index of refraction of 1·525	27	15	3·73	[illegible]
4. Foucault's prism	8	40	1·528	[illegible]
5. Hartnack's prism—				
a. Original form...	35	15·9	3·51	[illegible]
b. With largest field	41·9	13·9	4·24	[illegible]
c. With field of 30°	30	17·4	3·19	[illegible]
d. With field of 20°	20	20·3	2·70	[illegible]
6. Glan's prism	7·9	50·3	0·831	[illegible]
II. The New Polarising Prism				
1. With calc-spar: largest field ...	44	13·2	4·26	[illegible]
2. ,, field of 30° ...	30	17·4	3·19	[illegible]
3. ,, field of 20° ...	20	20·3	2·70	[illegible]
4. With nitrate of soda: largest field	54	16·7	3·33	[illegible]
5. ,, ,, field of 30°.	30	24	2·25	[illegible]
6. ,, ,, field of 20°.	20	27	1·95	[illegible]

As an analysing prism of about 6 mm. clear width, and 13·5 mm. long, the new prism is stated by its inventor to be the most essential service, and it would certainly appear that the arrangement is rather better adapted for small prisms than for those of considerable size. Any means by which a beam of polarised light of large diameter—say 3 to 3½ inches—could be obtained with all the convenience of a Nicol would be a great advance, for spar of sufficient size and purity for such a purpose has become so scarce and therefore so valuable that large prisms are difficult to procure at all. So far as an analyser is concerned, the experience of the writer of this notice would lead to the opinion that improvements are to be looked for rather in the way of the discovery of an artificial crystal which absorbs one of the polarised rays than by further modifications depending upon total reflection. The researches of Dr. Herapath on iodo-sulphate of quinine (*Phil. Mag.*, March, 1852, 161, and November, 1853, 346) are in this direction; but crystals of the so-called herapathite require great manipulative skill for their production. If these could be readily obtained of sufficient size, they would be invaluable as analysers.

This opinion is supported by the existence of an inconvenience which attends every form of analysing prism. It is frequently, and especially in projecting apparatus, required to be placed the focus of a system of lenses, so that the rays may cross in the interior of the prism. This is an unfavourable position for a prismatic analyser, and in the case of a powerful beam of light, such as that from the electric arc, the crossing of the rays within the prism is not unattended with danger to the cementing substance, and to the surfaces in contact with it.

PHILIP R. SLEEMAN

ON VARIOUS SUGGESTIONS AS TO THE SOURCE OF ATMOSPHERIC ELECTRICITY[1]

WE have seen that, taking for granted the electrification of clouds, all the ordinary phenomena of a thunderstorm (except *globe* lightning) admit of easy and direct explanation by the known laws of statical electricity. Thus far we are on comparatively sure ground.

But the case is very different when we attempt to look a little farther into the matter, and to seek the source of atmospheric electricity. One cause of the difficulty is easily seen. It is the scale on which meteorological phenomena usually occur; so enormously greater than that of any possible laboratory arrangement that effects, which may pass wholly unnoticed by the most acute experimenter, may in nature rise to paramount importance. I shall content myself with one simple but striking instance.

Few people think of the immense transformations of energy which accompany an ordinary shower. But a very easy calculation leads us to startling results. To raise a single pound of water, in the form of vapour, from the sea or from moist ground, requires an amount of work equal to that of a horse for about half an hour! This is given out again, in the form of heat, by the vapour when it condenses; and the pound of water, falling as rain, would cover a square foot of ground to the depth of rather less than one-fifth of an inch. Thus a fifth of an inch of rain represents a horse-power for half an hour on every square foot; or, on a square mile, about a million horse-power for fourteen hours! A million horses would barely have standing room on a square mile. Considerations like this show that we can account for the most violent hurricanes by the energy set free by the mere condensation of vapour required for the concomitant rain.

Now the modern kinetic theory of gases shows that the particles of water-vapour are so small that there are somewhere about three hundred millions of millions of millions of them in a single cubic inch of saturated steam at ordinary atmospheric pressure. This corresponds to 1/1600 or so of a cubic inch of water, *i.e.* to about an average raindrop. But if each of the vapour particles had been by any cause electrified to one and the same potential, and all could be made to unite, the potential of the raindrop formed from them would be fifty million million times greater.

Thus it appears that if there be any cause which would give each particle of vapour an electric potential, even if that potential were far smaller than any that can be indicated by our most delicate electrometers, the aggregation of these particles into raindrops would easily explain the charge of the most formidable thundercloud. Many years ago it occurred to me that the mere *contact* of the particles of vapour with those of air, as they interdiffuse according to the kinetic theory of gases, would suffice to produce the excessively small potential requisite. Thus the source of atmospheric electricity would be the same as that of Volta's electrification of dry metals by contact. My experiments were all made on a small scale, with ordinary laboratory apparatus. Their general object was, by various processes, to precipitate vapour from damp air, and to study either (1) the electrification produced in the body on which the vapour was precipitated; or (2) to find on which of two parallel, polished plates, oppositely electrified and artificially cooled, the more rapid deposition of moisture would take place. After many trials, some resultless, others of a more promising character, I saw that experiments on a comparatively large scale would be absolutely necessary in order that a definite answer might be obtained. I communicated my views to the Royal Society of Edinburgh in 1875, in order that some one with the requisite facilities might be induced to take up the inquiry, but I am not aware that this has been done.

I may briefly mention some of the more prominent attempts which have been made to solve this curious and important problem. Some of them are ludicrous enough, but their diversity well illustrates the nature and amount of the difficulty.

[1] By Prof. Tait. Read at the meeting of the Scottish Meteorological Society on March 17, and communicated by the Society.

The oldest notion seems to have been that the source of atmospheric electricity is aërial friction. Unfortunately for this theory, it is *not* usually in windy weather that the greatest development of electricity takes place.

In the earlier years of this century Pouillet claimed to have established by experiment that in all cases of combustion or oxidation, in the growth of plants, and in evaporation of *salt* water, electricity was invariably developed. But more recent experiments have thrown doubt on the first two conclusions, and have shown that the third is true only when the salt water is boiling, and that the electricity then produced is due to friction, not to evaporation. Thus Faraday traced the action of Armstrong's hydro-electric machine to friction of the steam against the orifice by which it escaped.

Saussure and others attributed the production of atmospheric electricity to the condensation of vapour, the reverse of one of Pouillet's hypotheses. This, however, is a much less plausible guess than that of Pouillet; for we could understand a particle of vapour carrying positive electricity with it, and leaving an equal charge of negative electricity in the water from which it escaped. But to account for the separation of the two electricities when two particles of vapour unite is a much less promising task.

Peltier (followed by Lamont) assumed that the earth itself has a permanent charge of negative electricity whose distribution varies from time to time, and from place to place. Air, according to this hypothesis, can neither hold nor conduct electricity, but a cloud can do both; and the cloud is electrified by conduction if it touch the earth, by induction if it do not. But here the difficulty is only thrown back one step. How are we to account for the earth's permanent charge?

Sir W. Thomson starts from the experimental fact that the layer of air near the ground is often found to be strongly electrified, and accounts for atmospheric electricity by the carrying up of this layer by convection currents. But this process also only shifts the difficulty.

A wild theory has in recent times been proposed by Becquerel. Corpuscles of some kind, electrified by the outbursts of glowing hydrogen, travel from the sun to the upper strata of the earth's atmosphere.

Mühry traces the source of electricity to a direct effect of solar radiation falling on the earth's surface.

Lüddens has recently attributed it to the friction of aqueous vapour against dry air. Some still more recent assumptions attribute it to capillary surface-tension of water, to the production of hail, &c.

Blake, Kalischer, &c., have lately endeavoured to show by experiment that it is not due to evaporation, or to condensation of water. Their experiments, however, have all been made on too small a scale to insure certain results. What I have just said about the extraordinary number of vapour particles in a single raindrop, shows that the whole charge in a few cubic feet of moist air may altogether escape detection.

And so the matter will probably stand, until means are found of making these delicate experiments in the only way in which success is likely to be obtained, viz. on a scale far larger than is at the command of any ordinary private purse. It is a question of real importance, not only for pure science but for the people, and ought to be thoroughly sifted by means which only a wealthy nation can provide.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The General Board of Studies propose to appoint, early in Easter Term, a number of Readers and University Lecturers, including the following: a Reader in Comparative Philology, stipend 300*l*. per annum; a Reader in Botany, stipend 100*l*.; University Lecturers in Sanskrit, in Comparative Philology, in Mathematics (one in each group of the Tripos, Part 3), in Applied Mechanics, in Botany, in Animal Morphology, in Advanced Physiology (three), in Geology, in History (five), and in Moral Science; all at 50*l*., except in Animal Morphology and in Geology, to which 100*l*. is assigned. The University Lecturers will for the most part be chosen from such College Lecturers as open their lectures to the University generally; but the Board is not necessarily restricted to such; nor to persons who may apply. Candidates are to send in their names and testimonials (if any) to the Vice-Chancellor not later than April 25. It is understood that two lectures a week during term time shall be the minimum during two terms for each lecturer receiving 50*l.* per annum. As far as possible the University Lecturers are to give special personal attention to their pupils, so as to obviate as much as possible the necessity of private tuition in the subject of the lectures; and the students' fees are to be understood as payment for this personal supervision.

The Special Board for Biology and Geology have published a report showing urgent need for a Senior Demonstrator in Elementary Biology and Animal Morphology at 200*l.* a year; the classes have grown enormously, consequent on recent changes in the M.B. examinations. They recommend that the Lecturers, by whose aid Mr. Sedgwick carries on the work of the late Prof. Balfour, shall be appointed University Lecturers, Dr. Hans Gadow in the Advanced Morphology of Vertebrates, and Mr. W. F. R. Weldon in that of Invertebrates. Moreover, they consider an Assistant Demonstrator as well as other occasional demonstrators are required.

Prof. Hughes has written a letter on the subject of the proposed Sedgwick Museum, suggesting that educational utility rather than architectural display should be the principal aim in the building, and pleading strongly against possible curtailment of the site available for the new museum to satisfy demands of other departments. The area now proposed, 240 feet by 50 feet, with room behind for future extension by annexes, &c., is not too large. If sufficient space can be secured for future extension, it is best to place the museum entirely on one floor; but if this is not certain, it would be desirable to have two long rooms one above another, each 20 feet high.

SCIENTIFIC SERIALS

THE *Quarterly Journal of Microscopical Science* for January, 1884, contains:—Notes on Echinoderm morphology, No. vii.: on the apical system of the Ophiurids, by P. Herbert Carpenter, M.A. (plate 1).—On the homologies of the primary larval plates in the test of Brachiate Echinoderms, by W. Percy Sladen (plate 1).—On the origin of metameric segmentation and some other morphological questions, by Adam Sedgwick, M.A. (plates 2 and 3).—On certain abnormalities in the common frog (*Rana temporaria*): (1) the occurrence of an ovotestis; (2) abnormalities of the vertebral column, by A. Gibbs Bourne, B.Sc. (plate 4).—Researches on the intracellular digestion of Invertebrates, by Dr. E. Metschnikoff (translated from *Arbeiten Zool. Instit. Wien*, 1883.—On the ancestral history of the inflammatory process, by Dr. E. Metschnikoff.—The structures connected with the ovarian ovum of Marsupialia and Monotremata, by Edward B. Poulton, M.A. (plate 5).—On the skeletotrophic tissues and coxal glands of Limulus, Scorpio, and Mygale, by Prof. E. Ray Lankester, M.A. (plates 6 to 11).

THE *Journal of Physiology*, vol. iv., No. 6, February, 1884, contains:—On the electrical phenomena of the excitatory process in the heart of the frog and of the tortoise as investigated photographically, by Dr. J. Burdon-Sanderson and F. J. M. Page (plates 13 to 20).—Experiments on the ears of fishes with reference to the function of equilibrium, by Dr. Henry Sewall.—On the influence of certain drugs on the period of diminished excitability, by Dr. S. Ringer and Dr. H. Sainsbury (plate 21).—On the action of digitalis, by Dr. J. Blake.—On the coagulation of the blood, by L. C. Wooldridge, D.Sc.—An investigation regarding the action of rubidium and cæsium salts compared with the action of potassium salts on the ventricle of the frog's heart, by Dr. S. Ringer (plate 22).—Some notes on the fibrin ferment, by S. Lea, M.A., and J. R. Green, B.Sc.

THE *Journal of the Royal Microscopical Society*, February, 1884, contains:—On the constituents of sewage in the mud of the Thames, by Lionel S. Beale, F.R.S. (plates 1 to 4).—On the modes of vision with objectives of wide aperture, by Prof. E. Abbe (figures); and the usual summary of current researches relating to zoology and botany.

Morphologisches Jahrbuch, Bd. ix., Heft 11, contains:—On the comparative anatomy of the excretory sexual organs of insects, by J. A. Palmen.—Contributions to the comparative anatomy of fishes, No. i.; on the cranium of *Amia calva*, L., by Dr. M. Sagemehl (plate 10).—A contribution to a knowledge of the pseudobranchiæ in osseous fishes, by Dr. F. Maurer (plates 11 and 12).—On the morphology of the mammalian teat, by Hermann Klaatsch (plates 13 to 17).

Archives Italiennes de Biologie, tome iv., fasc. 11, December 15, 1883, contains:—New researches on the alterations in organs in diabetes, by Dr. P. Ferraro.—New researches on the normal and pathological anatomy of the human placenta and of that of mammals, being the substance of three letters to Prof. Albert Kölliker, by Dr. G. B. Ercolani.—On the ciliary muscle in reptiles, by Dr. Ferruccio Mercanti.—On the reproduction of epithelium of the anterior crystalline capsule in adult animals under normal and pathological conditions, by Dr. F. Falchi.—On some dangers from fly's excrement, by Dr. B. Grassi.—On the course and termination of the optic nerve in the retina of a crocodile (*Champsa lucius*), by Dr. A. Tafani (with a plate).—On the development of the vertebral column in osseous fishes, by Dr. B. Grassi.—Notice of the death and writings of Dr. P. Burresi, and of the death of Prof. G. B. Ercolani of Bologna.

Rivista Scientifico-Industriale, Florence, January 15.—A description, with illustration, of the seismoscopic clock invented by Brassart Brothers, by E. Brassart.—On the harmonic sounds produced by a fluid discharged through a tube, by Tito Martini.—Variations in the electric resistance of solid and pure metallic wires under varying temperatures; Part i., Historic survey of the works hitherto issued on the influence of temperature on the conductibility and electric resistance of solid and pure metals, by Prof. Angelo Emo.—Account of the semi-incandescent electric lamp invented by Tihon.—A practical application of Newton's rings in motion, by Prof. Augusto Righi.—On the periodical migrations of the *Myosus glis*, Gml., by S. Mina-Palumbo.—On the nest of the *Geophilus flavus*, by Prof. F. Fanzago.—On the mollusks at present inhabiting the province of Porto-Maurizio, Maritime Alps, by G. R. Sulliotti.

Rendiconti del Reale Istituto Lombardo, February 7.—Obituary notice of Prof. Emilio Cornalia (concluded), by Prof. Leopoldo Maggi.—A short description of the crystals of barium found at Vernasca, by Dr. F. Sansoni.—On the importance of certain symptoms in the diagnosis of sciatica and other affections of the hip, by Dr. G. Fiorani.—Whether women should be permitted to follow the legal profession, by Prof. E. Vidari.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 13.—"Notes on the Microscopic Structure of some Rocks from the Andes of Ecuador, collected by Edward Whymper. No. II. Antisana." By Prof. T. G. Bonney, D.Sc., F.R.S.

The specimens examined consisted of one series gathered by Mr. Whymper and another obtained by him from a collector. The latter came from the south-west or west side of the mountain, at elevations probably not exceeding 13,000 feet. Among them are pitchstones and augite-andesites, in which a little hypersthene possibly occurs. Mr. Whymper's own collection contains specimens of the great lava stream on the west side of Antisana, taken at about 12,340 feet above the sea. It is an augite andesite. The remainder represents the rocks forming the upper part of the mountain, collected from a moraine above 16,000 feet above the sea, supplied by occasional crags, which crop out through the snow and are mostly inaccessible. These are a series of augite-andesites, in some of which hypersthene is certainly present.

Linnean Society, March 20.—H. T. Stainton, F.R.S., vice-president, in the chair.—The Rev. Canon Jas. Baker, Mr. W. Brockbank, Mr. Robert Mason, and Mr. Ed. A. Heath were elected Fellows of the Society.—Mr. J. G. Baker showed and made remarks on a supposed hybrid between the Oxlip (*Primula elatior*) and the Cowslip (*P. veris*).—In illustration of his paper, a contribution to the knowledge of the genus *Anaphe*, Walker, Lord Walsingham exhibited a large and remarkable nest containing a packed mass of cocoons, also specimens of the insects and of the larvæ of a species of Congregating Moth of this genus from Natal; and he likewise showed a live example of a dipterous parasite which had emerged from the moth's eggs when hatched. He further stated that the nest and contents had been forwarded to him by Col. Bowker of Durban, and the larvæ were found alive on its receipt in England in August last. Many of the larvæ remained in the nest, but others in companies of twenty to forty occasionally marched out, moving in closely serried rank, much after the manner of the larvæ of the Procession Moth (*Cnethocampa*). From December to February about 250 moths emerged, but, from the difficulty of obtaining their natural food, all died, though a pair bred and the eggs hatched.

The mature insect closely resembles the *Anaphe panda*, Boisd., though under the latter name, it would seem, there are several well-marked local races. The genus is found in West Africa as well as Natal; and it appears that in the several species the colour, size, shape, and material of the common nest, as well as the individual silky cocoons, markedly differ. The habits of these moths when still more fully known in their native haunts will yet form a most interesting chapter to the traveller. Of *Anaphe* four species have hitherto been described, viz. *A. venata* from Old Calabar, *A. ambigua* from Angola, and *A. reticulata* and *A. panda* from Natal. To these Lord Walsingham adds *A. carteri* from the Gold Coast, and *A. infracta* from the Cameroons.—A paper, on the hairs occurring on the stamens of plants, by Mr. Greenwood Pim, was read. As to the morphology of these he sums up the groups thus: (1) simple unicellular, subulate, smooth, *Malva*, *Campanula*; (2) unicellular, subulate, rugose or papillar, *Cuphea*, *Nerium*, *Eutoca*; (3) unicellular, flattened, spathulate, rugose or striate, *Verbascum*, *Celsia*, *Antirrhinum*; (4) pluricellular, simple, smooth, *Salvia*, *Adhatoda*; (5) pluricellular, simple, rugose or striate, *Anagallis*, *Thunbergia*; (6) pluricellular and branched, *Browallia* and some forms of *Salvia*; (7) pluricellular with glandular tip, *Oxalis*, *Gesnera*; (8) multicellular, *Convolvulus*, *Ipomœa*.—A communication was read, "Closure of the Cyclostomatous Bryozoa," by Arthur W. Waters. While admitting that the group possesses few characters available for purposes of scientific determication, he nevertheless points out that the ovicells have a greater importance than that hitherto accorded them; also that the connecting pores are comparable with the rosette plates of the Chilostomata, and that stress must be laid on the size of the zooecial tube, and more particularly to the position and variation of its closure. The author states that in the Cyclostomata (simplest Bryozoa) he has found a calcareous partition closing the tubular zooecium, thus protecting the colony; whereas in the Chilostomata there is a horny operculum, which, unlike the other, is not a sign of death, but, being movable, protects the living polypide, and through it the colony.—A paper was read on the life-history of *Æcidium bellidis*, by Mr. C. B. Plowright, in which he gives the results of a series of experiments, noting the infection and appearance of the Uredo. He differs in opinion from most authorities, who regard the *Æcidium* of the daisy as a variety of *Æ. compositarum*, while he demonstrates it to be a true heterœcismal Uredine.—The last communication read was by Mr. F. Kitton, on some Diatomaceæ from the Island of Socotra, in which a number of new species are described and figured.

Geological Society, March 5.—Prof. T. G. Bonney, F.R.S., president, in the chair.—F. N. Maude, John Potts, and Corbet Woodall were elected Fellows, and Dr. Charles Barrois, of Lille, a Foreign Correspondent of the Society.—The following communications were read:—On the structure and formation of coal, by E. Wethered, F.G.S., F.C.S. The conclusions on the evidence elicited from the author's investigations were (1) that some coals were practically made up of spores, others were not, these variations often occurring in the beds of the same seam; (2) the so-called bituminous coals were largely made up of the substance which the author termed hydrocarbon, to which wood-tissue undoubtedly contributed. An appendix to the paper, written by Prof. Harker, Professor of Botany and Geology at the Royal Agricultural College, Cirencester, dealt with the determination of the spores seen in Mr. Wethered's microscopic sections. The writer concluded that the forms in the coal were from a group of plants having affinities with the modern genus *Isoëtes*, and from this Isoëtoid character he suggests the generic title of *Isoëtoides* pending further investigation.—On strain in connection with crystallisation and the development of perlitic structure, by Frank Rutley, F.G.S.—Sketches of South-African geology; No. 1, a sketch of the high-level coal-field of South Africa, by W. H. Penning, F.G.S. In this paper the author gave a sketch of the high-level coal-field of the Transvaal and the neighbouring region. This coal-field was described as extending 400 miles from north to south, with an average breadth of 140 miles, so that its area is about 56,000 square miles. The tract consists of an elevated plateau forming the "High Veldts" of the Transvaal and the plains of the Orange Free State. It slopes away to the north-west, and is scarped to the south and east by the heights known as the Stormberg and Drakensberg Mountains; nearly all the principal rivers of South Africa take their rise in this tract of land. The coal-bearing beds forming the plateau rest unconformably in the north upon deposits probably of Upper Palæozoic age, described as the Megaliesberg beds. In the south-west the Lower Karoo beds underlie the coal-beds, also unconformably. The beds of the high grounds consist above of sandstones, called the "High Veldt beds" by the author, and below of shales, for which the name of "Kimberley beds" is proposed, after the chief town of Griqualand West, in which district they form nearly the whole surface. These two series are conformable, and generally lie horizontally. In the shales coal occurs only in minute patches; the seams of coal are interstratified with the sandstones, into which the shales pass up gradually, and which sometimes include thick-bedded grits and conglomerates. Both shales and sandstones contain interstratifications and numerous dykes of trap, which have rarely produced much alteration in the sedimentary beds, from which the author concludes that the eruptions were sub-aqueous and contemporaneous, or nearly so. Owing to the persistent horizontality of the rocks, the mountains and valleys are merely carved out of the plateau, so that the thickness of the deposits is easily measured. The author gave 2300 feet as the minimum thickness of each series. By a comparative section it was shown that the coal-bearing sandstones ("High Veldt beds") are the "Upper Karoo" of Stow, and the "Stormberg beds" of Dunn. The "Kimberley beds" are the Upper Karoo beds of Dunn. In the latter part of his paper the author noticed briefly the different localities where coal has been found, namely, Newcastle, Lange's Nek, the Lebelelasberg Mountains, near New Scotland, several places on the High Veldt, Wemburg, Brandfoote, Cornet Spruit, Burgersdorf, and Indwe, twenty miles east of Dordrecht. The most northerly point of the Transvaal where coal has been found is on the Letsebo River. West of the Drakensberg coal occurs at a lower level.

Entomological Society, March 5.—Special General Meeting.—Mr. J. W. Dunning, president, in the chair.—Prof. J. O. Westwood, hon. life president, proposed, and Mr. H. T. Stainton seconded, a proposition "That it is desirable to obtain for the Society a Royal Charter of Incorporation." After a short discussion, the resolution was carried *nem. con.*

Ordinary Meeting.—Prof. Westwood, hon. life president, in the chair.—Two new members were elected.—Mr. E. A. Fitch exhibited a large geodephagous larva said to have been coughed up at Maldon by a young man who was suffering from bronchitis.—Mr. J. W. Dunning protested against the irregular manner in which the names of persons had lately been used in entomological nomenclature; and Mr. H. J. Elwes expressed his disapproval of the use of Hindoo mythological, and other names not of Latin or Greek derivation, in the same manner.—Mr. E. Saunders read the concluding part of his synopsis of the British *Hymenoptera Aculeata*, part iii. *Apidæ*; and also, further notes on the terminal segments of aculeate *Hymenoptera*.

EDINBURGH

Mathematical Society, March 14.—A. J. G. Barclay, vice-president, in the chair.—Mr. W. J. Macdonald gave an account of Pascal's "Essais pour les Coniques."—Mr. R. E. Allardice read a paper on the geometry of the spherical surface; and Prof. Chrystal gave an additional proof of one of his theorems.—Mr. Thomas Muir, F.R.S.E., contributed a note on the condensation of a special continuant.

Royal Physical Society, March 19.—Mr. B. W. Peach, F.R.S.E., F.G.S., president, in the chair.—The following communications were read:—Notes on a second collection of birds and eggs from Central Uruguay (with exhibition of specimens), by Mr. J. J. Dalgleish.—On a revised list of British *Ophiuroidea*, by W. E. Hoyle, M.A., F.R.S.E., of the *Challenger* Expedition Office.—On the Breadalbane Mines, by Messrs. J. S. Grant Wilson and H. M. Cadell, B.Sc., of H.M. Geological Survey of Scotland (communicated by permission of the Director-General of the Geological Survey). These mines are situated in the basin of the Tay, and the highest—those of Tyndrum—were first noticed. The galena veins were partly in a fissure traversing the quartzites in close proximity to a large fault which the authors had observed for the first time at Tyndrum. Another vein existed in the fault fissure itself or in the mica schists which were brought down by it against the quartzites. A difference in inclination brought the two fissures together, and at a certain depth they found a conjoint vein. Below the line of junction the ore almost disappeared, as had been proved by the old workings, and very little ore was visible in the portion of the conjoint vein exposed on the surface. The veins were of quartz with spathic iron and barytes, and were never more than four feet in thickness. The ore was distributed in broad rudely parallel diagonal bands, and the veins resembled in this as in other particulars those of the Upper Harz belonging to von Groddeck's "Type Clausthal." Lead ore was discovered at Tyndrum in 1741, and was mined with varying activity till 1862, when the mines were abandoned, as they had quite ceased to pay expenses. Chrome iron ore was known to occur in considerable quantity in a mass of serpentine at Coirie Charnaig in Glen Lochaig, but had never been extensively worked. An interesting occurrence of grey and yellow copper ore was found at Tomnadashan on the southern shore of Loch Tay. The ore was disseminated through a mass of crystalline rock resembling diorite, which had been injected into the schists, hardening and contorting them at its edges. The basic rock was in turn traversed by multitudes of veins of pink granitite, which at some places united and formed a stock-like mass with large pink orthoclase crystals. The ore was found most abundantly at the junction of the two rocks. Molybden glance occurred in the acid rock, but no traces of blende or galena had been discovered at Tomnadashan. At Corrai Bui near Ardeonaig rich argentiferous galena veins traversed the schists on the top of a hill which was capped by a series of calcareous beds. The galena contained from 85 to 600 ounces of silver per ton of ore, but the veins thinned out on passing down into the non-calcareous beds below, and became quite barren at a depth of 100 feet. There were many other very thin veins of pyrites, blende, galena, &c., in the Breadalbane district, but none were thick enough to be worked with profit.—Prof. Cossar Ewart, F.R.S E., exhibited, with remarks, the following specimens:—(1) the Tadpole fish (*Raniceps trifurcus*); (2) the Great Fork-beard (*Phycis blennioides*); (3) the Power Cod (*Gadus minutus*); (4) an Albino specimen of the Haddock (*Gadus æglefinus*).—Prof. Ewart also exhibited and described a new hatching-box he had devised for adhesive eggs to take the place of the American "Clark" hatching-box. The advantage of Prof. Ewart's box is that the glasses are arranged in a horizontal position, so that the embryos, when hatched, pass at once into comparatively still water, instead of having to run over and under a varying number of vertical glass plates.—Prof. Ewart also described an easy method of stocking spawning beds capable of being readily used by the fishermen themselves. All that was required was an ordinary wooden tub and a shallow galvanised iron tray about twenty inches in diameter, with the bottom consisting of two portions each hinged to a central bar so as to open downwards. The object in view is to deposit stones on the spawning bed coated with fertilised ova. To do this the tray is placed in the tub, which is then filled with sea-water. Into the tray a number of flat stones are arranged; the water is then fertilised and the stones coated with eggs. This done, the tray is lowered to the bottom by means of four cords—two attached to the rim of the tray, and one to each half of the bottom. When the tray has reached the sea-floor, the cords attached to the false bottom are set free, and the tray raised by the cords attached to its edge, the result being that the egg-coated stones are left at the bottom. By this method the fishermen, without any trouble or expense, could add 200 or 300 eggs for every herring they removed from the sea, and thus do their best to restore the balance of nature which their operations had disturbed.

PARIS

Academy of Sciences, March 17.—M. Rolland in the chair.—On the new map of Tunis to the scale of 1 : 200,000, now being prepared in the French War Office, and the first six sheets of which have just appeared, by M. F. Perrier. The map, which will be completed early next year, will comprise twenty sheets altogether, uniform with that of Algeria, of which it forms a natural continuation.—Relative rapidity of combustion of explosive gaseous mixtures, by MM. Berthelot and Vieille.—On the solution of a very extended class of equations in quaternions, by M. Sylvester.—Notice of the labours of the late M. Sella, Corresponding Member of the Section of Mineralogy, by M. Daubrée.—Notice of the second volume of the Emperor of Brazil's "Records of the Rio de Janeiro Observatory," by M. Faye.—Remarks on a note by Sir Richard Owen on the discovery of a mammal (Tritylodon) in the South African Trias, by M. Albert Gaudry.—Application of the incandescent lamp for the lighting of astronomical instruments, by M. G. Towne.—Remarks on the shadows cast by the faculæ on the penumbra of the solar spots (one illustration), by M. E. L. Trouvelot.—On some arithmetical applications of the theory of elliptical functions, by M. Stieltjes—On a new generalisation of the Abelian functions, by M. E Picard.—On the thrust of a mass of sand with horizontal upper surface against a vertical or inclined wall, by M. J. Boussinesq.—Theory and practical formulas of magneto-electric machines with alternate currents, by M. Félix Lucas.—Note on Hall's electro-magnetic phenomenon, by M. A. Leduc.—On the laws regulating the decomposition of salts in water, by M. H. Le Chatelier.—Note on the action of chloruretted aldehydes on bea[illegible] in the presence of chloride of aluminium, by M. Alph. Com[illegible].—On the addition of chloride of iodine to monobromure[illegible] ethylene, by M. Louis Henry.—Note on the dialysis of the [illegible] of the gastric juice, by M. Ch. Richet.—Distribution of the motor roots in the animal muscular system, by MM. F[illegible] and Lannegrâce.—Memoir on the relations between plants [illegible] the nitrogen consumed by them, by M. W. O. Atwater.—N[illegible] on the cultivation of the sedimentary matter brought up from great depths by the dredgings of the *Travailleur* and *Talisman* during the expeditions of 1882-83, by M. A. Certes. The object of these experiments is to show that the absence of [illegible] or animals in decomposition at the bottom of the sea is probably due to the presence of microbes analogous to those which, [illegible] our eyes, are daily working at the transformation of organic in[illegible] inorganic matter.—On the renal organs of the embryos of Hel[illegible] by M. P. de Meuron.—On spermatogenesis and the phenomena of fecundation in *Ascaris megalocephala*, by M. P. Hallez.—[illegible] the Simœdosaurian, a reptile belonging to the Cernay formation of the Rheims district, by M. Victor Lemoine.—On the morphological value of the cortical libero-ligneous masses in the stems [illegible] the Calycantheæ, by M. Oct. Lignier.

CONTENTS

THURSDAY, APRIL 3, 1884

THE "CHALLENGER" REPORTS

Report of the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76, *under the Command of Capt. George S. Nares, R.N., F.R.S., and Capt. Frank T. Thompson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S., and now of John Murray, F.R.S.E., one of the Naturalists of the Expedition. Zoology, vol. viii. (London: Published by Order of Her Majesty's Government, 1883.)

THE eighth volume of the Zoological Series of Reports on the Scientific Results of the Expedition of H.M.S. *Challenger* contains three Reports. That on the Copepoda is the second Report on the Entomostraca, and is by Dr. G. S. Brady. That on the Calcareous Sponges is by Mr. N. Poléjaeff of the University of Odessa; and that on the Cirripedia is by Dr. P. P. C. Hoek. We learn incidentally from a note by the editor, Mr. John Murray, that the Report on the Foraminifera, by H. B. Brady, F.R S., is now (December 1883) nearly printed, and that it will be issued at once as vol. ix.

Dr. G. S. Brady's Report on the Copepods contains descriptions of 106 species, for 12 of which it has been necessary to establish 11 new genera. These species were taken almost entirely from surface-net gatherings made during the cruise. While in some few of these gatherings no Copepods were found, Mr. Murray feels certain that these forms were rarely if ever absent from the tow-net gatherings when these were examined on board ship. It seems now certain that the sea from the Equator to the Poles supports everywhere a profusion of Entomostracan life, chiefly of the order Copepoda. The appearance of these little crustaceans on the surface would seem to depend on conditions not yet well understood. Night seems to call them up in larger numbers than the day, but sometimes even in the day they will appear in multitudes so vast as to colour the surface of the ocean for distances of many miles. The cold waters of the Arctic and Antarctic seas are even more favourable to the increase of the Copepods than the warmer waters of the tropics, and Dr. Brady notes that while individuals of some one or two species seem in the polar seas to predominate, in the equatorial and sub-tropical area no one species seems to occur in a very preponderating abundance, but there is a far greater variety of genera and species. While the range of the distribution of the Copepods is extremely wide, still some forms, as *Calanus finmarchicus*, seem to be characteristic of the Arctic seas, while others, as *Undina darwinii* and *Euchæta prestandreæ*, occupy a like position in the tropical and warmer temperate seas.

Dr. Brady follows the sevenfold division into areas adopted in his Report on the Ostracoda. The only undoubted deep-sea species found is *Pontostratiotes abyssicola*, a single specimen of which was dredged in a depth of 2200 fathoms. The fish parasites described are remarkably few, and with one exception seem to have occurred on surface-living fish. It would perhaps not be safe to conclude from this that the deep-sea fish are free from such parasites, but is it not possible that if such forms existed they may have been torn off or destroyed in the transit of the host fishes from the abyssal depths? The single species found was described in manuscript by the late Dr. von Willemoës Suhm, whose description and figures are given. It is called *Lernæa abysssicola*, and was found on a specimen of *Ceratias uranoscopus*, Murray, which was taken at Station 89, from a depth of 2400 fathoms. It is a strangely attenuated and wonderfully transparent form. The thread-like cephalic region and body portion together only a little exceed 13 mm. in length. This most important Report is accompanied by fifty-five plates, all drawn by the skilled hand of the author.

The Report on the Calcareous Sponges, by Mr. A. Poléjaeff of Gratz, a graduate of the University of Odessa, and a trusted pupil of Prof. F. E. Schulze, is a most excellent contribution to our knowledge of this highly interesting group, and entitles its author by its comprehensive criticism and by its attention to practical details, to a high place among modern systematic zoologists. The author had much invaluable assistance in his work, and though living in the somewhat out-of-the-way, though beautifully situated capital of Styria, he had the immense advantage of being able to consult the collection of Oscar Schmidt. It is with pleasure we fully recognise the good use he has made of all these opportunities, and we heartily congratulate him on the result. The Calcareous Sponges of the *Challenger* Expedition were found to belong to thirty species, twenty-three of which are described as new. To describe these was a comparatively easy task, and to arrange them in an orderly sequence was there not the splendid essay of Ernst Haeckel, "Die Kalkschwämme"? True; but there was just the difficulty: for the twelve years that had elapsed since the appearance of this most remarkable work had added so much to our knowledge of the morphology and embryology of this group as to expose the extremely artificial nature of Haeckel's system. Possibly, if the chapter of the history of the Calcareous Sponges had for ever closed on the publication of Haeckel's monograph, the systematic arrangement there adopted, however open to logical attack, might for convenience' sake have stood its ground. But as a *natural* arrangement it would have ever been open to a destructive criticism. Not the least important part of this Report is the free but generous criticism on Haeckel's classification which will command the attention of every one interested in the group of the Sponges. It should also be read by all working on the details of structure of the lower forms of animal life.

It would be impossible in a general notice of this Report to venture into minute details, but while referring those interested in the facts to the first two dozen pages of the introductory remarks, we may observe that the author concludes that "the peculiarities of the canal system of the sponges, the early development of their mesoderm, the circumstance that it is just the mesoderm which in them gives origin to the generative products, and finally the absence of cnidoblasts and nervous elements, taken altogether, though they do not justify the establishment of a new class for the Sponges, are yet important enough to entitle them to occupy an independent position among the Cœlenterata as a sub-class. Within this class the Calcareous Sponges occupy an essentially isolated position, and as a group these may be divided into two orders: (1) Homocœla, and (2) Heterocœla; the former with the single family Asconidæ (Leucosolenia, Bwbk.), the latter with the three families Syconidæ, Leuconidæ, and Teichonidæ. The concluding portion of the introductory chapter we quote as showing that, however destructive may be the author's criticism, he is not unmindful of the merits of the author of "Die Kalkschwämme;" while many of Prof. Haeckel's statements have thus proved to be founded on error, it must never be forgotten that it was his Monograph that called forth and facilitated later investigations, and if we are forced to agree to a certain extent with the judgment of M. Barrois upon this great work, that "l'imagination y a trop souvent pris la place de l'observation scientifique et froide," every one will also agree with another judgment of the very same naturalist, that with the appearance of Prof. Haeckel's Monograph "l'histoire des Éponges entra dans une phase nouvelle." M. Poléjaeff's Report is accompanied by nine plates, in which all the new forms are figured.

The Report on the Cirripedia is by Dr. P. P. C. Hoëk. Taking Darwin's Monograph as a basis of departure, the author gives us (1) a sketch of the development of our knowledge with regard to the number of the genera and species known, their geographical and bathymetrical distribution; (2) a summary of what has been added to our knowledge of the anatomy, embryology, &c., of the group; and (3) a discussion of the different opinions published with regard to the classification of the group, especially since the discovery of the so-called Cirripedia Suctoria or Rhizocephala. The first of these sketches is, from a faunistic point of view, very interesting and instructive, showing both how much and how little is known as to the forms to be met with on our coasts or in our oceans; and, if properly studied, this section may give a very great impetus to the local study of these forms. We read that all "the Cirripedia of the Baltic belong to the genus Balanus;" but, if we are not mistaken, the extremely curious species *Anelasma squalicola* has been found on sharks in this sea, and specimens, we believe, from this locality are to be found in the Berlin and Dublin Museums. To the record given of species of fossil forms described since the date of Darwin's Monograph we may add one that has a peculiar interest being from the pen of the late head of the civilian staff of the *Challenger* Expedition, describing *Loricula macadami* from the Upper Greensand of the County Antrim.

Out of seventy-eight species of Cirripeds represented in the *Challenger* collection only nineteen had been previously recorded, and fifty-nine are named and described now for the first time. In 1854 Darwin gave the number of known Cirripedes as 147, and since then only some eighteen new species have been recorded.

Of the thirty-four genera of Cirripedia at present known the species of twenty-eight have never been observed at a depth greater than 150 fathoms. Two have been found from the shore to 400 fathoms (Alepas and Pœcilasma). Balanus occurs from the shore down to 510 fathoms. Dichelaspis ranges down to 1000 fathoms; and finally only two genera (Scalpellum and Verruca) have been observed at depths greater than 1000 fathoms. The occurrence of these two latter genera in the greater depths of the ocean coincides in a striking manner with their palæontological history, but Dr. Hoëk has not been able to identify any of the recent species with the extinct forms described by Darwin, Bosquet, and Reuss. Of the genus Scalpellum only eleven species were known up to the cruise of the *Challenger;* over forty species were added to the list as the result of the cruise. The majority of the species are inhabitants of deep water; indeed Scalpellum appears to be the only genus of the stalked Cirripedia which is to be often met with at great depths. It is also worthy of note that the observation of Darwin made with regard to the number of specimens of Cirripeds during the Cretaceous period may be made for the recent species of Scalpellum: "The number of species is con-

Scalpellum darwinii.

siderable, the individuals are rare." While the species found during the *Challenger* cruise amounted to forty-three, twenty-six of these are represented by a single specimen only; four are represented by two specimens; five by three; two by four; and only six species are represented by more than four specimens. The study of the complemental males found in some of the species of Scalpellum has given some very interesting results, but we are promised a more detailed treatment of the organisation of these little creatures in a supplementary memoir, which will deal with the anatomy of the group, and which will very shortly be published. In the account of *S. stroemii*, Sars, we find the following:—

"On opening a specimen of this species, dredged in August 1882 by H.M.S. *Triton*, it was found to contain within the mantle cavity a few large embryos; on microscopic examination these were found to have passed already the Nauplius-stage and to have arrived at the Cypris-stage. The exuviæ of the Nauplius-stage still adhered to the covering of the Cypris; still it was not easy to make out which parts had developed from the Nauplius-appendages."

The largest species of the genus known has been called *S. darwinii.* Only a single specimen of this splendid form was dredged during the *Challenger's* cruise, and of it, through the courtesy of Mr. Murray, we are enabled to give the woodcut illustration on the previous page. This specimen was found as represented attached to a manganese nodule; these nodules, according to Mr. Murray, are formed by concretionary depositions around shark's teeth, pumice, and other substances at the bottom of the sea; it was dredged at Station 299, December 14, 1875, lat. 33° 31′ S., long. 74° 43′ W., at a depth of 2160 fathoms, from a bottom of gray mud. Four large complemental males were found attached between the mantle and the scutum at a short distance from the apex of the valve and close to its occludent margin. Three specimens were on the left and one on the right side.

Of the genus Verruca, ten species, of which six are new, were found. They are among some of the most interesting forms of animal life collected during the Expedition, and prove that the number of recent species is much greater than had been to this supposed to exist, and that the genus has a true worldwide distribution. Of the six stations which yielded Verruca one belongs to the Northern Atlantic, three to the Southern Atlantic, one to the Pacific, and one to the Malay Archipelago. By these discoveries the range in depth has been immensely increased; the greatest depth known to Darwin for *V. strömia*, O.F.M, was 90 fathoms, but the six new *Challenger* species inhabit depths of from 500 to 1900 fathoms. Of the genus Balanus nine species are referred to, and five described as new; and of the genus Chthamalus one new species is described. This memoir is accompanied by thirteen plates.

The volume has been edited by Mr. Murray, and is one of the most important to the student of invertebrate forms yet published of these Reports.

GERMAN METEOROLOGY

Repertorium der Deutschen Meteorologie. Leistungen der Deutschen in Schriften, Erfindungen und Beobachtungen auf dem Gebiete der Meteorologie und des Erdmagnetismus von den Ältesten zeiten bis zum Schlusse des Jahres 1881. Von G. Hellmann. (Leipzig: verlag von Wilhelm Englemann, 1883.)

IN this goodly octavo volume of 498 pages, presenting an exhaustive catalogue of the meteorological literature of Germany from the earliest to the present time, Dr. Hellmann has done a service to science, the practical value of which it would be difficult to overestimate. The work is divided into three parts. The first part comprises the writings and discoveries, and is in two divisions. The first of these divisions gives the names of authors and the titles of their works; and the fulness and satisfactoriness of detail with which this is gone into may be seen by referring to "Dove," who was the prince of German meteorologists, and "Helmholtz," the latter contributing only one paper—on whirlwinds and thunderstorms—and the former 208 papers, embracing all departments of the subject. The principal events in the biography of each author are briefly indicated, together with the date of publication of each contribution and the work in which it appeared. The second division is an index of subjects comprised under meteorology, terrestrial magnetism, and atmospheric electricity; and the completeness with which this part of the work is done may be seen by a reference to "Barometer," the various papers relating to which are grouped under thirty heads. The heading "Astro-Meteorologie" shows that even the antiquities of the science have not been overlooked.

The second part gives a catalogue of stations, and is in two divisions—the first comprising stations and the different series of observations made at them; and the second, indexes of subjects and observers. The stations are arranged according to the different States of Germany where they are situated; and sections are set apart for stations the observations at which have been published *in extenso;* at which six or more observations have been made daily; stations for investigating forest meteorology, for weather telegraphy, and for international meteorology; high-level stations at heights of 1969 feet and upwards; and stations at which observations have been made for at least fifty years. To these is appended an index of observers' names and their stations.

The third part is historical, presenting an outline of the history of meteorological observations in Germany; a valuable chronological table from the eighth century downwards, detailing the more important facts in the history of meteorology and terrestrial magnetism; and the book closes with interesting statistics showing for the decennial periods beginning with 1480 the progress and extension of meteorological observations over Germany. A map is added showing the meteorological stations in the German Empire at the present time; and on the same sheet a small map showing the stations in Germany in 1781, including those established in connection with the Societas Meteorologica Palatina.

The extreme importance of this undertaking to all workers in meteorology, terrestrial magnetism, and atmospheric electricity, and the ability with which Dr. Hellmann has carried it through, make us regret with a strong feeling of shame the financial difficulty that was allowed to stand in the way of completing a similar catalogue of the meteorological literature of all nations. From Dr. Hellmann's letter to the International Meteorological Committee at Berne, dated July 20, 1880, it appears that all that was required to complete this great work was the raising of a sum not exceeding 1200*l.* As however there appeared to be no hope of this small sum being raised or even guaranteed, Dr. Hellmann, in a spirit and with an energy which cannot but call forth the warmest approbation of scientific men, set to work in the autumn of that year, and was in a position in May 1883 to sign the preface of the work now before us. No small praise is also due to Herr Engelmann, for the effective help he has given in its publication.

For want of such catalogues, the workers, not merely in meteorology, but in every department of science, are crippled, and the remark applies with peculiar emphasis in the case of those who are entering on the work of scientific research. Indeed, the waste of time and brain-work in carrying on scientific work no longer necessary because it has been already done is so great, and the consequent material loss to the nation so serious, that the time cannot be far distant when the Governments of this and other countries will have no choice, but yield to the demands made for a moderate annual grant towards defraying the expenses incurred in preparing and publishing these indispensable aids to all workers in science.

OUR BOOK SHELF

Berly's Electrical Directory. Third Edition. (London and New York, 1884.)

THIS work consists of three separate directories, separately paged, but bound up together; the first, of 228 pages, relates to British trades and professions connected with electricity; the second, of 273 pages, is devoted to similar matters from America; whilst the third is Continental. Of the last, 71 pages are French and Belgian, 12 German, and 3 relate to other countries, chiefly Russia. This arrangement, though convenient probably to the compilers, strikes us as being bad for many purposes. The American and French sections are particularly full of information. The British section opens with remarks on the progress made in electrical business during the past year, after which come various tables and formulæ. These are by no means satisfactory. In the formulæ for dimensions of units, many of the numbers which should have been printed as powers are given as simple multipliers. Though the table begins with C.G.S. units, and professes to describe those accepted by the British Association and the International Congress of 1881, the ohm is given as equal to 10^7 absolute units and the volt as 10^6, whereas the figures should respectively be 10^9 and 10^8. All this is very misleading. So also is the following statement:—"Calling gravitation the natural unit of force, the absolute unit of force will be $\frac{1}{9 \cdot 81}$th part of it." This statement ushers in the following definition:—"*Unit of Mechanical Effect* is the unit of force carried up through one centimetre, or $\frac{1}{9 \cdot 81}$ raised one centimetre." Is it possible that this chapter on formulæ has been translated literally from the pages of some French writer who was in the habit of using a mixed metre-gramme-second system instead of either the centimetre-gramme-second or the metre-kilogramme-second system? With the exception of the scientific part, the editing appears to have been carefully and soundly done, and the commercial information is very extensive.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

"The Unity of Nature"

IT was, I think, in the course of last year, or of the year preceding, that I ventured to remonstrate against the use sometimes made of your columns by Mr. G. J. Romanes for the purpose of inculcating his personal beliefs, and disbeliefs, on subjects which lie outside the boundaries of physical science.

The observations made by him in your paper of March 20 upon the book I have lately published ("Unity of Nature") show that in that remonstrance I committed an offence which Mr. Romanes has not forgotten or forgiven. Nevertheless I must repeat it; and this time I have the advantage of his own confession, that "the pages of a scientific journal are not suited to an examination" of those parts of my book which he has nevertheless denounced in your pages with unusual violence of language. If your pages are not suited to such an examination, neither can they be suited to comments which nothing but that examination could justify. The tone of these comments is a very clear proof of the necessity of our all keeping within the marches when we meet on neutral ground. Scientific facts and scientific hypotheses constitute that neutral ground. On the other hand, the bearing of these facts and of these hypotheses on questions of philosophy and of religion constitutes a separate region in which, if we meet at all, it must be outside the pages of a purely scientific journal. In that separate region it has always been my endeavour to argue without personal passion and without contumely towards opponents. I should be ashamed in any argument to display the animus which has in this case dictated the language of Mr. Romanes on subjects which, by his own confession, he has no right to drag into your pages. He may hold that the highest aim of the human intellect is to prove the mindlessness of nature. My book deals, and was intended to deal, with this philosophy; and I did not expect Mr. Romanes to like it. How much he dislikes it is remarkable. But he will find no passage in it which descends to the level of some of his comments.

Having dismissed, as irrelevant in your columns, the criticisms of Mr. Romanes on the "Unity of Nature" which have no connection with science, I now turn to some of those which have this connection, and are at least perfectly legitimate in their character.

Mr. Romanes is quite right when he says that I object to the "*newer philosophy*" which makes experience the source of instinct. In my view this theory is, in the strictest meaning of the word, nonsense, because experience is obviously a "synthesis of intuitions," and not the source of them. It is a plain fact that instinctive movements and instinctive sensations are the conditions precedent—the sole materials—of experience. Experience is nothing but the memory in living creatures of their own previous action on external things, and of the reaction of external things upon themselves. It is the combined consciousness of both which builds up what we call experience. But in every step of this process, whether of action, or of reaction, or of the combined memory of each, not one instinct only, but several instincts are concerned. Experience therefore is the result of instinct, and not the converse.

With this argument Mr. Romanes does not even attempt to deal.

He does, however, attempt to deal with my contention that instinct is always strictly correlated with organic structure, and that special instincts are always connected with "organs already fitted for and appropriate to the purpose." He says that my own case of the dipper ought to have taught me better; "for," he adds, "the dipper belongs to a non-aquatic family of birds and *therefore* has no organs specially adapted to its aquatic instincts."

This argument, as an argument, is a *non sequitur*; and as a statement of fact is altogether erroneous. It is quite true that the dipper has not webbed feet. But it is not true that webbed feet are at all necessary for aquatic habits of a particular kind; nor is it true that the dipper is wanting in other peculiarities of structure which are most specially adapted to its peculiar aquatic habits and instincts. There are many birds which swim excellently well without webbed feet, as, for example, all the Gallinules, and some of the Tringidæ. The dipper does not need webbed feet, because it neither swims nor dives in deep water, and because on the other hand it positively needs feet free from web for grasping stones under rapid streams, as well as for grasping rock-surfaces in the places of its nidification. On the other hand, the structure of its wings, and above all the structure and texture of its feathers, are all specially modified and adapted to its aquatic habits.

It is for Mr. Romanes to prove, if he can, that the dipper once had an ancestor which began to dive in water, whilst as yet its wings had not a shape and a texture adapted to the purpose, and whilst its plumage was still pervious to water, and so was liable to be drenched and sodden.

Mr. Romanes protests against my suggestion that rudimentary organs may, sometimes at least, be the beginnings of a structure destined for future use, and not the relics of a structure whose use has been in the past. Yet in the same paper he himself suggests that the dipper may be on the way to having webbed feet, and only wants them now because it has "not yet had time to develop" them. But when these webs do begin to appear, they would naturally be small, and would appear to be rudimentary; so that in this stage they would exactly represent the "wholly untenable doctrine" which Mr. Romanes denounces as an "inversion of Mr. Darwin's teaching." As a matter of fact rudimentary organs on the way to future use can be identified in the aquatic larvæ of the Ephemeræ.

The truth evidently is that the theory of the origin of species by transmutation, involves of necessity a constant succession of structures which are on the wane, and another succession of structures which are on the stocks. Whether any particular structure now dissociated from use, belongs to the one or to the other class, is a question of evidence from associated facts. But the idea of some structures being on the rise, is an idea inseparable from the theory of evolution as taught by Darwin. Fully persuaded, as I am, that there is a very large amount of truth in that theory, I am equally persuaded that, as yet understood, it is incompetent to solve the most important phenomena of creation. In the hands of Mr. Romanes, and of many others, it is almost reduced to the repetition of mere verbal formulæ, under which anything and everything may be brought, only because they are empty of any definite meaning. The derivation of instinct from experience is an excellent example.

ARGYLL

Rain-band Spectroscopy Attacked Again

I HAVE just had the honour of receiving a copy of an essay read before the Philosophical Society, Washington, D.C., and printed in the *American Journal of Science* for the present month, wherein I read on p. 209:—

"The results of observations with the rain-band spectroscope are now called in question by many prominent meteorologists. In fact the unsatisfactory nature of the evidence may be easily shown to the satisfaction of any one possessing an instrument. If the spectroscope is first turned to the sky in any direction and afterward to a white wall fifty feet distant, it will be found impossible to distinguish between the appearance of the rain-band as shown by the whole atmosphere and by the layer fifty feet thick."

If this be the most damaging accusation that can be brought up, after the memorable correspondence in both NATURE and the *Times* during the autumn of 1882, there is hope of converting "the prominent meteorologists" yet.

For cannot they, as well as other men, see, that a white wall close to an observer in daylight, necessarily reflects the light, and with that, the spectrum, of the sky which is illumining it, solar lines and telluric lines and all!

Or if the worthy gentlemen still doubt, let them illumine their white wall at midnight with policemen's lanterns or Swan's incandescent lamps; and then I can promise them they will get out of it and the "layer of air fifty feet thick" in front of it, neither solar nor telluric spectrum lines in any kind of weather.

C. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, March 25

The Remarkable Sunsets

IN reply to inquiries sent out by me to Prof. John Milne of the University of Tokio, Japan, I am informed that no volcanic dust was known to have fallen in Japan during or after the Krakatoa eruption. He forwards, however, the following extracts, which may be of interest to your readers.

JOHN W. JUDD

Science Schools, South Kensington, S.W.

"*Japan Gazette, Friday, Sept.* 21, 1883.—Shortly after noon on August 30 the sun seemed to diminish in power, and a uniform yellow gray haze spread over the sky, gradually becoming more pronounced, and at two hours before sunset its rays were merged into a faint halo emerging from a globe of light no larger than the full moon. On Friday, August 31, at 8 a.m., sun the same. At 11 a.m. looked like full moon; could easily observe it with the naked eye. At intervals, faint clouds like puffs of smoke crossed the sun's face; they were enormously high. No wind; atmosphere dull and heavy, and neither heat nor light. September 1, the same. On Sunday, sun became as usual, and haze passed away. The Japanese were alarmed, and expected earthquakes."

Prof. Milne adds the note: "If this were due to Krakatoa, almost 2500 miles away, the speed of the dust must have been thirty miles an hour, assuming the date of the eruption to be 12 p.m. on August 26."

THE coloration of the sky in the neighbourhood of the sun, described by "B. W. S." in NATURE of March 27 (p. 503), has been repeatedly observed by myself from February 20 (or thereabouts) up to March 24. My first record of it is on February 24, when I describe it as a "rusty-red" tint. On other occasions I have called it "rusty brown" and "pale brick-red." Sometimes it has had a purplish or roseate hue. It has been chiefly seen between 10° and 20° from the sun (at a rough estimate), and only when the sun was hidden by a detached cloud. Frequently, when the sky has been clear, the intervention of a house or other object between the observer and the sun has revealed the presence of a hazy metallic-looking glare around the sun—an appearance not perhaps very remarkable in itself, but remarkable by its frequent repetition.

If, as seems probable, the explanation of these phenomena is to be found in a gradual subsidence of the reflecting matter which occasioned the remarkable sunsets, it will be well for observers to be prepared with suitable arrangements for catching what may fall. I have myself had in operation for some time past two separate devices for this purpose, the one intended for dry weather, the other for rain. In dry weather I expose a tray containing a number of glass slides, each with a drop of glycerine in a shallow cell, ready to be covered with this glass after sufficient exposure. For rain I use a 12-inch bell-glass supported in an inverted position on a three-legged stand, the legs partly buried in the earth, and the height such as to raise the receiving area of the glass to 30 inches above the soil. A rain-gauge is less suitable for the purpose, and experience has shown me the necessity of guarding against the introduction of particles of soil by the rebound of hailstones.

An investigation of this kind is difficult in the neighbourhood of a city, and it is much to be wished that observers living in isolated situations may be induced to undertake it.

It may be worth recording that on February 24, after an interval of several weeks, we had a striking recurrence of the sunset phenomena so often described. It was not perhaps the very finest example, but, as regards the primary glow, there had been nothing equal to it since January 12. Unfortunately I was not able to watch for the secondary glow. It is singular that at both the beginning and end of this series of phenomena there should have been outlying examples separated by some weeks from the rest. The first of the peculiar sunsets observed in this country appears to have been on November 9. Then I find no record until November 24. From that date (allowing for interruption by weather) they may perhaps be considered to have been continuous until February 2, becoming scarcely noticeable towards the last. Then, finally, after an entire absence of fully three weeks there comes, on February 24, a sunset which must be ranked amongst the finest of the series.

Clifton, March 31 GEORGE F. BURDER

REFERRING to the "decidedly unusual *pink tinge*" occasionally observed around the sun "when shining in a somewhat hazy sky, the colour being brought out with great distinctness if a light cloud happens to be passing across it" (see NATURE, March 27, p. 503), I would mention that, under the described circumstances, I have often noticed last winter a peculiar colour, to which I would apply the French term *pelure d'oignon* (onion skin), used to describe certain kinds of champagne. I offer this suggestion, as I know the value of precise and happily chosen terms, especially in the difficult matter of the terminology of colours. O. S.

Heidelberg, Germany, March 29

Thread-twisting

THE habit of thread-twisting with the palm of the hand on the thigh is one which may be seen in every part of India at the present day; we think it can hardly be termed a rude method, or a savage art, though the Mohammedans, whose ancestors came not so very long ago from Central Asia, practise it as much as, or even more than, the Hindoos. As "J. S." observes in NATURE of March 20 (p. 478), it may be one of the survivals from a barbarous period which we have lost since the introduction of machinery. Perhaps some of your correspondents may be able to tell us whether it is in use in the Orkneys and the Hebrides, or elsewhere, where the people still spin their own wool.

COSMOPOLITAN

MEASURING HEIGHTS[1]

THE system of barometric hypsometry described in this treatise—first communicated in 1877 to the Philosophical Society of Washington—was suggested by the needs of the geographical surveys conducted by the Government of the United States in the mountainous region lying between the Great Plains and the Pacific Ocean. The system proposes a new method of observation and computation. It is not of universal application, but the range of work to which it is adapted is large and deserving the attention of the geographer.

The *method of observation* is as follows:—Two base stations are established—one high, the other low. Their difference in altitude is made as great, and their horizontal distance as small, as practicable. Each station is furnished with a barometer only, and observations are made at frequent intervals through each day. At each new station a barometer is observed, and no other instrument. The difference in altitude of the two base stations is determined by spirit level, and forms a vertical base by which all other intermediate altitudes are *computed as follows*:—The readings, being corrected for index error and temperature of instrument, are collected in groups of three, each observation at a new station being accompanied with the simultaneous observations at the two base stations. The resulting difference of heights of the lower and the new station is then computed by the following formula, in which if L, U, N represent the height of the lower, upper, and new stations respectively, and l, u, n the simultaneous corrected barometric readings at the same stations, and also let $B = U - L$, $A = N - L$, and $B - A = U - N$; then it is found approximately that—

$$A = B\frac{\log l - \log n}{\log l - \log u} + \frac{A(B - A)}{D}.$$

where $D = 490{,}000$, if A and B are reckoned in *feet*; or 149,349 if in *metres*. This formula consists of two terms—the first, or *logarithmic term*, is the principal one; the second, or *thermic term* (so called), is always very small in comparison with the first—so that it suffices to substitute for A in the second term the value of the first. The following example of computation further illustrates the formula:—

In August 1872 the simultaneous mean pressures at Sacramento, Colfax, and at Summit were 29·879, 27·475, and 23·336 inches respectively, and the altitude of Summit above Sacramento is 6989 feet. Required the altitude of Colfax above Sacramento. In this case:—

$l = 29{\cdot}879$ $\log l = 1{\cdot}47537$
$n = 27{\cdot}475$ $\log n = 1{\cdot}43894$
$u = 23{\cdot}336$ $\log u = 1{\cdot}36803$
$\log l - \log n = 0{\cdot}03643$
$\log l - \log u = 0{\cdot}10734$

log (0·03643) = − 2·56146
log (0·10734) = − 1·03076

Difference = − 1·53076
log B = 3·84441 6989 = B

sum = log (first term) = 3·37511 ...2372·0 = first term = A nearly
log $(B - A)$ = 3·6644 ...4617 = $(B - A)$ (approximately)
colog (490000) = − 6·3098 ...

Sum = 1·3493 = log 22·4 ...the second term

Required difference of altitude = 2394·4 feet.

[1] "A New Method of Measuring Heights by Means of the Barometer." By G. K. Gilbert. Extract from the Annual Report of the Director of the U.S. Geological Survey, 1880-81. (Washington: Government Printing Office, 1882.)

The author, considering the direct calculation of the second term inconvenient, has calculated a table of double-entry showing the value of this term as a correction of the first term for every 100 feet of B and of the approximate value of A, which is appended. A graphic table is also appended (plate lxii.) for computation of this *thermic* correction. However, as the table of logarithms must be to hand, the direct calculation does not seem to present any particular inconvenience.

By thus abandoning the thermometer and psychrometer, and employing the barometer alone, the author reverts to elementary principles upon which all barometric measurements depend, and presents in his first chapter a review of the purposes and conditions of barometric hypsometry in general, and although not presenting anything new, is yet very interesting. The principle which underlies the measurement of heights by the barometer is exceedingly simple, but its application is fraught with difficulty. The law of the relation of altitude to atmospheric pressure is consequent on the law of the compressibility of gases, and is simply a certain multiple of the logarithm of the air-pressure. But there are numerous modifying conditions which must be considered in the application of this law. After describing the construction of barometers, of which the mercurial is both the oldest and the most accurate, the author passes to the consideration of the modifying conditions of the temperature and humidity of the atmosphere which are ever varying, so that the static order of densities is broken, currents are set in motion, and the circulation and the inequalities of temperature conspire to produce inequalities of moisture. Every element of equilibrium is thus set aside, and the air is rendered heterogeneous in composition, temperature, and density. Moreover, the disturbing factors are so multifarious and complex that there is infinite variety of combination and infinite variety of result. Approximate solutions of the problem are therefore only expected; and the author, after describing the disturbing factors—gradients, temperature, humidity—and the various devices for the elimination of the errors due thereto, and other general devices for diminishing hypsometric errors and the relative importance of different sources of error, arrives at the conclusion that the difficulties which inhere in the use of the barometer for the measurement of heights are so numerous and so baffling that there is no reason to hope they will ever be fully overcome. The best that can be done is to mitigate them, keeping in mind that the barometric method must not be so elaborate that its cost will approach that of the use of the spirit level. The problem, therefore, which occupies the attention of those who have occasion to use the barometer in extended surveys is how to secure the best result from a single observation at a new station combined with a series of observations at one or more base stations.

The author next proceeds in the second chapter to develop his *new method*, as explained above, and determines a mean value of the *thermic constant*, D. In Chapter III., on "Comparative Tests," various tables are given of the comparative results obtained by means of the new method and the ordinary and other empirical methods in use. This comparison shows the advantage of the new method in a reduction of one-half the error of the ordinary method, and one-fourth that of the empiric method. Nevertheless there is a considerable range of special cases in which the ordinary method can never be superseded.

Having shown that the new method is theoretically plausible and practically successful, the author considers in the fourth chapter the nature of possible improvements. This chapter, and the following fifth chapter on the limits of utility, and the sixth on the work of others, are more specially addressed to the students of hypsometry. This interesting work closes with a short chapter, the seventh, on the use of the table of the values of the *thermic term* —before-mentioned—and a supplementary note on devices to eliminate the influence of wind-pressure.

It may be stated that of the seven plates referred to as illustrating this work, six are wanting in the copy now under notice.

ON A METHOD OF ESTIMATING THE STEADINESS OF ELONGATED SHOT WHEN FIRED FROM LARGE GUNS

IN Cctober last it was stated in the newspapers that "at the request of Lord Alcester," and in the presence of the Lords of the Admiralty, "comparative trials of a Krupp gun and a 6-inch breechloader took place *greatly to the advantage of the former*." . . . "The projectile used in the English weapon was 100 lb. with a 34 lb. charge, and that in the Krupp gun 64 lb. with a 14 lb. charge, *the results from the latter being far in advance of the former*." If this statement be exact, the matter calls for the most careful consideration. In such a case the superiority of the Krupp gun must have arisen either from the higher initial velocity, or from the greater steadiness imparted to the shot by the Krupp gun, or probably from both these causes combined. The comparative merits of these or any other guns could be very readily settled by well-known methods of experimenting, at the expense of little more than the cost of 5 to 10 rounds of ammunition for each gun. There is no necessity for a repetition of the Armstrong and Whitworth competition, said to have cost some 30,000*l*.

Numerous experiments were made in this country in 1867-68 with guns of 3, 5, 7, and 9 inches calibre, to determine the resistance of the air to the motion of both round and elongated projectiles. Coefficients of resistance were then determined for all velocities between 900 f.s. and 1700 f.s. Additional experiments were made in 1878-79 with elongated projectiles alone, which gave the coefficient of resistance K corresponding to all velocities between 430 f.s. and 2250 f.s. But after this report had been printed, which contained general tables for both *time* and *space* within the above-named limits of velocity, it was decided to have additional experiments made with both lower and higher velocities. The final report of these experiments was published in 1880, which contained general tables for *space* and *time* for velocities between 100 f.s. and 2900 f.s. The values of K_v corresponding to the velocity v, as given in this report, will be hereafter referred to as the "tabular" values of K_v. The weight of a cubic foot of air was taken to be 534·22 grains.

In testing any new gun I would proceed, as in the above-named experiments, to measure the times occupied by the shot in passing over a succession of equal distances. These observations would readily give the velocity v of the shot at any point of its path, and also the corresponding coefficient of resistance K_v. Then according as the mean value of K_v derived from 5 to 10 rounds, was found to be *greater* or *less* than the tabular value of K_v, it would be evident that the gun on its trial gave a *less* or *greater* degree of steadiness than the average of the guns used in the experiments of 1867, &c.

Let us examine the relative value of these four guns in rounds where the middle velocity was about 1280 f.s.

Rounds 6-12, 124 and 126 were fired from the 3-inch gun, with projectiles of 9 lb., giving for K_{1280} respectively the values 136·5, 110·7, —, 114·5, 118·2, 121·0, 119·2, 111·7, and 111·2; the mean of which, 117·9, is 8·9 *higher* than 109·0, the tabular value of K_{1280}. Consequently this gun falls *below* the average in steadiness very decidedly.

Rounds 164-168 were fired from a 5-inch gun with projectiles of 47·68 lb., giving for K_{1280} respectively the values 110·2, 98·9, 91·0, 101·5, and 97·9; the mean of which, 99·9, is therefore 9·1 *below* 109·0, the tabular value of K_{1280}. Consequently these solid 5-inch shot had a very *high* degree of steadiness.

Rounds 148-153 were fired from the same 5-inch gun, but with hollow projectiles of 23·84 lb., giving for K_{1280} respectively the values 105·1, 113·4, 101·5, 105·4, 107·7, and 102·0; the mean of which, 105·9, is 3·1 *below* 109·0, the tabular value of K_{1280}. The steadiness of these shot was *above* the average, but inferior to that of the solid 5-inch shot.

Rounds 97-101 were fired from a 7-inch gun, with projectiles of 123·125 lb., giving for K_{1300} respectively the values 109·8, 118·7, 108·6, 117·6, and 117·5; the mean of which, 114·4, is 5·8 *greater* than 108·6, the tabular value of K_{1300}. The 7-inch projectiles were therefore *deficient* in steadiness.

Rounds 218-221 and 228 were fired from a 9-inch gun with projectiles of 250 lb. giving for K_{1280} respectively the values 110·4, 104·8, 126·0, 118·9, and 131·2; the mean of which, 118·2, is 9·2 *above* the tabulated value 109·0 of K_{1280}. The 9-inch shot were therefore very *unsteady*.

We thus arrive at the character of each of the experimental guns from the error in K_v. In the 3-inch gun the error was + 8·9; in the 5-inch gun (solid shot), − 9·1; in the 5-inch gun (hollow shot), − 3·1; in the 7-inch gun, + 5·8; and in the 9-inch gun, + 9·2.

Some experiments were made with projectiles provided with various forms of heads in 1866. Although the programme was never fully carried out, the rounds fired with hollow ogival-headed shot of one and two diameters were tolerably numerous. The two forms of shot were fired alternately, and gave the following values of K_{1400}.

Round	One diameter	Error	Round	Two diameters	Error
14	108·6	+0·1	15	108·0	+4·6
16	113·1	+4·6	17	—	—
18	109·6	+1·1	19	—	—
20	108·0	−0·5	21	103·5	+0·1
22	105·3	−3·2	23	104·6	+1·2
24	110·1	+1·6	25	99·1	−4·3
26	108·1	−0·4	27	100·8	−2·6
28	108·4	−0·1	29	103·0	−0·4
30	109·6	+1·1	31	104·0	+0·6
32	104·4	−4·1	33	104·2	+0·8
	10)1085·2	16·8		8)827·2	8)14·6
Means ...	108·5	1·7	Means ...	103·4	1·8

The tabular value of K_{1400} is 104·7, which was derived from experiments made with ogival-headed shot struck with a radius of one diameter and a half. The unit of K in the above cases corresponds to about the 1/50,000 of a second.

M. Krupp has recently circulated some tables which are based on coefficients, a little less than the tabular numbers above referred to, and about such as would have been obtained if I had used those coefficients only which were given by the most steady moving projectiles. Since 1868 there have been great improvements made in the manufacture of slow-burning powder, &c., which may have tended to give increased steadiness to the shot, and thus to reduce the resistance of the air slightly. Still I do not think it desirable at present to reduce my coefficients sensibly, because in all my experiments the velocities have been determined during the motion of the shot just after it had left the gun. But when the range of the shot is considerable, the direction of the axis of the shot must become inclined to the direction of the motion of the shot, and this must increase the resistance of the air. If it was thought desirable to reduce the coefficients of resistance throughout any range in a particular case by $\frac{1}{20}$th or $\frac{1}{10}$th, &c., this could easily be effected by multiplying $d^2 \div w$ by $(1 - \frac{1}{20})$, $(1 - \frac{1}{10})$, &c. For heavy shot the range should be extended much beyond 500 yards

The pamphlet alluded to above is entitled "Table de Krupp pour le calcul des vitesses restantes horizontales et des durées de trajet des projectiles oblongs. Essen, 1881." M. Krupp does not give any details of the experiments on which he professes to have founded his tables, or acknowledge any kind of assistance from any other author. He remarks that for a long time the resistance of the air was supposed to vary as v^2, then to depend upon two powers of v, and afterwards to vary as v^3 or v^4. Experiments have shown that these so-called laws of resistance are not good for all velocities. "Cette expérience devait le faire paraître utile de trouver une nouvelle méthod pour le calcul des vitesses restantes" (p. 16). And again, "Un tel tableau pour différences de vitesse de 10 cm. a été établi par l'usine Krupp au commencement de l'année 1880" (p. 18).

M. Krupp's tables are precisely the same as those that have been used in England since 1871, except only that French replace English measures, and that a small reduction of the English coefficients of resistance has been made throughout. Taking one of Krupp's examples (last page) 11/6/79, where $d = 355$ mm. $= 13·977$ inches; $w = 525$ kilos. $= 1157·43$ lbs.; commencing velocity 490 m.s. $= 1607·64$ f.s.; remaining velocity 415 m.s. $= 1361·57$ f.s., at distance 2384 m. $= 7821·6$ ft.; weight of 1 cubic metre of air $= 1·200$ kilos., M. Krupp finds from his table 411·8 m s. for the remaining velocity instead of 415 m.s. given by his experiment. My table gives a remaining velocity of 405·7 m.s. But supposing we reduce the coefficients of resistance in the proportion 99·9 : 109·0 given by the experiments made with the 5-inch gun (solid shot), then we obtain 412·0 m.s. for the required remaining velocity, which is nearly the same as 411·8 m.s. obtained by the use of Krupp's table. Again, taking the experiment 6/8/79 with a projectile 400 mm. in diameter, commencing with a velocity 533·4 m.s., M. Krupp finds a remaining velocity of 447·0 m.s. by the use of his table, while I obtain 440·4 m.s. and 443·8 m.s. is given as the result of experiment. But if I reduce all my coefficients as before in the ratio 99·9 : 109·0, then my table gives 447·4 m s. as the remaining velocity, which agrees with M. Krupp's calculations. Hence it appears that M. Krupp claims by these tables that his guns of 1880, on the average, give a degree of steadiness about equal to that given by the best of the four English experimental guns used in 1867-68. I have not much confidence in the accuracy of velocities measured at a distance of near one mile and a half from the gun by an instrument not specified, but I have used these data as a means of indicating to what extent the tables give different results. As a test of the tables I should much prefer a careful determination of the commencing velocity of the shot, and the time of flight to some known distant point, where all the times were measured by a *single* instrument.

For further information I beg leave to refer M. Krupp to (1) "Tables of Remaining Velocity, Time of Flight and Energy of various Projectiles, &c.," 1871; (2) to the *Proceedings of the Royal Artillery Institution*, Woolwich, September 1871, p. 382, &c.; (3) *Ib.*, April 1872, p. 1, &c.; (4) *Ib.*, December 1877, p. 250, &c.; (5) "Treatise on the Motion of Projectiles, &c.," 1873; (6) "Principles of Gunnery," by Major Sladen, R.A., 1879; (7) "Handbook for Field Service" (R.A.), 1878; (8) "The Construction of Ordnance, &c.," p. 359, &c., 1877; (9) "Reports on Experiments, &c., 84/B/2853," 1879; (10) "Final Report on Experiments, &c., 84/B/2909," 1880; and (11) and (12) "Manual of Gunnery for H.M. Fleet," 1880. And since that date my "General Tables" have been reprinted in four different books.

Since the above was written, I have noticed that the introducer of the Navy Estimates, 1884, remarked:—"*The old breech-loader* had been found to be of no more use than a muzzle-loader, and the Government had adopted a *gun twice as long* as the *old* form of breech-loader." I always understood that the profitable use of the new slow-burning powder required a *long* barrel, and that the breech-loading arrangement was introduced because it permitted the use of a longer barrel on shipboard than could be employed with muzzle-loading.

March 22 FRANCIS BASHFORTH

THIRD NOTE ON THE ELECTRICAL RESISTANCE OF THE HUMAN BODY

IN two previous communications last year, I showed that the amount of this important basis of rational electrotherapeutics had been enormously overstated. Since then I find it given in the new edition of Rosenthal's "Elektricitätslehre," published in the current year, as about 5000 ohms, and, to my surprise, so competent an observer as my friend Prof. Dolbear, in Lockwood's "Handbook of Electric Telegraphy," states it vaguely as from 6000 to 10,000 ohms. On the other hand, Count Du Moncel, in his paper on the conductivity of imperfect conductors in the *Annales de Chémie et de Physique*, vol. x., 1877, approaches more nearly to the real value in stating it from wrist to wrist to vary from 350 to 220 kilometres. This is probably the Swiss unit given in Clark and Sabine's tables as equal to 10·42 ohms or thereabouts. Both Rosenthal and Du Moncel furnish internal evidence that their excessive estimates were due to imperfect contact through the skin: for the former speaks of using fifty chromic acid elements of two volts E.M.F. each; whereas the current from this large battery, with proper contact, would be utterly unbearable to the patient, if not dangerous. The highest current I have seen employed was from twenty-two of these cells through less than 2000 ohms resistance. It was done against my advice, and produced a large carbuncular boil at the nape of the neck, where the negative pole was applied. I have since then completely modified my method of making the skin contacts, and no similar accident has occurred.

Even with a far smaller current, namely, that of eight Daniell cells and small platinum electrodes, of which the size is accurately given, namely, 4½ by 3 cm. (roughly, the length of two shillings side by side, and the breadth of a florin), Du Moncel produced a similar though much more serious accident. The current was passed at intervals for an hour and a half from wrist to wrist, the patient being a lady, and afterwards for shorter periods in the opposite direction. "On withdrawing the electrodes," says the writer, "to my great astonishment I found, on the parts of the wrists where my electrodes had been applied, very pronounced scars resembling burns produced by an acid or a caustic. These scars, to the number of three at the negative pole, were large and deep. At the positive pole they were very small, and thirty-two in number. During the first two days after the experiment no inflammation supervened, but on the third day it began about the negative scars, and it was necessary to have recourse to poultices, which were kept up for a month; even then the sloughs were not detached." It is satisfactory to find that no permanent harm was done; but it is evident that the excessive resistance recorded, amounting at times to 3500 ohms, was mainly due to this cause. It is perhaps not to be wondered at that the scientific Count should have relinquished this branch of his investigation.

With hands soaked in strong brine, and then enveloped in a thickness of flannel wetted with the same solution, bandaged surgically over this with a spiral strip of lead at least 30 cm. long and 5 cm. broad, no local accident has ever occurred to me, nor has any local pain been mentioned. But with ten bichromate cells in good order the shock felt at making and breaking circuit has often been considerable. Indeed my tall and athletic clinical clerk, Mr. Shackel, who kindly consented to act as a resistance, noticed that, when being tested from foot to hand (in his case a length of 7 feet) with 1027 ohms resistance, the opposite side of the body was jerked at these instants. In all recent experiments I have never exceeded this E.M.F., which is at the outside 20 volts, or about 18 volts as the cells run down.

In all cases hitherto named an ordinary battery current has been employed. In a paper read by me before the British Association at Southport, I named a rotating commutator and also one on the plan of a metronome which I had tried for the purpose of diminishing currents of polarisation by regular inversion. I preferred, however, the rapid manipulation of an ordinary commutating key with the fingers of the left hand until the "throw" of a damped galvanometer was all but extinguished.

At the Southport meeting, however, my friend, Dr. Oliver Lodge, suggested the use of alternating currents of induction, and a telephone in place of the galvanometer, and Prof. Lankester, the President of the Section in which my paper was read, kindly suggested that I should apply to the Royal Society for a grant in aid to purchase the expensive apparatus required for these experiments. The latter suggestion I at once acted on, and met with unconditional refusal on a printed form. Being thus thrown on my own small means, I proceeded to act on the former suggestion, and ordered an induction apparatus of an excellent London maker. But the British workman, if sure, is decidedly slow, and the instrument, though stated to be in a condition of forwardness, is not yet ready. In the meanwhile, in the pages of the *Electrical Review* for January 12, a diagram, description, and woodcut of a pretty little instrument designed by Prof. Kohlrausch of Wurzburg for the measurement of fluid resistances appeared; by his kindness I was put in communication with the firm of Hartmann and Co. of that town, the makers. They at once forwarded me the instrument, which proves to be beautifully made, and extremely moderate in price. This acknowledgment I owe to the Professor's courtesy towards a stranger, and their briskness in carrying out his wishes. Upon its details it is needless now to insist, it being practically a small induction-coil united to a metre-bridge of platinum-silver wire, with resistances of 1, 10, 100, and 1000 ohms, to be intercalated in the divided circuit. It emits a steady buzz of about 120 vibrations per second, which is reproduced in the telephone by methods well understood. In my first experiments I found the original and the phantom buzz difficult to separate. The former is easily lessened by mounting the apparatus on vulcanised rubber tubing and a solid support. The R. is read off the scale by inspection: towards the left hand or middle of the wire with great accuracy; towards the right-hand end the ohms get squeezed together. When I drew the plug of the 1000 R. my willing student-patient gave a jump out of his two brine baths and said he could not stand it. It was therefore necessary to use the 100 ohm plug. Even with this, however, the results were very remarkable. In this early period of my experiments two illustrative cases may be given. A female patient suffering from diabetes, but otherwise in good health, and able to walk about the ward, gave from foot to foot with an E.M.F. of 3·6 volts, a resistance of 1210 ohms; from right hand to right foot 1350 ohms; and from left hand to left foot exactly the same figure. With the induction current she gave from foot to foot only 473 ohms; from hand to foot 735 ohms on the right, and 750 ohms on the left, side. The difference was so great that at first I suspected instrumental error, but subsequent testings show that such is not the case. The discrepancy of 15 ohms between the two sides was clearly owing to my unfamiliarity with the telephone in place of galvanometer, and has materially lessened with greater experience.

A male patient suffering from dysentery, now perfectly well, gave from right hand to foot with a current of 3·6 volts a R. of 1580, with 6·2 volts a mean of 1510, with 18 volts a R. of 1366. Each observation was taken wice; the first and last agreeing exactly, the intermediate only differing from 1520 to 1500. This is impossible at times to prevent from the unintentional motions of the patient slightly shifting the level of the brine baths. With the same baths and poles the induction current gave only 590 ohms resistance.

In neither of these cases was there any morbid condition of the muscles tested. The distance was in each case from the external malleolus of the foot to the head of the ulna in the corresponding hand. In recording these results, I prefer, as on the former occasion, to give them at once in their rough state before waiting for a plausible explanation, or endeavouring to procure a fallacious agreement between the two methods. It is clearly not, as a writer in the *Electrical Journal* thought, a case of mere "cable-testing." What I stated then I now reaffirm, that there is some important difference of a physiological character between the human body as a conductor and ordinary fluid electrolytes.

No doubt, as Dr. Lodge suggests, "an alternating current ought to show too low a resistance, because of electro-chemical capacity, which it would treat like conductivity." But the difference is far too great for such an explanation, nor does it occur to this extent in saline solutions. I am at present engaged in testing its amount in physiological fluids, such as blood-serum, ascitic and ovarian effusion, and the like.

A beautiful metre-bridge on Prof. Kohlrausch's pattern, with platinum-silver wire of 3 m. long, has just reached me from Hartmann; with this I am using a "sledge" inductorium of Du Bois Reymond's with three different secondary coils of different lengths and fineness of wire. For the determination of the alternating currents passing I am using the small dynamometer with aluminium wire suspended coil which was shown before the Physical Society, and briefly described in NATURE.

This I shall check by a fine instrument now on its way from Wurzburg, with a single wire suspension and torsion head instead of the more sluggish bifilar method. Ultimately it may be necessary to use a quadrant electrometer.

Even at this stage it is obvious that the fact of the human body being about twice as permeable to induction as it is to low tension continuous currents is of great physiological and therapeutical importance.

W. H. STONE

INTERNATIONAL WEIGHTS AND MEASURES [1]

ALTHOUGH to some it might appear that the work of the Bureau at Sèvres is perhaps proceeding slowly, yet by reference to the two publications which have been issued under the authority of the Comité International it may be seen that the Bureau is doing its work thoroughly. The extent of the questions investigated is well shown in the first publication issued in 1881 (tome i.), which included papers by the director, Dr. Broch, on the force of gravity, the tension of vapour, the boiling point of water, and the weight of a *litre* of air; as well as independent investigations by Dr. Benoit on Fizeau's dilatometer; by Dr. Pernet, on thermometers; and by M. Marek, on weighing apparatus, &c.

The present publication (tome ii. 1883), to which we would now invite attention, contains accounts by Dr. Benoit of his expansion experiments; by M. Marek, on the methods and results of the weighings made at the Bureau from 1879 to 1881; and by Dr. Broch, on the expansion of mercury. In the experiments on the dilatation of standard measures of length, there has been followed a method attributed to General Wrede. It consists in the first instance in adjusting under two micrometer-microscopes a platinum-iridium bar, on which the

[1] "Bureau International des Poids et Mesures." *Travaux et Mémoires*, tome ii., 400 pp. Paris, 1883.

length of the metre has been marked by means of two fine lines. The position of the lines at a constant temperature is then determined by the micrometers, the bar being placed for this purpose in a trough of water, the temperature of which is maintained constant by an improved automatic regulator. A second metal bar, whose rate of expansion is to be determined, is placed in a separate trough of water, the temperature of which differs considerably from that in the other trough. This trough is then also brought into position under the microscopes, and the positions of the lines on the second bar determined relatively to those on the first bar. This method has the advantage that the results are independent of any change in the distance between the axes of the two microscopes during the comparison of the two bars. The optical effect of the immersion of the bars in water was investigated by M. Krusper in 1872–73, who found it to affect the comparisons very little.

The comparing apparatus at the Bureau was originally made by M. Sörensen of Stockholm, but was subsequently altered and improved by the Geneva Society for the construction of physical instruments, under the directions of M. Turettini. The lines on the bars were illuminated by light reflected on to a small mirror fixed at an angle of 45° inside the microscope, a little above the object glass. The determinations of the errors of each micrometer-screw throughout its whole length, for even no micrometer-screw has yet been made in which appreciable errors may not be detected in its use, was made in accordance with methods followed by Drs. Foerster and Hirsch, and MM. Starke and Kammerer.

The thermometers used were constructed after the form adopted by the Bureau (tome i. p. B 8), and were made at Paris by M. M. Baudin and M. M. Alvergnat. It is satisfactory to find that to the important question of thermometers the Bureau has given much attention, as in such investigations errors of thermometers are of as great importance as the errors of the micrometer-microscopes, but are not, however, always so carefully attended to as they should be. The thermometers were calibrated after the methods suggested by Dr. Thiesen and M. J. Marek ("Repertorium der Carl," t. xv. 1879), and were corrected for "exterior pressure" to a barometric height of 760 mm. at 0° lat. = 45°, as well as for "interior pressure," or vertical position, the thermometers reading from 0°·02 to 0°·06 C. too high when placed in a horizontal position.

During the past years this apparatus has been used in determining the rates of expansion of the platinum-iridium metres deposited at the Bureau, which are intended hereafter to be the universal standards or prototypes of the metric system. The linear coefficient of expansion for 1° C. of the platinum-iridium was found to vary from 0·000008668 to 0·000008689, with a probable error of only ± 0·0000000075.

The high accuracy of the results obtained at the Bureau in the weighings there executed, have been already previously referred to, as they appeared in a separate form in 1881. In the present volume M. Marek gives the particulars of the experiments made by him in redetermining the density of mercury of the kind actually used in barometer tubes, taking the mean density of mercury as being comprised between that of perfectly dry mercury and of mercury exposed to moist air. Illustrations are given of the modes of purifying and of weighing the mercury. The density of four samples of mercury, as determined by weighing in water, was found after many experiments to be as follows:—

Mercury A = 13·595631 ± 0·000029
,, B = 13·595633 ± 0·000024
,, C = 13·595458 ± 0·000056
,, D = 13·595930 ± 0·000055

In the paper, "Dilatation du Mercure," we find again that painstaking investigation and high accuracy which characterised the papers published in 1881 above referred to. The most exact observations on the dilatation of mercury are undoubtedly those of M. Regnault (*Mémoires de l'Académie des Sciences*, tome xxi. 1847); and it is to the mathematical reduction of these observations that Dr. Broch has now applied a critical examination, employing as his first coefficient of dilatation the value obtained by M. Wullner ("Lehrbuch der Experimental Physik," t. iii.):—

$$d_t = 10^{-9}\,(181168 + 11{\cdot}554t + 0{\cdot}021187t^2),$$

instead of that of Regnault—

$$d_t = 10^{-9}\,(179007 + 25{\cdot}232t).$$

By a reduction by the precise method of least squares, of the original observations to the latitude of 45° at the level of the sea (B = 760 mm.), there is now obtained for the cubic expansion of mercury the following formula, which we would recommend to the attention of those engaged in accurate work:—

$$1 + kt = 1 + 0{\cdot}000181792\,.\,t + 0{\cdot}000{,}000{,}000175\,.\,t^2 + 0{\cdot}000{,}000{,}000035116\,.\,t^3.$$

We note that for the current year the President of the Bureau is General Ibanez (Madrid), the Secretary being Dr. Hirsch (Neuchâtel), the Committee including MM. Dumas (Paris), Foerster (Berlin), Gould (Cordoba), Govi (Naples), Herr (Vienna), Hilgard (Washington), Krusper (Budapest), Stas (Brussels), Wild (St. Petersburg), and Wrede (Stockholm). This country is not represented on the Committee, our Government having decided not to take part in this international project.

LILÆA[1]

THE genus *Lilæa* was founded by Humboldt and Bompland for a very curious plant closely allied to our native *Triglochin*, which was first found by them in New Grenada. The present memoir, which has apparently only recently reached Europe, is one of the most elaborate studies probably ever made of the entire morphology, histology, and development of a single flowering plant, and is due to the unexpected discovery of the plant in 1875 in the Argentine Republic. The curious reductions of structure which are the result of a more or less aquatic mode of life have always made plants of this kind attractive to investigators.

The careful investigation of the structure of the flower throws some light on a point which has been much controverted, whether the stamen is ever an axial structure or not. *Lilæa* bears its flowers in a spike, and there are no less than three kinds:—(1) below, female; (2) in the middle, hermaphrodite; (3) at the top, male flowers. These latter consist of a single stamen in apparent direct prolongation of the floral axis. It is about these in the similar cases of *Naias* that discussion has arisen. Now Hieronymus contends that this stamen is really only pseudo-terminal, but that it consumes in its development the primitive meristem of the growing point, and so eventually occupies its place. He extends the same explanation to the cases of *Naias, Zannichellia, Casuarina, Brizula,* and others which have been held to support the axial origin of stamens. But as Sachs remarks ("Textbook," second edition, p. 541), the question cannot be settled wholly on anatomical grounds. And in *Lilæa* there can be no doubt that in the hermaphrodite flowers the stamens are lateral. In the male flowers he sometimes finds a lateral rudiment of a pistil; and this must be held to clinch the argument that the stamen is not really cauline, but always lateral and only pseudoterminal.

Lilæa has a fourth class of flowers, the adaptive origin of which is interesting. The whole plant is at first partially submerged—perhaps was once wholly so. The

[1] "Monografia de Lilæa subulata." Por J. Hieronymus. *Actas de la Academia nacional de Ciencias en Córdoba.* (Buenos Aires, 1882.)

lowest flowers of the inflorescence are female, and seated in the axils of the sheathing leaves; but the style is enormously elongated so as to carry the stigma to the surface of the water for fertilisation. This recalls the habit of *Vallisneria*. But, as Mr. Bentham reminds us, the resemblances of *Hydrocharideæ* and of *Naiadaceæ* are essentially adaptive, and must not blind us to the real profoundly divergent affinity.

It is worth noting, as a hint to those interested in researches of this fascinating kind, that the investigations of Dr. Hieronymus were made partly on material preserved in a mixture of two-thirds alcohol and one-third glycerine, partly in an aqueous solution of salicylic acid (no further details are given). W. T. T. D.

PROFESSOR FLOWER

PROFESSOR FLOWER'S resignation of the office of Conservator of the Museum of the Royal College of Surgeons was received at the last meeting of the Council of that body, held on March 13, whereupon it was moved by Sir James Paget, seconded by Mr. Erichsen, and resolved unanimously:—"That the Council hereby desire to express to Mr. William Henry Flower their deep regret at his resignation of the office of Conservator of the Museum of the College.

"That they thank him for the admirable care, judgment, and zeal with which for twenty-two years he has fulfilled the various and responsible duties of that office.

"That they are glad to acknowledge that the great increase of the Museum during those years has been very largely due to his exertions and to the influence which he has exercised, not only on all who have worked with him, but amongst all who have been desirous to promote the progress of anatomical science.

"That they know that, whilst he has increased the value and utility of the Museum by enlarging it, by preserving it in perfect order, and by facilitating the study of its contents, he has also maintained the scientific repute of the College by the numerous works which have gained for him a distinguished position amongst the naturalists and biologists of the present time.

"And that, in thus placing on record their high appreciation of the services of Mr. Flower, the Council feel sure that they are expressing the opinion of all the Fellows and Members of the College, and that they will all unite with them in wishing him complete success and happiness in the important office to which he has been elected."

The conditions under which the Conservatorship of the Museum of the College will be held in future are at present under discussion, and will probably be decided at the next meeting of the Council on the 10th inst., when the office will be declared vacant, and candidates invited to send in their applications.

THE DEEP-SEA DREDGINGS OF THE "TALISMAN"—CRUSTACEA

IN a previous article attention was called to some of the more remarkable of the deep-sea fishes taken during the recent cruise of the French frigate the *Talisman*: not less interesting were the numerous forms of Crustacea dredged during the same cruise, a fine collection of which were also on view at the Jardin des Plantes, Paris, as part of the spoils brought home after the voyage. From a survey of the specimens it is evident that these Crustacea are to be found at all depths of the ocean: some pass their lives floating on its surface, feeding thereon or amid the acres of Sargassum weed; while others live at depths of from 4000 to 5000 metres. The so-called swimming crabs which form a section of the Brachyura would seem to be extremely rare at great depths. Certain species taken during the *Talisman's* cruise are remarkable for their very extensive geographical distribution; thus, species of Batynectes which were found at depths of from 450 to 950 metres off the coasts of Morocco and about the Cape Verd Islands, seemed very closely related to the swimming crabs (Portunus) of our own seas, and again to be very nearly connected to species of the same genus collected at the Antilles, in the Mediterranean, and in the Arctic Ocean. Another section of the Brachyura, with sharp triangular bodies (Oxyrhyncha), contains species which are to be met with at much greater depths; thus *Lispognatus thompsoni* (A. M. Edw.) was dredged off the coasts of Morocco from depths of between 600 and 1500 metres, and *Scyramathia carpenteri* was taken at the same place from a depth of 1200 metres. The former of these species has been found in the North Sea, and the latter has been taken off the north of Scotland and in the Mediterranean. The Crustacea intermediate by their forms between the Brachyura and the Macrura were found in abundance at very great depths, and the forms found seemed in great measure to belong to "transition" forms; so one was often surprised to find a form, which taken by itself appeared abundantly distinct, quite connected with others by numerous intermediary forms. Thus species of Ethusa, Dorippe, Homola, and Dromia seem to present such numerous shades of gradation as to perplex one completely in the difficult task of classifying these genera. Some of these forms are also very remarkable for their geographical distribution: a species of Dicranomia, described by Milne-Edwards from the Antilles, was found off Morocco, and *Homola cuvierii*, up to this thought to be peculiar to the Mediterranean, was found at the Azores and the Canaries. But the most remarkable instance of the geographical extension of which some genera are capable is furnished by some species of the family Lithodina. These Crustacea to this have been known as inhabitants of the Arctic and Antarctic regions, living in the littoral zone, but now they have been found under the tropics; the only difference being that in this latter locality they have contrived to find congenial conditions of life by abandoning their shallow-water life and betaking themselves to the cool depths of over 1000 metres. A fact like this is not without its interest, inasmuch as it shows how some forms can spread themselves from the frozen seas of the north to the seas of the tropics, and so from the region of one Pole to the other; altering their conditions of life as necessity demanded, and resuming their old habits when the opportunity to do so again occurred.

The Crustacea known as Hermit Crabs were found to extend to a depth of 5000 metres; as is well known, the terminal portions of the bodies of these Hermits are soft, not covered like the head and claws of the crab with a strong calcareous shell, and these animals have the habit of tucking the soft part of their bodies for security into the body-whorl of some empty shell; but at the great depths referred to shells suitable for this purpose are not to be found, and the hermit crabs inhabiting these depths must often be in great difficulties for material wherewith to cover themselves. In one specimen taken off Morocco this covering consisted of a living colony of a very pretty species of Epizoanthus.

Species of the family Galatheidea were found in profusion at all depths; but the colour of their body, generally that of a red or pink hue, was in the forms from the great depths of a uniform white. Some species were found which occupied the interior of those lovely siliceous sponges belonging to the genus Aphrocallistes. One new species, *Galathodes antonii*, was found at a depth of 4000 metres, and another, from the same depth, with its abdomen coiled twice upon itself, has been also described by A. M. Edwards as new (*Ptychogaster formosus*).

Of the group of Eryonidæ a considerable number of both genera and species were dredged. Of these, those belonging to the genera Polycheles, Wilmoesia, were from depths of from 4000 to 5000 metres, and the wonderful transparency of the forms permitted the whole internal viscera to be distinctly seen. Some species of Pentacheles were evidently allied to the fossil forms of Eryon.

Of the Crustacea belonging to the group of Macrura, the one to which the crayfish and shrimps belong, many were taken at very great depths. Off the Cape Verd Islands, from a depth of 500 metres, a thousand individuals of a new species of Pandalus were taken. Among the most remarkable of all of these forms is the one which, through the courtesy of the editor of *La Nature*, from which journal this notice is in part translated, we are enabled to give the accompanying illustration. Named *Nematocarcinus gracilipes* by Alphonse

Nematocarcinus gracilipes (A. M. Edw.).

Milne-Edwards, it was, when taken fresh from a depth of 850 metres, of a splendid rose colour. The extreme length of its antennæ will at once attract attention, and no less remarkable are the wonderfully attenuated feet, of which the third, fourth, and fifth pairs are longer than the first and second. The eyes are large, but the eye-stalks are not elongated. In another member of this group, *Glyphus marsupialis*, the female had the lateral portions of the abdominal segments developed so as to form a pouch-like receptacle, in which the eggs were deposited.

When trying to draw conclusions from the phenomena presented by the numerous forms of Crustacea collected during the *Talisman* cruise, one is struck by the strange diversity in these phenomena. While some of the species are blind, others have well-developed organs of vision; while in some the eye-stalks are flexible, in others they are immovable; while in some there is a very marked transparency of the integuments and a decided softness of the muscular tissues, in others neither of these facts is at all apparent. Some of the deep-sea Crustacea are beautifully phosphorescent, and in certain species this phosphorescence is not diffused but is limited to some special areas of their bodies, and in a new species, *Acanthephyra pellucida* (A. M. Edw.), the feet are adorned with phosphorescent bands. We of necessity know so little of the habits of these new, strange forms, that it would be premature to draw scientific conclusions from their structure.

THE SOCIETY FOR THE BIOLOGICAL INVESTIGATION OF THE BRITISH COASTS

THE meeting which we previously announced as about to be held for the purpose of inaugurating a new society having the above title, took place last Monday in the rooms of the Royal Society, Prof. Huxley being in the chair. The meeting was large and influential. Among those present were the Duke of Argyll, the Earl of Dalhousie, Lord Arthur Russell, Sir Lyon Playfair, M.P., Dr. W. B. Carpenter, Sir Joseph Hooker, the Hon. Edward Marjoribanks, M.P., Sir John Lubbock, M.P., President of the Linnean Society, Mr. J. Blake, M.P., Sir George Nares, Dr. John Rae, Sir Joseph Fayrer, Capt. Verney, R.N., Prof. Flower, Prof. Ewart, Dr. John Evans, Prof. Bonney, Dr. Spencer Cobbold, Mr. John Murray (of the *Challenger* Office), Dr. J. Gwyn Jeffreys, Dr. Günther, Prof. Moseley, Mr. G. J. Romanes, Mr. H. C. Sorby, Mr. Francis Galton, Mr. Brady, Prof. Crofton, Mr. Dawson Williams, Prof. St. George Mivart, Mr. Busk, Dr. Sclater, Dr. Dodson (Netley), Mr. Thiselton Dyer, Mr. H. C. Burdett, Prof. Donkin, Dr. John Murie, librarian of the Linnean Society, Mr. W. H. Dallinger, Dr. A. Geikie, Mr. E. Forbes Lankester, Mr. Saville Kent, Mr. M'Lachlan, Dr. Herbert Carpenter (of Eton), Prof. Jeffrey Bell, Mr. Frank Crisp, and Prof. Ray Lankester. Letters regretting inability to attend were read from Lord Derby, the Marquis of Hamilton, Sir Thomas Dakin, Mr. Chamberlain, Mr. Burdett-Coutts, Mr. R. W. Duff, M.P., and Dr. Dohrn.

Prof. Huxley, in opening the proceedings, began by observing that the object with which the meeting had to deal was not in his hands, but in those of Prof. Lankester, who had requested that the Royal Society should foster an undertaking which promised well for the progress of science. The establishment of marine biological stations had been undertaken during the last few years by most of the civilised countries, and was, indeed, a necessary result of the great change which had taken place in the aims of biological science. The study of development began about half a century ago, and the ramifications of that inquiry, which had been extended to the mode of becoming of all live things by Mr. Darwin, had caused a complete change in the methods of biological research. In order to investigate the living being it was now no longer deemed sufficient, as in the days of our great-grandfathers, to observe its outside, or even, in the days of our grandfathers, to examine its anatomy. We have now to trace its developmental growth from the egg, and we are able to do so with a thoroughness of which no one in his young days could have had any conception. Such was one good reason for founding an institution of this kind from a purely scientific point of view. But there was another reason from another point of view which was practical. We had great fisheries and great fishery interests, and up to within the last thirty years legislation with reference to them was almost entirely haphazard, owing to our ignorance of the habits, modes of life, reproduction, and so on, of marine animals which were economically useful. If we are to have any considerable improvement in our legislation in this respect, our arguments and reasonings with a view to it must rest upon sound and exact observation. In conclusion, he wished to say with special emphasis that there was no possibility of any rivalry between the society which it was now proposed to found and another society the formation of which was announced a few days ago by H.R.H. the Prince of Wales. That society was, in the ordinary sense of the word, practical. He trusted that when both societies were established, so far from there being any conflict between their aims, they would work in concurrence to a common end.

The Duke of Argyll said the resolution which had been placed in his hands was—"That in the opinion of this meeting there is an urgent want of one or more laboratories on the British coast, similar to those existing in France, Austria, Italy, and America, where accurate researches may be carried on, leading to the improvement of zoological and botanical science, and to an increase in our knowledge as regards the food, life, conditions, and habits of British food fishes and mollusks in particular, and the animal and vegetable resources of the sea in general." The fact of their being called together to form a voluntary society to carry out these objects implied a discovery on the part of those who had taken a leading part in this matter that the work was not likely to be taken up by the Government. He was afraid that in this respect the British Government had always stood rather behind those of other countries, whether monarchical or republican. There were other agencies by which facts about food fishes would be obtained, and he instanced the researches of the President of the Royal Society, and a valuable paper recently contributed by Prof. Ewart upon one of the most important questions connected with food fishes—the spawning of the herring. When further researches of this kind should be forthcoming, it can scarcely admit of doubt that, by making us acquainted with the life-history and habits of the herring, they will serve to improve the herring fisheries. He had himself good reason to appreciate the importance of acquiring information of this kind, for in the vicinity of his own residence the fishing community was suffering distress on account of the herring having abandoned Loch Fyne without any one being able, in the present state of our knowledge, to assign the cause. Moreover, the opposition which was raised to ground-trawling in Loch Fyne, on the supposition that the practice is destructive of herring spawn, has been shown by such researches to be without any justification—the spawn having been found to adhere closely to the sea-bottom. But great as would be the probable economic nature of a marine biological station in the improvement of our fisheries, he thought that the chief object in promoting this society should be that of promoting the interests of biological science. Enlarging upon the importance of this science, he concluded by observing that the branches of it which would fall to the lot of this society to cultivate would have the advantage of avoiding contact with the question of vivisection; for he supposed that even the most susceptible of anti-vivisectionists would scarcely have their feelings touched by physiological experiments on jelly-fish.

Sir Lyon Playfair, M.P., in seconding the resolution, dwelt upon the anomaly that a country which depends so much upon its fisheries as Great Britain should hitherto have been the only Great Power which had not founded a zoological station. He then proceeded to enumerate some of the economic advantages which had been secured by such institutions elsewhere, especially in America.

Lord Dalhousie and Prof. Flower also supported the motion.

Dr. W. B. Carpenter moved:—"That it is desirable to found a society, having for its object the establishment and maintenance of at least one such laboratory at a suitable point on the coast, the resources of the laboratory its boats, fishermen, working-rooms, &c., being open to the use of all naturalists under regulations hereafter to be determined."

Sir John Lubbock, as President of the Linnean Society and a trustee of the British Museum, in seconding this motion said he thought they owed their thanks to Prof. Lankester for the efforts he had made to found the proposed society.

Dr. Günther supported the resolution, which was passed.

Sir Joseph Hooker moved:—That this meeting does hereby agree to constitute itself such a society under the title of "The Society for the Biological Investigation of the Coasts of the United Kingdom." He dilated upon the importance of such a society to the interests of botanical science. The motion was seconded by Prof. Moseley, who appropriately called attention to the fact that most, if not all, life upon this planet was littoral in origin, and afterwards spread on the one hand to the deep sea and on the other to the land.

On the motion of Sir William Bowman, F.R.S., it was resolved that gentlemen whose names follow be requested to act as a provisional council and report to an adjourned meeting to be held on Friday, May 30, as to the constitution and organisation of the society and other matters, and in the meantime have power to admit suitable persons to the membership of the society; further, that Prof. Lankester be asked to act as secretary and Mr. Frank Crisp as treasurer *ad interim*. Those named were the Duke of Argyll, the Earl of Dalhousie, Lord Arthur Russell, the Lord Mayor, the Prime Warden of the Fishmongers' Company, the President of the Royal Society, the Presidents of the Linnean, Zoological, and Royal Microscopical Societies; Dr. W. B. Carpenter, F.R.S.; Mr. W. S. Caine, M.P., Mr. Frank Crisp, Mr. Thomas Christy, Mr. Thiselton Dyer, F.R.S., Prof. Flower, Mr. John Evans (treasurer of the Royal Society), Dr. Albert Günther, F.R.S., Sir Joseph Hooker, Prof. Michael Foster (secretary of the Royal Society), Prof. Ray Lankester, F.R.S., Prof. M. Marshall, Prof. Moseley, F.R.S., Mr. John Murray, F.R.S.E., the Rev Dr. Norman, Mr. George J. Romanes, F.R.S., Prof. Burdon Sanderson, F.R.S., Dr. Sclater, Mr. Adam Sedgwick, Mr. Percy Sladen, Mr. H. C. Sorby, F.R.S., and Mr. Charles Stewart, F.L.S.

Mr. G. J. Romanes, in seconding the motion, took occasion to observe that in his opinion one of the most important functions of the society when formed would be that of conducting researches upon invertebrate physiology. He was sure he would be but carrying with him the assent of all physiologists when he said that it is to the invertebrate forms of life that we must now look for the elucidation of many of the most fundamental problems connected with life-processes. It is in the Invertebrata that we meet with life in its least compounded state, and therefore in the state best suited to observation and experiment directed towards the solution of these fundamental problems. The sea is the great magazine of invertebrate life, and if the rich stores of material therein presented have been hitherto almost entirely neglected by physiologists, the explanation may be found in the fact that physiological research can only be conducted in well-equipped laboratories, which have been of but comparatively recent institution upon the sea-coasts of Europe and America.

Prof. Ray Lankester then moved a vote of thanks to the President of the Royal Society for taking the chair, and said it had been estimated that from 6000*l*. to 10,000*l*. would be required to start the project. He invited immediate subscriptions, payable *ad interim* to the treasurer, Mr. Frank Crisp, 6, Old Jewry, E.C. Sir Joseph Fayrer seconded the motion, and the President having briefly replied, the proceedings terminated.

NOTES

In the death of the youngest and one of the most accomplished of the Queen's sons the cause of education has sustained a loss. The Duke of Albany knew well what science meant, and on several occasions publicly expressed his sense of its value in respect of the nation's welfare, and the necessity for its introduction into our systems of education. There can be no doubt that had he lived he would have rendered service to the best interests of the country. It is so rarely that princes have the tastes and leanings of the late Royal Duke that we could ill afford to lose him.

The organising committee of Section F (Economic Science and Statistics) have arranged the following programme of subjects for discussion at the Montreal meeting of the British Association. The subjects will be distributed over the four or five days which will probably be at the disposal of the Section. Group I. Population: (1) Emigration; (2) Census results; (3) Distribution of wealth and condition of the poor. Group II. Land: (4) Agriculture; (5) Land laws; (6) Forestry. Group III. Trade: (7) Manufactures, shipping, and foreign markets; (8) Internal communication by land and water. Group IV. Finance: (9) Monetary system; (10) Public debts (Governmental and Municipal). Writers have been engaged for most of the subjects in the above programme.

We regret to announce the death, at the age of sixty-seven years, of Mr. Nicolas Trübner, the well-known publisher, who has done so much to place within the reach of the English public some of the best works in German philosophy, science, and learning. He will be missed by a wide circle of friends, among whom are many men of science, English and foreign.

The Prince of Wales has formally urged upon the Corporation and the Livery Companies to lend still further aid to the City and Guilds of London Technical Institute, which is greatly in need of funds; and the Corporation proposes to vote a further sum of 1000*l*. provided the Livery Companies subscribe the rest of the 20,000*l*. needed by the Institute.

As usual there was some pleasant talk at the Civil Engineers' dinner last week; Prof. Huxley in replying to the toast of "Science," said there was one educational aspect which was extremely instructive and important, and that was the insensible and almost unconscious education in science which was carried on upon the masses of the people by the great work of engineers and mechanicians. The work of the engineer and all who were applying the teachings of science was surrounding the population with the symbols of scientific faith.

Mr. W. Saville Kent, F.L.S., F.Z.S., has been appointed Inspector of Fisheries to the Government of Tasmania, and proceeds shortly to the scene of his new duties. The more extensive introduction and distribution of the Salmonidæ already acclimatised in Tasmanian waters, and the resuscitation by artificial culture of the once prolific but now greatly depleted oyster fisheries, are among the special subjects that will engage the attention of the newly appointed Inspector. A systematic investigation of the marine fauna, with the view of turning to profitable account those edible, indigenous forms which are as yet but little utilised for economic purposes, will likewise be initiated. It is to be hoped that the Colonial Government will recognise the fitness of the opportunity that now presents itself of establishing in this quarter of the antipodes a well-equipped if small marine observatory for the artificial cultivation and scientific observation of the habits and developmental phenomena of the many interesting types peculiar to this region, and of which, as yet, biologists possess little or no knowledge. Mr.

Saville Kent's reputation as a marine zoologist, and the experience he has already gained as naturalist to various of the large public aquaria of this country, peculiarly qualifies him for the conduct of original investigation in this new field, which could not fail to yield important results for both the interests of science and the fishing industries of Tasmania.

The Institution of Naval Architects is meeting this week. The session was opened yesterday under the presidency of the Earl of Ravensworth. The papers down for yesterday were:—On the Riachuelo, by J. D'A. Samuda; description of the electrical launch built last year, by A. F. Yarrow; on the vibration of steam vessels, by Otto Schlick. To-day the following papers will be read:—On cross curves of stability, their uses, and a method of constructing them, obviating the necessity for the usual correction of the differences of the wedges of immersion and emersion, by William Denny, F.R.S.E.; the use of stability calculations in regulating the loading of steamers, by F. Eigar, Professor of Naval Architecture, University of Glasgow; on a new method for calculating, and some new curves for measuring the stability of ships at all angles of inclination, by M. Daymard; on some points of interest in connection with the construction of metacentric diagrams, and the initial stability of vessels, by P. Jenkins; on the combustion of fuel in furnaces of steam boilers by natural draught and by air supplied under pressure, by J. Howden; on the application of hydraulic machinery to the loading, discharging, steering, and working of steamships, by A. B. Brown; cast steel as a material for crank shafts, &c., by J. F. Hall; repairs to steamship machinery, by Andrew K. Hamilton. To-morrow the following are set down for reading:—Contributions to the solution of the problem of stability, by L. Benjamin; on the uses of Amsler's integrator in naval architecture, by Dr. A. Amsler; on the comparative safety of well-decked vessels, by Thomas Phillips; the graphic calculation of the data depending on the form of ships required for determining their stability, by J. C. Spence; description of Alexander Taylor's stability indicator, for showing the initial stability and stowage of ships at any displacement, by A. Taylor; some considerations relating to the riveting of iron ships, by H. H. West; on the ventilation of merchant steamers, by J. Webb; on water brakes, by Capt. F. J. Heathorn, R.A.; on improvements in apparatus and means for indicating the position of a ship's helm, by J. E. Liardet.

The Geographical Society of Bremen publishes in vol. vii. part 1 of its *Deutsche Geographische Blätter* an interesting paper, by Dr. A. H. Post, on the development of family life among mankind from an original "matriarchal" condition. He brings forward some new evidence collected by Dr. C. A. Wilken in the Dutch East Indies, showing the existence of Malay families consisting of mothers and their children, to which the fathers do not belong as members at all, being in fact only visitors. Dr. Post, tracing the stages of progressive change under the influence of landholding and the union of individuals in states, which in the course of ages converted matriarchal into patriarchal society, expounds with much clearness the theory which has arisen in the last few years out of the works of Bachofen and McLennan. Some of this clearness arises no doubt from ignoring difficulties, but a sketch of this kind does not involve the responsibilities of a full-grown treatise.

The International Health Exhibition will be opened by the President, the Prince of Wales, on Thursday, May 8, at 3 p.m.

The death is announced of Dr. George Engelmann, the well-known botanist, who died at St. Louis on March 3, aged seventy-five. Also of Dr. Siegfried Aronhold, formerly Professor of Natural History at the Berlin Technische Hochschule, who died at Berlin on March 13.

News from the Austrian traveller, Eduard Glaser, who had fallen dangerously ill, states that he has recovered, and left for Haschid on February 6, a part of Arabia hitherto unexplored by Europeans.

M. Gabriel de Mortillet, Conservateur of the Museum of National Antiquities at St. Germain, has begun to issue a new monthly journal, *L'Homme*, entirely devoted to anthropology.

M. Fremy, Director of the Museum of Paris, has published a pamphlet defending the establishment against the Central Administration, which is desirous of appointing a director. Up to the present time the director has been nominated by his fellow professors. This liberal mode of nomination was established by the National Convention in 1793. It is probable that an effort will be made in the present session to extend this privilege to other establishments, as the Observatory and the Conservatoire des Arts et Métiers.

M. Fremy is desirous of establishing on the coast a marine laboratory in connection with the Museum of Paris. It is thought the money may be granted for establishing one in Algeria.

The motion proposed by Admiral Mouchez to sell the Paris Observatory ground, has been defeated before the Academy of Sciences by a large majority. Only two members, MM. d'Abbadie and Faye, voted with the Admiral.

A correspondent referred last week to the changes which have been introduced into the examinations for admission into the Royal Military College, and the subject was brought up in the House of Lords last Thursday by Lord Salisbury. "The change with respect to natural science," he said, "was much to be regretted, because there was no body of men to whom a knowledge of science could be more useful, and conduce more to their happiness, especially when it was considered that they had to pass their time in various parts of the world, often with no adequate employment for their spare hours." The Earl of Morley in reply said that "by the new scheme greater importance was given to modern languages and mathematics, less importance to science, and the English paper had been excluded from Class I. The object of these changes was to improve the examinations, and to encourage the subjects which must be taught. In drawing up this scheme the War Office had been in constant communication with the Civil Service Commissioners, and with many gentlemen interested in education. The main purpose of these examinations was to test the results of general education, and for that purpose the subjects themselves had, as far as possible, to be of a general nature. That constituted one of the evils of the present system. He did not think it was necessary, or even desirable, in framing a scheme of this kind to confine themselves to the curriculum of the public schools. It was, no doubt, a matter of regret that during the last five years the number of successful candidates who came direct from the public institutions to the Royal Military College had diminished rather than increased. He did not wish to speak harshly of the race of private tutors. Some of them were extremely able and ingenious, but as a rule their whole object was mark-making. These tutors did not require their pupils to read the books on which they were examined, but by an ingenious process of analysing their contents all the questions that could be put to them could almost be exhausted. But cram did not last, and it was no substitute for education." The Duke of Cambridge said that "the great object of the examination was to put forward such a syllabus that all young persons educated at the public schools of the country should be able to enter Woolwich or Sandhurst direct without going through the hands of the crammer. What was wanted to bring about this result was a general education which they could say every young gentleman ought to have to fit him for any sphere in life which he might intend to adopt. It would be time enough to teach military subjects when the candidates for the army got into the military schools. Up to that time their education should be general, and not special. The proposed change was entirely with the view of inducing the public schools, such as Wellington, Marlborough, and others, besides Eton and Harrow, to co-operate with the authorities in the endeavour to get rid of cramming." The Marquis of Salisbury believed that "nothing would ever get rid of cramming so long as there was a system of competitive examination. Cramming belonged to competitive examination. He ventured to say that the Government were pursuing their object in rather a dangerous way. If there was a difference between the great public authorities and the public schools, the former should lead. With respect to the question of English literature, he did not understand why boys should not be expected to get a general knowledge of it in the same way that they were expected to have a general knowledge of Latin literature. In France and Germany the language, literature, and history of the country were systematically studied, but we seemed to treat them as matters of no importance, or as things which might be learnt in the nursery, or accidentally in conversation after leaving school."

THE Ninth Annual Meeting of the members of the Sunday Society was held at 9, Conduit Street, W., on Monday last, Prof. W. H. Corfield, M.D., in the chair. The annual report, which was read by Mr. Mark H. Judge, Honorary Secretary, set forth the work of the Society during the past year. It referred at considerable length to the action taken in the House of Lords, and pointed out that the policy embodied in the resolution proposed this year by Lord Thurlow at the request of the National Sunday League differed from that advocated by Lord Dunraven and other representatives of the Sunday Society in both Houses of Parliament. Statistics of the Society's Sunday Art Exhibitions were given. The movement in the provinces had been successful at Newcastle-on-Tyne, the Public Library there having been opened on Sundays by the Town Council. His Grace the Duke of Westminster was elected President of the Society.

Two shocks of earthquake were felt at San Francisco in the afternoon of March 25. The series of earthquakes which began on the 25th ult. continues in the south of Hungary. In Vukovar some slight shocks were again felt on March 27 at 11 p.m. On the night of the 29th about sunset a pretty severe shock of earthquake was felt at Sinope and other places in the neighbourhood. In the town of Costamboul some old buildings fell, but no lives were lost.

THE Easter Monday and Tuesday excursion of the Geologists' Association this year will be to Lincoln; on Saturday, April 26, there will be an excursion to Guildford.

THE number of high-level meteorological stations has been recently increased by the opening of a station at Poni, on the Suram Pass of the Great Caucasus.

MR. CHARLES SMITH, Fellow and Tutor of Sidney-Sussex College, Cambridge, to whose valuable treatise on "Conic Sections" we have already drawn attention, has prepared a new elementary mathematical work which will bear the title, "An Elementary Treatise on Solid Geometry." It will be published almost immediately by Messrs. Macmillan and Co.

THE additions to the Zoological Society's Gardens during the past week include two Malbrouck Monkeys (*Cercopithecus cynosurus* ♀ ♀) from West Africa, presented by Messrs. G. Somerford and G. A. Zobel; an Axis Deer (*Cervus axis* ♀) from India, presented by Mr. L. B. Lewis; a Bosman's Potto (*Perodicticus potto*) from West Africa, presented by Capt. Grant Elliott; a Common Squirrel (*Sciurus vulgaris*), British, presented by Mr. P. Aug Holst; three Herring Gulls (*Larus argentatus*), European, presented by Mr. S. Aloof; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, presented by General Rundall, R.E.; a Grecian Ibex (*Capra ægagrus*), South-East European, presented by Mr. Thomas B. Sandwith; a Smooth Snake (*Coronella lævis*), British, presented by Mr. W. H. B. Pain; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, a Rose-coloured Pastor (*Pastor roseus*) from India, deposited; a Leopard Tortoise (*Testudo pardalis*) from South Africa, an Egyptian Cobra (*Naia haje*) from Africa, purchased; a White-fronted Lemur (*Lemur albifrons*), a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE DOUBLE-STAR α HERCULIS.—Smyth, in his "Cycle of Celestial Objects," attributes to Sir William Herschel the discovery of the duplicity of this star; but the companion was detected two years earlier than Sir William's first observation, and under somewhat curious circumstances. It was perceived by Maskelyne while observing the meridian passage on August 7, 1777, and only seven days later Christian Mayer, also observing the transit of the star with his mural quadrant, noted it to be double. The particulars are detailed in Mayer's work, "De Novis in Cœlo Sidereo Phenomenis," published at Mannheim in 1779. He had communicated to Maskelyne a number of his results bearing upon the double-stars; and the Greenwich astronomer, in replying towards the end of 1777, relates that he had observed a similar phenomenon in α Herculis on the date given above, "et videns valde obstupui," he remarks, since he had so often observed the star on the meridian without perceiving the companion. Maskelyne considered it of the sixth magnitude, the principal star being estimated a third; the latter he judged to be reddish, and the companion pale; Mayer, who discovered the smaller star on August 14, called it a seventh or eighth magnitude.

Adopting Sir George Airy's intervals for the transit-wires in Maskelyne's instrument, we find from a number of transits of the two components—

For about 1778·2 ... $\Delta\alpha$ ... + 0·324s., $\Delta\delta$ ... – 2″·80.

And hence the angle of position 120°·8, and the distance 5″·47.

Mayer's observations extend from August 14, 1777, to August 26, 1779. His differences of right ascension vary from 0·75s. to 0·2s., and those of declination from 6″ to 1″·8, while his estimates of the magnitude of the smaller star vary from 6 m. to 8·9.

Sir William Herschel's first measures were made on August 29, 1779. Taking means of those made between this date and 1783·252, we find—

Position, 1782·36 ... 116°·9 Distance, 1780·33 ... 4″·88.

VARIABLE STARS.—Mr. Burnham, in a note to No. 545 of his recently published Catalogue of 748 double-stars, remarks: "The principal star is strangely wanting in many of the star catalogues." It was observed by Lamont in zone 364, and estimated 5 m.; it does not occur in Lalande, D'Agelet, or Bessel. On Bremicker's Berlin map it is marked 7 m., and it is 6 m. in Harding's Atlas. In the *Uranometria Argentina* it is called 6·3; Gould has no note upon it. We have also the following estimates:—

1879·345	Burnham	6·5
— ·549	Stone (Cincinnati)	7·5
— ·575	Burnham	6 5
1880·442	Stone	6·0
— ·520	Burnham	5·5
1881·383	,, ...	6·5
— ·578	,, ...	6·8

The star may perhaps vary from about the fifth to the seventh magnitude, but systematic observation is wanted to decide. Its position, brought up from Lamont to 1885·0 is in R.A. 17h. 8m. 46·9s., N.P.D. 104° 27′ 4″.

D'Agelet 5057 (a star to which attention has been already called in this column) deserves frequent examination. It was observed by D'Agelet on July 26, 27, and 29, 1783, being twice noted 6 m. and once 6·5. It was not observed either by Lalande or Bessel, but in the *Durchmusterung* we find it estimated only

9·4. Its place for 1885·0 is in R.A. 19h. 27m. 35·5s., N.P.D. 72° 29′ 54″.

Nos. 2577–78 of the *Astronomische Nachrichten* contain the late Prof. Julius Schmidt's results of observations of variable stars made at Athens in 1883, which were communicated about a fortnight before his sudden decease.

ON THE AURORA BOREALIS IN ICELAND

As considerable doubt has hitherto prevailed as to the form and nature of the aurora borealis in Iceland, I have decided to pass the winter here in Reykjavik, in order to study the phenomenon on principles which I followed during my sojourn at Kautokeino last winter, 1882–83 (NATURE, vols. xxvii. p. 394, and xxviii. p. 397).

I arrived here about the middle of October last, and began my regular observations on November 6; and although the series of observations as yet is brief, and, through very unfavourable weather, not so complete as might be desired, I believe that a few preliminary remarks on this phenomenon may not prove without interest, particularly as the appearance of the aurora borealis here is somewhat different to what we might expect and what is generally assumed.

Weather more unfavourable than I have encountered since my arrival it is impossible to imagine. A sky nearly always cloudy, rain, snow, and storm following upon storm—such have its chief characteristics been. A clear sky is quite an exception, and when it occurs there is a wind blowing so keen and cutting that no human being can walk out of doors for any length of time. Iceland is, no doubt, not favoured with very congenial weather, but such a winter as the present must, according to the dwellers here, be considered as quite an exceptional one.

I have shown in Table I. the average cloud calculations of each evening hour (the observations begin generally at 5 p.m., and continue until two or three hours after midnight) from November 6 to January 28. Here 5 indicates the hour from 5h. to 5h. 59m., &c. The scale is the usual one, viz. from 0 (clear) to 10 (cloudy).

TABLE I.

Hour	5	6	7	8	9	10	11	12	13	14	15	Average
Clouds	8·06	7·72	7·51	7·83	7·90	8·10	8·24	8·03	7·32	8·29	8·66	7·91

If an average of the nebulosity on each evening be taken, each value of the scale will fall on the number of days shown in Table II. The former are also calculated in per cents. of the total days (83).

TABLE II.

Clouds	0	1	2	3	4	5	6	7	8	9	10
Days	2	8	2	1	4	1	1	9	9	15	31
Per cent.	2·4	9·6	2·4	1·2	4·8	1·2	1·2	10·8	10·8	18·1	37·3
	14·5			7·2			22·9			55·4	

These figures speak so plainly for themselves that any comment is needless.

Through Iceland being situated in the zone of the terrestrial magnetism, it might be assumed that the aurora borealis attained a high degree of development and splendour here; but this has not been the case this winter, in Reykjavik at all events, even allowing for the unfavourable weather. The auroræ here are generally faint and wanting in force; it is only seldom that there is any energy in the movements, and but rarely that the forms are sharply defined, while the outlines are dim and vague.

There have therefore only been a few occasions on which I have been able to effect somewhat satisfactory measurements with the auroral theodolite of azimuth and the height. The aurora doubtless often reaches far up on the sky, and even travels far down on the southern horizon, but the force of light is very small. In spite of the circumstance that Reykjavik lies—judging by the appearance of the aurora borealis on the horizon—much nearer to the auroral maximum zone than Kautokeino, the appearance of the auroræ in the two places cannot be compared. There was activity, force, and colour; here is vagueness, uncertainty, and want of character. Only once—on January 25—I observed an aurora during one hour which was a true Arctic one, with defined, elegant outlines, intense play of colour, and bold movements.

The more extensive auroræ which I saw in Kautokeino generally finished by the bands or streamers changing into luminous clouds, which again shortly afterwards assumed the wave-like motion I have called "coruscation," and which often lasted for hours, flooding the entire heavens. This form of the aurora borealis *I have not observed on a single occasion here*, which appears to me to be a very remarkable circumstance. Extensive auroræ finish here through the simple vanishing of the light or by the changing of the forms into faint, luminous clouds consisting of stripes (north-east to south-west), or vague, cloudy bands which by degrees lose in energy and finally die away.

Any real corona I have not seen as yet, and the usual colours, viz. red and green, I have only noted on six occasions.

On forty of the eighty-three evenings I have effected observations there have been auroræ, which is rather a high figure when the unfavourable weather conditions are taken into consideration. But the aurora is, however, not always present when the sky is clear or nearly so; on the contrary, it is not nearly as frequent here as in Kautokeino. This will be understood from Table III., which has been framed on the assumption that all observations were equally divided over the twelve hours, viz. from 4h. to 15h., which also shows that in every hour there was observed one hundred times either aurora or clear sky without aurora. The lower figures show in per cents. when the sky was without aurora.

TABLE III.

Hour	4	5	6	7	8	9	10	11	12	13	14	15
W	75	72	77	88	91	97	89	83	63	53	62	33
ø	25	26	23	12	9	3	11	17	37	47	38	67

In consequence of the great magnetic declination in Iceland, viz. about 40° N.W., the points of culmination of the arcs and bands fall far outside the astronomical meridian, and their direction is nearly north-east to south-west. From the measurement of twenty arcs, partly on the north, partly on the south horizon, I have certainly only obtained an azimuth of 22°·4 W., but I do not accept this as any definite result before more complete observations are in my hands.

The intensity of the aurora borealis here I have defined approximately in Table IV. by four degrees, viz. from one to four. From the total determinations of intensity for every hour when no aurora is visible, in spite of clear sky, being determined by 0, the following average figures are obtained:—

TABLE IV.

Hour	5	6	7	8	9	10	11	12	13	14	15	Average
Intensity	0·90	0·76	1·04	1·26	1·45	1·05	0·82	0·59	0·40	0·44	0·03	0·95

From these figures a decided maximum of intensity is manifest between 9h. and 10h.

As regards the position of the auroræ on the sky and the relative frequency of the various forms, I append a tabular list of observations. The abbreviations made in the same are these:—

HN. Aurora stands near the northern horizon, *i.e.* the magnetic north.
lN. ,, ,, low in the north.
N. ,, ,, in the north (to a height of about 45°).
Nh. ,, ,, on the northern horizon (to a height from the horizon about 70°).
Nh—Z. ,, ,, on the northern horizon to zenith.

Further, *Z* indicates through or on both sides of the zenith *S*, south; *SZ*, south of zenith; *Sh*, south horizon; *t*, over the whole sky; ÷, with the exception of; *N* + *S*, auroræ in the north and south (but not in zenith); 0, no aurora. Below *N′* I have collected the values of *HN*, *lN*, *N*, *Nh*, and *Nh—Z*; and under *S′* those of *SZ*, *Sh*, and *S*; and under *t′* the others, with the exception of 0.

Table V. gives percentally, assuming an evenly divided time of observation, a view of the position of the auroræ in the sky.

Table VI. shows the relative appearance of the various forms calculated percentally on the same basis as in the previous tables. Here *I* indicates one arc; *I=*, several arcs; *II*, a band; *II=*, several bands; *j*, diffused; *s*, streaming; *js*, simultaneously diffused and streaming, or a variety between the two; *III* isolated streamers, or bunches of streamers; *V*, luminous clouds

TABLE V.

Hour	4	5	6	7	8	9	10	11	12	13	14	15	Average
HN	0	0	0	0	0	3	4	13	5	0	0	0	2·2
lN	0	11	14	14	22	12	25	22	11	11	0	0	15·0
N	8	37	31	26	22	19	21	9	11	0	0	33	19·8
Nh	8	5	6	2	3	0	7	0	0	0	0	0	2·9
Nh–Z	8	0	3	12	9	9	7	0	0	5	13	0	6·2
Nh–SZ	8	5	6	12	16	19	4	9	5	11	25	0	10·3
Z	0	0	0	2	6	0	7	0	0	5	13	0	2·6
SZ	0	0	3	2	0	3	0	0	0	0	0	0	1·1
Sh	8	0	0	5	0	0	0	0	0	0	0	0	1·1
S	8	0	0	2	0	3	4	0	5	0	0	0	1·8
t+(N+S)	8	0	3	0	3	6	0	0	5	0	0	0	2·2
t+lS	0	5	0	2	3	9	4	9	5	16	0	0	4·8
t+lN	0	0	0	2	0	0	0	0	0	0	0	0	0·4
N+S	8	0	6	2	6	3	4	9	5	0	0	0	4·0
t	8	11	6	5	0	6	4	13	11	5	13	0	6·2
o	25	26	23	12	9	3	11	17	37	47	38	67	19·4
N'	25	53	54	53	56	47	64	43	26	16	13	33	46·2
S'	17	0	3	9	0	6	4	0	5	0	0	0	4·0
t'	23	16	20	26	34	44	21	39	32	37	50	0	30·4
S'+t'	50	16	23	35	34	50	25	39	37	37	50	0	34·4

TABLE VI.

Hour	4	5	6	7	8	9	10	11	12	13	14	Total
Ij	3·3	3·3	4·6	5·5	4·0	2·9	2·9	0·8	2·2	1·3	0	30·8
Is	0	0	0	0	0	0	1·4	1·7	1·1	0	2·0	6·2
Ijs	3·3	1·1	1·5	1·0	2·0	2·4	0·7	2·5	7·2	1·3	0	18·0
IIj	0	0	0	1·5	0	0	0·7	1·7	1·1	1·2	2·0	8·3
IIs	0	0	0·8	0	0	0·6	1·4	0	0	1·3	0	4·1
IIjs	0	0	0	1·5	2·7	1·2	0	0·8	1·1	1·3	0	8·6
III	0	0	0·8	2·5	0·7	0·6	0·7	3·3	1·1	1·3	0	11·0
V	0	2·2	1·5	1·5	1·3	1·2	2·1	2·5	3·3	5·0	2·0	22·6
I=j	0	1·1	2·3	1·0	0·7	1·2	0·7	0	0	0	0	7·0
I=s	0	0	0·8	0	0·7	0	0	0·8	0	0	0	2·3
I=js	3·3	4·4	1·5	2·5	2·7	2·9	3·6	2·5	2·2	1·3	0	26·9
II=j	0	0	1·5	1·5	0	0	0·7	1·7	0	0	4·0	9·4
II=s	3·3	0	0·8	0	0·7	0·6	0·7	0	1·1	0	2·0	9·2
II=js	6·7	4·4	2·3	3·0	4·0	3·5	2·1	0·8	0	0	0	26·8
I	10·0	10·0	10·8	10·0	10·0	9·4	9·3	8·3	7·8	3·8	2·0	91·4
II	10·0	4·4	5·4	7·5	7·3	5·9	5·7	5·0	3·3	3·8	8·0	66·3
j	3·3	4·4	8·5	9·5	4·7	4·1	5·0	4·2	3·3	2·5	6·0	55·5
s	3·3	0	2·3	0	1·3	1·2	3·6	2·5	3·3	1·3	4·0	22·8
js	13·3	10·0	5·4	8·0	11·3	10·0	6·4	6·7	5·6	3·8	0	80·5

On the valuable isochasme chart, in which Prof. Fritz has denoted the increasing frequency of the aurora borealis northwards, the maximum zone of the phenomenon falls far south of Iceland. I must, however, first explain what my definition of the word maximum zone is at present. It is a line passing across the places where the aurora not only appears and is most frequently visible, *provided the weather permits*, but where it also, as a rule, appears in zenith, or as often on the northern as the southern hemisphere. According to this definition, the correctness of which I think can neither be disputed nor doubted, Iceland lies, at all events this year, as was the case with Kautokeino and Bossekop last year, considerably south of the maximum zone, which is, in fact, clearly shown in Table V.

I hope to be able to demonstrate this in a more conclusive manner still on a future occasion, when the winter is over and the numerous exact determinations of the southern border of the aurora borealis will be discussed.

The reason why the maximum zone lies so far south on Prof. Fritz's chart may be sought, perhaps, in the circumstance that the climatic conditions of Iceland to a great extent reduce the number of auroræ which an ordinary observer, who only casually or on particular occasions looks at the sky, may observe. That the maximum zone of the aurora does not really fall across the part shown in the chart is also distinctly apparent from what I learnt of its appearance at the Färoe Islands during my sojourn there.

It may perhaps be superfluous to state that neither here nor in any other place have I heard the mystic auroral *sound*. Neither has it ever been heard by any of the Icelanders I have as yet met with.

Shortly before leaving Copenhagen last autumn I spoke with a celebrated Danish *savant*, who had some years ago spent some time in Reykjavik, and who told me that he had on several occasions seen auroræ descend below and in front of the mountain Esja, about 2500 feet in height, and lying six to seven English miles away (NATURE, vol. xxix. p. 337). I was delighted with the prospect of being able to see a similar phenomenon, as, although my observations in the plane Bossekop-Kautokeino, previously referred to, had greatly contributed to strengthen my belief in the height of the aurora borealis being 100 km. or more above the earth (NATURE, vol. xxix. p. 412), I would with pleasure have accepted a proof so tangible pointing in another direction. I regret to say that my expectations have not been fulfilled. This is not because the aurora has not been in close proximity to Esja, as, the mountain lying to the north-east from this place, nearly all arcs and bands rise with their eastern end up behind and run above it, but *never have I been so fortunate as to see any auroral light descend to the top of the mountain or in front of its steep sides.* Even the highest-lying clouds are also, in Iceland, *below* the plane of the aurora borealis.

In connection with this point I may further mention that the faint luminosities referred to by Prof. Lemström above the mountain-tops at Sodankylä, and in other places (NATURE, vol. xxvii. p. 322), as well as phenomena of a similar nature have, I venture to assert, never been observed here. I have continually had my attention directed to this point, and there are several mountains here, but I have never been able to trace the slightest indication of such a phenomenon.

I brought with me the necessary apparatus and appliances for effecting such experiments as Prof. Lemström pursued on some mountains in Northern Finland for the production of an artificial aurora borealis, and shortly after my arrival I came to the conclusion that the above-mentioned mountain Esja was the most advantageous for such. Its great height, steep fall into the sea, and short distance from the town, were advantages such as no other spot in the district offered, but as I only brought with me 1000 m. of insulated wire—telegraph-poles with insulators cannot be employed in consequence of the nature of the ground—and wished to conduct the wire from the top of the mountain down to the sea at its foot, I was obliged to wait until I obtained more wire by the steamer at the end of November. Since then the execution of this plan has been attempted a number of times; men, boats, and horses have been ready, and everything prepared, but every time the unfortunate weather has frustrated the same. Even in the middle of summer the Esja is a mountain difficult to ascend, and at this time of the year it would be very dangerous to undertake an ascent with the heavy wires, insulators, and poles, without the weather being remarkably quiet for several days.

I intend, however, very shortly to make another attempt, and should this fail I will select a more distant but much lower and more unfavourably situated mountain top. I will only add that a few days after my arrival I fixed one of Prof. Lemström's "utströmnings" apparatus—with 200 points—on the flat roof of a stone tower, 30 to 40 feet in height, and which lies free and isolated on a height in the vicinity of the town; but the same has up to the present, in spite of numerous trials, given no result whatever. Any current between the points and the earth cannot be traced, and of any luminous phenomena above them there has not been the faintest appearance. SOPHUS TROMHOLT

Reykjavik, February

ON THE NATURAL AND ARTIFICIAL FERTILISATION OF HERRING OVA[1]

IN 1862 Prof. Huxley arrived at the conclusion that herring visit our shores in order to spawn twice a year, some schools arriving during the autumn, while others make their appearance during the winter. The herring which spawn during the autumn chiefly frequent banks on the east coast, while those which spawn during winter are most abundant on the west coast. A report of the Scottish Fishery Board referring to the east coast spawning beds was published in NATURE on November 29 last. The present paper deals chiefly with the Ballantrae spawning bed, which lies off the coast of Ayrshire.

In 1862 Prof. Allman made some investigations for the Scottish Fishery Board, and succeeded in dredging and hatching what was considered herring ova; but since then, although important results have been obtained by the German and American Commissioners of Fisheries, little or nothing has been done in this country.

When examining the Ballantrae Bank the author of this paper succeeded in dredging several specimens of herring ova attached

[1] Abstract of a paper read by Prof. J. Cossar Ewart, M.D., at the Royal Society, March 27. Communicated by the Author.

to stones, seaweed, and sea-firs. These stones coated with eggs varied from 6 inches to 1½ inches in length, and from 4 inches to 1 inch in breadth, but in all cases the eggs were attached to a comparatively smooth surface, and they were arranged either in low cones or in comparatively thin layers one or two eggs deep. The eggs on the sea-firs were always attached in small clusters about half an inch in diameter around the stems. On examining the spawn found on the stones and seaweed, embryos at various stages of development were at once visible, some of them apparently only three days old, while others had distinct eyes, and from their violent movements and their size seemed almost ready for hatching. Some of the egg-coated stones were taken to the University of Edinburgh, where the eggs hatched on March 15, eight days after their removal from the spawning ground, and to-day (March 17) they are three-eighths of an inch in length, extremely active, and swimming freely about in the water.

By taking soundings over the Ballantrae Bank in various directions, it was ascertained that it consisted of rock, stones, shells, and coarse sand, and that the depths varied from 7 to 13 fathoms. The outer edge of the bank shelved at most points rapidly until a depth of 17 fathoms was reached, and at this depth the bottom consisted of fine, soft mud. While on the east coast spawning grounds examined during the autumn the surface temperature in most cases varied from 53° F. to 55° F., and the bottom temperature from 52° F. to 54° F., even at a depth of 40 fathoms, the temperature at the Ballantrae Bank varied from 42°·8 to 43°·8 F. at the surface, and from 43°·5 to 42°·8 F. at the bottom. The corresponding surface temperature, however, on the east coast during the week ending March 8 was from 2° to 3° F. lower than at Ballantrae.

According to previous observers—

"When spawning takes place naturally, the eggs fall to the bottom and attach themselves." "But at this time the assembled fish dart wildly about and the water becomes cloudy with the shed fluid of the milt. The eggs thus become fecundated as they fall, and the development of the young within the ova sticking to the bottom commences at once."

Mr. Mitchell, in his book on "The Herring," referring to the once famous spawning bed off Dunbar, states that—

"About August 30 the shoals began to deposit their spawn a short distance from the harbour, and on September 3 the fishermen found that a very large body of herrings remained fixed to the ground in the progress of spawning, the ground being of a rocky or stony nature."

While many fishermen believe that herring spawn on hard ground, some believe that they also spawn on a clayey bottom; and while some think they spawn near the bottom, others affirm that they spawn near the surface. Having secured at Ballantrae a large number of live herring, some of the largest and ripest males and females were placed in a large wooden tank into which a number of stones and a quantity of seaweed had been previously introduced. After the fish had been about two hours in this tank, the stones and seaweed were examined. Although a few eggs were attached to both stones and seaweed, it was quite evident that the eggs had not been deposited in the same way as those found on the stones dredged on the previous day; but we were not surprised that only a few isolated eggs were found on the stones, because the fish had been disturbed every few minutes by the pouring of water into the tank.

On reaching Rothesay the hatching boxes and live herring were at once transferred from H.M.S. *Jackal* to the tanks—a tank into which comparatively little light entered being selected for the ripest and most vigorous herring. In about half an hour after they were introduced a large full herring was seen moving slowly about the bottom of the tank with four other fish making circles around her at some distance from the bottom. Appearing satisfied with a particular stone which she had evidently been examining, she halted over it and remained stationary for a few minutes about half an inch from its surface, the tail being in a straight line with the tank and the pectoral fins near or resting on the bottom.

While in this position a thin, beaded ribbon was seen to escape from the genital opening and fall in graceful curves on the surface of the stone, so as to form a slightly conical mass almost identical with a cluster on one of the stones dredged at Ballantrae. As this little heap of eggs increased—some falling to the left side one moment, while others fell to the right the next, according to the currents in the water—the males continued circling round her at various distances, while the other females in the tank remained apart. The males remained from 8 to 10 inches above the bottom of the tank, and formed circles varying from 18 inches to 2 feet 6 inches in diameter. Some of the males were swimming from right to left, others from left to right; and although there was no darting about, no struggling amongst themselves, there was a peculiar jerking of the tail as they performed their revolutions. Soon the object of this peculiar movement was sufficiently evident. Three or four times during each revolution each fish expelled a small white ribbon of milt, which varied from half an inch to three-quarters of an inch in length, and was nearly a line in breadth across the centre, but pointed at both ends, and somewhat thinner than it was broad. These delicate ribbons slowly fell through the water, sometimes reaching the bottom almost undiminished in size, but in most instances they had almost completely dispersed before the bottom was reached. In this way the whole of the water about the female became of a very faint milky colour, and practically every drop of it was charged with sperms, as was afterwards ascertained. It will thus be seen that there is no attempt whatever on the part of the males to fertilise the eggs as they escape from the female. While the female is depositing the eggs at the bottom, the males concern themselves with fertilising the water in the neighbourhood, and it will be observed that the males are careful to guard against the influence of currents by forming circles around the female and shedding milt on the way. It matters little how the currents are running, they are bound to carry some of the milt towards the eggs, the milt, like the eggs, sinking though not adhering to the bottom.

This then is the natural process of depositing and fertilising the ova of the herring in comparatively still water. When the female had deposited a certain number of eggs at any given spot, she moved forward in a somewhat jerky fashion without rising from the bottom, and as she changed her position the males changed theirs, so that the female was always surrounded by a fine rain of short sperm ribbons. A specimen of *Hydrallmannia* sent from Eyemouth seems to indicate that the female moves about amongst sea-firs and seaweeds in exactly the same way as she does amongst stones. On each stem of the colony there is a cluster of ova about the size of a small grape, and all the clusters had reached on arrival the same stage of development as if they had been deposited about the same time and by the same fish.

This method of depositing and fertilising the eggs accounts, I think, for all the eggs, or at least for a very large percentage of those found attached to sea-firs, seaweeds, and stones, containing developing embryos.

When a female was depositing her eggs, she was very easily disturbed; whenever anything was introduced into the tank she at once darted off. When strong currents were made, she at first seemed to apply herself nearer to the bottom, to make sure, as it were, that the spawn would get fixed before it could be carried away; but when the currents were further intensified she at once changed her position, and arrested the escape of the spawn. A spawning female was held immediately under the surface of the water so as to cause the spawn to escape. When this was done the spawn escaped in long ribbons consisting of a single row of eggs. So firmly do the eggs adhere to each other that in perfectly still water the ribbon was sometimes over a foot in length before it broke. When it had only about two feet of water to travel through, it fell in wide loops at the bottom, but when it had to fall over three feet the chain broke up into numerous segments which formed an irregular pattern on the bottom. From experiments made, it seems the further the eggs have to fall and the longer they are in contact with the water before they reach the bottom, they are more widely dispersed, and have all the less adhesive power. When the eggs are expressed in water moving rapidly in various directions, the chains soon break into short segments, and the individual eggs and the small groups are often carried a considerable distance before they reach the bottom.

A number of flat stones and pieces of seaweed were obtained, and a spawning female held over them at different distances in still water, in water with gentle currents, and in water with strong currents. In this way we obtained groups of eggs which mimicked in a very striking manner all the arrangements of the eggs on the stones and seaweeds dredged on the Ballantrae Bank. When gently pressed, a beaded ribbon consisting of a single row of eggs always escaped; when there were no currents, it formed a conical heap; when in a gentle current, the ribbon fell in irregular loops, the elements of which rearranged themselves so as to form a flattened cone; but when strong currents acted on it the ribbon was broken into fragments and only a few eggs succeeded in fixing themselves to the objects introduced. When the currents were strong, the males were seen not only to swim nearer the bottom but to expel longer ribbons of milt, which reached the bottom before getting dispersed and remained visible sometimes for ten minutes. On gently expressing a male under the water it was never possible to expel so fine or so short portions of milt as escaped naturally, but it was extremely easy expelling a ribbon from 18 inches to 3 feet in length, measuring 2 lines across and 1 line in thickness. Such ribbons fell to the bottom and remained almost unchanged for nearly two hours; they then assumed a segmented appearance, and in about three hours and a half had all but disappeared.

Eggs were allowed to escape into a vessel containing fine sand, and into another containing mud. The eggs after being fertilised underwent the early stages of development, but either owing to their moving freely about with the sand particles or owing to their getting coated over with the sand and mud their development was arrested. I have not yet determined finally if the development is arrested when the eggs are detached while development is proceeding, but this seems extremely probable.

When at Ballantrae I noticed that the trammel nets secured often more males than females. Mr. Wilson, fishery officer at Girvan, informs me that the ripest fish are caught in the trammel nets, while most of the unripe fish are obtained in the drift nets, and that at the end of the fishing season there are about three males taken for every two females, indicating not necessarily that the males are more abundant than the females, but rather that the males remain longer on the spawning ground; and Mr. Wilson believes that herring prefer quiet water free from strong currents when spawning, and that when the weather is fine the herring remain long upon the bank and deposit their spawn leisurely, but when there are strong currents they either hurry the spawning process or disappear into deep water.

As to artificial fertilisation and hatching I found, after many experiments at Ballantrae, that the best results were obtained when both the male and female were held under water while the milt and ova escaped, *i.e.* when the natural process of spawning is followed.

An ordinary wooden tub was obtained and filled with sea-water. Into this a small quantity of milt was expressed, the male being held completely under water while the milt escaped. A glass plate was then held about four inches beneath the surface of the water, and, the female herring being held about one inch beneath the surface, by gentle pressure the eggs readily escaped in the characteristic narrow beaded ribbon, and, by moving the fish over the surface of the glass, either a close or an open network could be formed. At first, where one loop crossed another, the eggs were two or more layers thick, but, either owing to the weight of the eggs or the gentle currents set up in the water, before a few minutes had elapsed, the eggs formed a single and almost continuous layer, the network arrangement having disappeared. The plate was then allowed to rest for two or three minutes at the bottom of the tub, and a few short ribbons of milt were again introduced. After moving the plate once or twice across the top of the tub in order to wash off any scales that were adhering, it was placed either in a hatching or a carrying box. Many thousands of ova treated in this way contain extremely active embryos, which are expected to hatch on March 22 or 23.

Prof. Ewart exhibited a number of specimens showing herring eggs attached to stones, seaweeds, and sea-firs, and some of the herring fry hatched on March 24 from the eggs artificially fertilised on March 8.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The electors have awarded the Radcliffe Travelling Fellowship after examination to Mr. J. E. Blomfield, B.A., late Natural Science Demy of Magdalen College, and now of University College Hospital, London. The Fellowship is of the annual value of 200*l.*, and tenable for three years provided that the Fellow travels abroad for his improvement in the study of medicine. This is the fourth time in the last five years that this prize Fellowship has been won by a student of Magdalen College.

CAMBRIDGE.—From the report of the last Local Examinations it appears that the answers in pure mathematics exhibited considerable improvement, while in applied mathematics the work was inferior, and much of the teaching in statics was imperfect, and not based on mathematics. In chemistry great inequality was shown, some centres sending uniformly good work, others being very inferior. The practical work is better done than the theoretical. The teaching of experimental physics is still very ineffectual in its results. In the senior paper in electricity and magnetism only two of the candidates showed any proof of accurate knowledge or scientific training.

In biology the answers were, on the whole, not good, yet at some centres candidates did extremely well. In botany vegetable physiology showed improvement, but floral diagrams are not sufficiently used. In zoology the candidates seemed to have no idea of the relative value of facts. In physical geography a marked absence of scientific method was noticeable in the answers; great ignorance of meteorological terms used in most daily papers was manifested.

The Cambridge Local Lectures have made good progress in the past session, much good having resulted from the conference of local committees and lecturers held last year. In a number of centres local associations have been formed for putting the lectures on a permanent basis. At Derby an Artisans' Higher Education Society has been formed, the subscription being very low. At the Midland Railway works the large mess-rooms have been utilised in giving short lectures to arouse interest among the men, Prof. Teall lecturing on chalk, Mr. Bemrose on the transit of Venus, Mr. Heycock on digestion, respiration, &c., and the men have always been appreciative. In the Newcastle district much eagerness has been shown by pitmen to attend the lectures, often at great personal cost and inconvenience. The cost, indeed, is so great as to form an obstacle of serious magnitude, and it is found that the desire for lectures is such that the overcoming of financial difficulties would lead to an enormous extension of the work. Efforts are being made to get the rules of the Trades Unions altered so as to enable them to contribute towards the cost of the lectures.

It is now proposed to constitute an examination in French or in German as the additional subjects required of candidates for honours degrees, unless the candidates choose rather to pass the General Examination for the B.A. degree. This change would be welcomed by the large number of students to whom the study of works in French and German would be an important aid in their Tripos subjects.

SCIENTIFIC SERIALS

THE *Journal of Botany* for March contains the conclusion of Mr. T. Hick's valuable paper on protoplasmic continuity in the Florideæ. In quite a number of distinct genera belonging to this class he has now traced connecting threads between the protoplasm from cell to cell. He regards these threads as permanent and essential structures, normally present in all parts of the thallus from the oldest to the youngest, not restricted to special localities and special cells.—Some details of the life-history of a rare and little-known British plant, *Lithospermum purpureo-cæruleum*, are contributed by Mr. Jas. W. White.

American Journal of Science, March.—Experimental determination of wave-lengths in the invisible prismatic spectrum, with plate, by S. P. Langley.—The Quaternary gravels of Northern Delaware and Eastern Maryland, with map, by Frederick D. Chester. From a careful survey of this region the author infers that the peninsula became depressed at least 350 feet towards the close of the Glacial period, when the estuary thus formed received the discharge of the Delaware River, which pushed its way across the present States of Delaware and Maryland to the head of the Chesapeake. By this current and the subsequent distributing action of the waves the red gravel was deposited. Later on the land began to rise, the violence of the flood was abated, and the northern glacier gradually broke up. During this period the Philadelphia Clay was deposited, and the boulders distributed over the estuary by the icebergs from the glacier. The land continuing to rise, the shoal gravels were piled up by the waves and tides, the river began to assume its present channel, and the Delaware and Chesapeake were finally parted.—On the identity of scovillite with rhabdophane, by G. J. Brush and S. L. Penfield.—A theory of the recent sun-glows, by H. A. Hazen. The author attributes the phenomena to the presence of watery vapour, ice crystals, or frozen water particles under a peculiar form in a rarefied atmosphere at a low temperature.—On the topaz and associated minerals found at Stoneham, Maine, by George F. Kunz.—A contribution to the study of the geology of Rhode Island, with map, by T. Nelson Dale.—On the crystalline form of the supposed herderite from Stoneham, Maine, by Edward S. Dana.

SOCIETIES AND ACADEMIES

London

Chemical Society, March 20.—Dr. W. H. Perkin, president, in the chair.—The following gentlemen were elected Fellows:—F. W. Brown, H. Cave, F. W. Fleming, E. E. Graves, A. E. Lewis, J. E. London, G. A. Parkinson, S. Smith, G. Tunbridge, T. U. Walton.—The following papers were read:—Note on the preparation of marsh gas, by Dr. J. H. Gladstone and Mr. A. Tribe. In 1873 (*Chem. Soc. Journ.* xi. 682) the authors described a reaction in which pure marsh gas was obtained by the action of the copper-zinc couple on methyl iodide in the presence of alcohol. The loss of the methyl iodide was considerable, 23 to 50 per cent. In the present note the authors describe a slight modification by which this loss can be prevented. It consists essentially in passing the gas evolved through a vertical tube twelve inches long filled with the copper-zinc couple.—On the action of dibrom-α-naphthol upon amines, by R. Meldola. The author has investigated the action of dibrom-α-napthol upon anilin, orthotoluidin, paratoluidin, and α-naphthylamin. With anilin a body was obtained which proved to be β-naphthoquinonedianilide; similar bodies were obtained with toluidin, &c. This reaction therefore furnishes a simple method of obtaining these quinoneimides in large quantities. The author also discusses the bearing of this reaction on the constitution of these bodies.—Note on the existence of salicylic acid in the cultivated varieties of pansy and in the Violaceæ generally, by A. B. Griffiths and E. C. Conrad. The authors state that they have extracted salicylic acid from the leaves, stems, and roots of the pansy; apparently none exists in the flowers.

Zoological Society, March 18.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Tegetmeier exhibited specimens showing a variation in the colour of the feet of the pink-footed goose (*Anser brachyrhynchus*).—A communication was read from Sir Richard Owen, K.C.B., on the extinct birds of the genus *Dinornis*, forming the twenty-fifth of his series of memoirs on the subject. The present paper gave a description of the sternum of *Dinornis elephantopus*.—Mr. J. B. Sutton, F.Z.S., read an account of the results of his investigations of the more important diseases which affect the carnivorous animals living in the Society's Gardens.—Mr. J. W. Clark, F.Z.S., exhibited and read an account of three skulls of a sea-lion from the east coast of Australia. The largest, that of an adult male, had been exhibited, together with the stuffed skin, at the Fisheries Exhibition last year, where it had been named *Arctocephalus cinereus*, Gray. The object of the paper was to trace the history of the species for which the name *Otaria cinerea* had been suggested by Péron in 1816, and to show, by comparison with the type skull at Paris, that these specimens had been rightly referred to.—A communication was read from the Rev. O. P. Cambridge, in which he gave descriptions of two new genera of spiders proposed to be called *Forbesia* and *Regillus*.

Physical Society, March 22.—Prof. Guthrie, president, in the chair.—The President announced that a meeting of the Society would be held on May 10 at Birmingham, by invitation. The next meeting will be on April 26.—Prof. S. P. Thompson then read a paper by himself and Mr. C. Starling on Hall's phenomenon. The authors had not agreed with Hall's explanation of his observed effect, and last year undertook experiments to investigate its nature. They employed a strip of tinfoil gummed on a mahogany board with vaseline, which, being soft and a non-conductor, answers well for this purpose. A top-shaped electromagnet with a pointed pole was used on one side of the strip to try the effect of a pointed pole. The current was obtained from accumulators. They found that the equipotential lines in the strip, which before magnetisation ran straight across the strip, were slightly curved on either side of the pointed pole after magnetisation. This curving was interpreted as a reduction of resistance in the strip at the pole, and subsequent tests of the resistance of the strips in a magnetic field confirmed this view. Iron strips, however, showed a slight *increase* of resistance. It was also found that an effect similar to Hall's was got by placing the pointed pole so that this change of resistance was not symmetrical with respect to the points in the strip to which the galvanometer was connected. But inasmuch as the effect was not reversible by reversing the magnetism, it was not Hall's effect, which they failed to obtain with the narrow pointed pole. In their experiments thermo-electric effects were eliminated, and their results, though different, do not clash with those of Mr. Bidwell.—A paper by Mr. Herbert Tomlinson on the same subject was read by Prof. Reinold. The author drew attention to a similarity between Hall's table of results and one of his on the effects of mechanical stress on electrical resistance.—Mr. Shelford Bidwell read a note on Hall's effect in tin, in which he showed that a small extension and a greater extension produced opposite thermo-electric effects in tin wires.—In answer to Prof. Guthrie and Mr. Walter Baily, Prof. Thompson stated that the change of resistance he had observed was sub-permanent, and died away in about half an hour. He believed it to be producible on the strip when no current traversed it.—Prof. S. P. Thompson then read a paper on some propositions in electromagnetics, giving a connected series of explanations throwing light on the laws of electromagnetics, and based on a practical experiment.

Royal Microscopical Society, March 12.—Rev. H. W. Dallinger, F.R.S., president, in the chair.—Mr. Glaisher introduced Mr. Dallinger to the meeting on taking his seat for the first time as president, and the latter made a short address in acknowledgment.—Mr. J. Mayall, jun., described the improved Nelson-Mayall lamp, in which the burner could be brought down very close to the table; also Boecker's improved freezing microtome.—Mr. Crisp exhibited Schieck's microscope with fine adjustment made by tilting the stage at one end; also Watson's rotating stage, Collin's set of fish-scales, and a slide of a hydroid polyp with extended tentacles, mounted by Mr. E. Ward.—Notes were read: On a multiple eye-piece by Mr. E. H. Griffith, in which eye-lenses of different powers were mounted on a rotating disk; by Col. O'Hara on some peculiarities in the form of blood-corpuscles; and a communication from a Microscopical Society recently formed at San Francisco, and consisting of ladies.—A paper was read by Mr. T. B. Rosseter describing some peculiar annular muscles in *Stephanoceros*; also by Prof. Reinsch, who stated that he had found bacteria and non-cellular Algæ to exist in considerable numbers on almost all copper and silver coins which had been for some time in currency; also by Mr. G. Massee on the formation and growth of cells in the genus *Polysiphonia*, being a further contribution to the evidence on the continuity of protoplasm through the walls of vegetable cells; also by Prof. Abbe on the distance of distinct vision, in which he pointed out the erroneous inferences which had arisen from the practice of expressing the amplifying power of a lens by reference to a fixed distance of vision (10 inches, or 250 mm.).—Some new forms of cells devised by Mr. Wilks and made by Mr. E. Ward for mounting without pressure in balsam were also exhibited and described.

Royal Meteorological Society, March 19.—Mr. R. H. Scott, F.R.S., president, in the chair.—Messrs. W. Baily, M.A., W. L. Blore, A. L. Ford, H. Leupold, A. F. Lindemann, F.R.A.S., and Rev. E. B. Smith were elected Fellows of the Society.—The President read a paper entitled brief notes on the history of thermometers. He stated that the subject had been handled in a comprehensive manner by M. Renou a few years ago in the *Annuaire* of the French Meteorological Society, so that he should merely mention some of the leading points. The name of the actual inventor of the instrument is unknown. The earliest mention of it, as an instrument then fifty years old, was in a work by Dr. R. Fludd, published in 1638. Bacon, who died in 1636, also mentions it. The earliest thermometers were really sympiezometers, as the end of the tube was open and plunged into water, which rose or fell in the tube as the air in the bulb was expanded or contracted. Such instruments were of course affected by pressure as well as temperature, as Pascal soon discovered. However, simultaneously with such instruments, thermometers with closed tubes had been made at Florence, and some of these old instruments were shown at the Loan Collection of Scientific Apparatus at South Kensington in 1876. They are in the collection of the Florentine Academy, and in general principle of construction they are identical with modern thermometers. Passing on to the instrument as we now have it, Mr. Scott said that most of the improvements in construction in the earliest days of the instrument were due to

Englishmen. Robert Hooke suggested the use of the freezing point, Halley the use of the boiling point, and the employment of mercury instead of spirit, and Newton was the first to mention blood heat. Fahrenheit was a German by birth, but was a *protégé* of James I., and died in England. Réaumur's thermometer in its final form owes its origin to De Luc, while the centigrade thermometer, almost universally attributed to Celsius, was really invented by Linnæus. Celsius's instrument had its scale the reverse way, the boiling point being 0°, and the freezing point 100°. Mr. Scott then gave a brief account of some of the principal forms of self-registering and self-recording thermometers.—After the reading of this paper the meeting was adjourned, in order to afford the Fellows and their friends an opportunity of inspecting the exhibition of thermometers and of instruments recently invented. This exhibition was a most interesting one, and embraced 136 exhibits. The thermometers were classified as follows: (1) standard, (2) maximum, (3) minimum, (4) combined maximum and minimum, (5) metallic, (6) self-recording, (7) solar radiation, (8) sea, (9) earth and well, (10) thermometers used for special purposes, (11) thermometers with various forms of bulbs, scales, &c., and (12) miscellaneous thermometers. In addition to these there were also exhibited various patterns of thermometer screens, as well as several new meteorological instruments, together with drawings, photographs, &c.

Anthropological Institute, February 26.—Edward B. Tylor, Esq., F.R.S., vice-president, in the chair.—It was announced that Dr. Walter H. C. Coffin, Dr. Emil Riebeck, Miss H. M. Hargreaves, and Miss Helen E. Pearson had been elected Members of the Institute.—The Rev. R. H. Codrington read a paper on the Melanesian languages. In the term Melanesia the author included (1) New Caledonia, with the Loyalty Islands; (2) the New Hebrides; (3) the Banks' and Torres' Islands; (4) Fiji; (5) Santa Cruz and the Reef Islands; (6) the Solomon Islands. The object of the paper was to set forth the view that the various tongues of Melanesia belong to one common stock, and that this stock is the same as that to which the other Ocean languages belong—Malayan, Polynesian, the languages of the islands that connect Melanesia with the Indian Archipelago, and Malagasy.—A paper by the Rev. Lorimer Fison, on the "Nanga," or sacred stone inclosure of Wainimala, Fiji, was read by Dr. Tylor. The author explained the constitution of the Nanga, and described the ceremony of initiation and other rites connected with it.

March 11.—Prof. Flower, F.R.S., president, in the chair.—The election of W. Ayshford Sanford was announced.—Mr. A. L. Lewis read a paper on the Longstone and other prehistoric remains in the Isle of Wight.—Mr. W. J. Knowles read a paper on the antiquity of man in Ireland. The author exhibited a series of flints discovered by him at Larne and other parts of the north-east coast of Ireland, some of which he believed to have been dressed in imitation of certain pear-shaped nodules or hammer-stones found at the same spot, while others showed more evident signs of human workmanship. One large chipped implement was found in what appeared to be true, undisturbed boulder-clay, and hence the author contended that the implements he exhibited were not only older than the Neolithic Age in Ireland, but older even than those previously known as Palæolithic, and that they carry the age of man back into the Glacial period.—A paper by Admiral F. S. Tremlett on the Cromlec of Er Lanic was read.—A paper by Mr. Henry Prigg on a portion of a human skull of supposed Palæolithic age from near Bury St. Edmunds was read. The author exhibited the fragment, which consisted of portions of the frontal and right and left parietal bones, and also two flint implements found in the same locality.

DUBLIN

Royal Society, February 18.—Section of Physical and Experimental Science.—G. Johnstone Stoney, F.R.S., in the chair.—On Mr. J. J. Thomson's theory of electricity, by Prof. G. F. Fitzgerald, F.R.S. After explaining Mr. Thomson's theory, Prof. Fitzgerald pointed out that it seems very unlikely that electrified bodies *in vacuo* would not attract or repel one another, inasmuch as experiments seemed to show that the only effect of matter between electrified bodies was to alter the specific inductive capacity of the space, and so Mr. Thomson's theory was more probable as an explanation of how gases had a specific inductive capacity different from unity. In a communication on the mechanical theory of Crookes' force made to the Society in 1878 he had shown that a polarisation of the motions of the molecules in a gas of a particular kind would produce the same stresses as are required to explain electrostatic actions. He explained how a suitable polarisation of the motions or positions of the superficial molecules of a conductor, due to their being on the surface of separation of a constant and variable electric potential, was probably the cause of electrostatic attractions. He pointed out that the ordinary hypothesis that molecules act on one another by means of the ether, and so transmit mechanical stress across intermolecular layers of ether was an assumption of precisely the same kind at intermolecular distances as Maxwell's theory of electricity was at molar distances, and expected that a suitable strain of the superficial molecules of a body would transmit a stress through the ether. Prof. Fitzgerald explained a particular hypothesis as to the nature of this polarisation of the superficial molecules on the vortex theory of atoms, which, however, seemed subject to the very serious objection that it appeared at first sight as if two oppositely electrified planes would tend to move bodily in one direction. The hypothesis was founded on the fact that when two vortex rings are going in the same direction, and one following the other, they attract; but if going in opposite directions they repel one another. The polarisation supposed was that an electrified surface had the superficial molecules all turned in one way, preferably negatively electrified bodies with the faces of the vortex atoms outwards, and positively electrified bodies with their backs outwards. He described how contact-electricity, thermo-electricity, and electro-chemical actions might be explained on this hypothesis. This hypothesis was put forward more as an illustration of how a polarisation of the superficial molecules of a body might produce attractions and repulsions than as an hypothesis that really explained electrostatic actions.—On Prof. Osborne Reynolds's mechanical illustrations of heat engines, by Prof. G. F. Fitzgerald, F.R.S. After explaining Prof. Osborne Reynolds's beautiful illustrations, he described three arrangements, one by setting a chain rotating in loops and nodes, one by a balanced centrifugal pendulum, and the third by a pair of masses running on a revolving radius, by means of which all the operations in Carnot's cycle might be illustrated, and explained how to arrange that temperature should be represented by the angular velocity of the rotating masses, and how by means of a chain passing over a pulley in the second case, and by a chain drawn off a table in the third case, it was easy to arrange that the masses should expand when given energy at a constant velocity. He explained how an arrangement in which the masses when not rotating would rest in any position represented an ideal gas in which no internal work is spent in expansion. Prof. Fitzgerald described how by means of a dynamo driven from a battery, a self-acting engine of this kind could be arranged which would show when it was absorbing and when giving out energy. He explained that it was easier to work these models when promiscuous agitation was represented by rotatory motion than when it was really promiscuous, and that it was for this reason rotatory motion was adopted. Mr. Stoney, in some remarks he made on this communication, explained how necessary it was that the energy be really promiscuous, in order that it be subject to the second law of thermodynamics, showing how it would be possible to get a region in which all the radiant energy was plane polarised to radiate into a hotter similarly polarised region without allowing the latter to lose any heat by radiating any of its original energy. He proposed to do this by means of a plate of quartz that rotated through 90° the plane of polarisation of the radiant energy that passed through it, and by a doubly refracting prism, thus admitting heat energy into the second region that was polarised at right angles to that originally there, while the polarised radiant energy that escaped back again was returned into the region it came from, being bent out of the path of the entering energy by the doubly refracting prism.—Prof. Fitzgerald exhibited a lecture balance. In this arrangement a beam of light fell parallel to the axis of the balance on a mirror attached at 45° to the axis, so that the reflected ray turns through the same angle as the balance. The balance was provided with an arrangement by which its stability could be altered very much, so as to be suitable for either rough or delicate weighing. As the difference of weights in the pans of a balance is proportional to the tangent of the angle of deflection, a vertical scale uniformly divided showed by the position of the spot of light the difference of the weights in the pans in a manner that could be easily read by a large class.

Section of Natural Science.—V. Ball, F.R.S., in the chair.—Gerrard A. Kinahan read a paper entitled "Notes on the Coal-fields of the North-West Territories of Canada."

CAMBRIDGE

Philosophical Society, March 10.—Mr. D'Arcy W. Thompson, B.A., Trinity College, was elected a Fellow.—The following papers were communicated:—Continuation of observations on the state of an eye affected with astigmatism, by Sir G. B. Airy. The paper consisted of a continuation of observations already recorded in the publication of the Society. The author gave tables of the distances from the cornea of the left eye at which a luminous point appears respectively as a horizontal and a vertical straight line. The observations have extended from the year 1825 to the present time.—On the measurement of the electrical resistance between two neighbouring points on a conductor, by Lord Rayleigh. In some experiments described in a recent paper read before the Royal Society, the author had occasion to arrange a set of resistance coils so that the difference of potential between two points on a circuit through which a current is flowing shall be exceedingly small and yet known to a high degree of accuracy. In the present communication the method is applied to determining the difference of potential between two neighbouring points on a conductor through which the same current is flowing. The resistance coils are adjusted until the difference of potential measured by the current produced in a galvanometer of comparatively high resistance is the same in the two cases. The method has been applied by Messrs. Ward and Shackle at the Cavendish Laboratory to determine the value of a small resistance of about 1/200 of a B.A. unit, and is capable of very great accuracy.—On dimensional equations and change of units, by Mr. W. N. Shaw.

SYDNEY

Linnean Society of New South Wales, January 30.—C. S. Wilkinson, F.G.S., president, in the chair.—The President delivered an address on the progress of science in Australia during the past year, and concluded by a general account of the geology of the country from an economic point of view.—The following papers were read:—Supplement to the Descriptive Catalogue of the Fishes of Australia, by William Macleay, F.L.S., &c. This paper contains references to, or descriptions of, 157 species of fishes not mentioned as Australian in the previously printed catalogue. The species here described for the first time are from the pens of Dr. Klunzinger, Dr. Günther, Messrs. De Vis, Ramsay, Macleay, and R. M. Johnston. The total number of Australian fishes now amounts to 1291 species.—On some new Batrachians from Queensland, by Charles W. De Vis, M.A. This paper contains descriptions of three new species of frogs, collected at Mackay, by Mr. H. Ling Roth, and named by the author as follows:—*Limnodynastes lineatus*, approaching *L. peronii*, but distinguished by shorter hind limbs, and continuity of dorsal stripes; *L. olivaceus*, and *Hyla rothii*.—On plants indigenous in the immediate neighbourhood of Sydney, by Mr. Haviland. This, the sixth of the series, gives an account of some species of the genus *Darwinia*, showing the supposed manner of fertilisation, and explaining, to some extent, the prevalence of the species *D. fascicularis*, notwithstanding the great disproportion between the fertilised and the fertilising flowers.—Studies on the Elasmobranch skeleton, by William A. Haswell, M.A., B.Sc.

PARIS

Academy of Sciences, March 24.—M. Rolland in the chair.—Influence of the density of explosive gaseous mixtures on pressure; isomerous mixtures, by MM. Berthelot and Vieille.—Separation of gallium from boric acid, by M. Lecoq de Boisbaudran. This concludes the series of exhaustive experiments conducted by the author for the purpose of obtaining the complete separation of gallium from all other known elements. A final communication is promised on the separation of gallium from tartaric acid, taken as a type of organic substances whose presence might affect several of the reactions indicated during the course of the foregoing studies.—On the concordance of some general practical methods, based on apparently opposite principles, for determining the tensions in a system of points connected by electric links and kept in equilibrium under the action of external forces, by General L. F. Menabrea.—Observations of Saturn and Uranus made at the Observatory of Nice, by M. Perrotin. These observations were made under unusually favourable conditions by Messrs. Norman Lockyer, Thollon, and Perrotin on March 16 and 18. The outer ring of Saturn appeared to consist of three distinct rings slightly diminishing in breadth outwardly, and each apparently made up of numerous subdivisions. Uranus, seen on the 18th, presented in some respects the general aspect of Mars, with dark spots towards the centre, and a white speck like the pole of that planet at the angle of position 380° on the edge of the disk. Mr. Lockyer, who was present at the sitting, read a telegram from M. Perrotin announcing a repetition of the observations on March 23 under equally favourable conditions.—Note on the polar spots in Venus, observed at the Meudon Observatory, by M. E. L. Trouvelot. These spots seem to be permanent, although varying greatly in brilliancy, and often rendered invisible by the distance of the planet towards superior conjunction.—On the thrust of a mass of sand with horizontal upper surface against a vertical wall, in the neighbourhood of which its inner angle of friction is assumed to be slightly increased according to a definite law, by M. J. Boussinesq.—On the extension of the theorems of Pascal and Brianchon to surfaces of the second order, by M. A. Petot.—On a probable cause of the discrepancies found to exist between the electromotor force of voltaic piles and the theoretical results of thermochemical observations, by M. G. Chaperon.—Note on the action exercised by polarised light on cellulose solutions in Schweizer's fluid, by M. A. Levallois.—Remarks on a case of dimorphism observed with the hyposulphite of soda ($NaO,S_2O_2,5HO$), by MM. F. Parmentier and L. Amat.—Researches on the sulphites and bisulphites of soda, by M. de Forcrand.—On the dissymmetric chloro-ioduretted and bromo-iodurетted ethylenes, by M. L. Henry.—Experimental researches on the influence of extremely high pressure on living organisms, by M. P. Regnard. These experiments were conducted by means of the press of MM. Cailletet and Ducretet, yielding pressures of 1000 atmospheres and upwards. Soluble ferments were unaffected by extreme pressure; starch at 1000 was changed to sugar; algæ at 600 were decomposed, and the carbonic acid liberated; infusoria, leeches, and mollusks at 600 were rendered insensible, but recovered when the pressure was removed; fishes with swimming bladder resisted 100, became insensible at 200, and succumbed at 300. These results show interesting coincidences with the phenomena observed by the naturalists of the *Talisman* at various oceanic depths.—On the action of cold on microbes, by MM. R. Pictet and E. Yung. Many inferior organisms resisted temperatures of from −70° to −130° C. for several hours. Others were either killed or lost their germinating functions.—On peritoneal transfusion, by M. G. Hayem.—On the medullar mechanism of paralyses of cerebral origin, by M. Couty.—Anatomical description of the fœtus of a gorilla recently brought from the Gaboon, by M. J. Deniker.—On the anatomy of the *Peachia hastata* discovered by Gosse in 1855, by M. Faurot.—On the structure of the auditory organ in *Arenicola grubii*, Clap., by M. Et. Jourdan.—Anatomy of the muscles in the abdomen of the bee, by M. G. Carlet.—Note on a deposit of gold at Peñaflor in Andalusia, by M. A. F. Noguès.—On certain changes in the appearance of the sky recently observed at Nice, by M. L. Thollon.—On the crepuscular glows observed at San Salvador, in Central America, by M. de Montessus.

BERLIN

Physiological Society, February 29.—Dr. Weyl spoke about the secretion in man of nitric acid, which he had analytically proved, and which, by administration of ammonia, he was able quantitatively to increase. After it had been experimentally established that a direct transference of albumen into urine was impossible, it was recognised that the formation of urine was no oxidising process of the albumen, but was effected circuitously by the formation of amido-compounds, whose introduction into the animal body increased the quantity of the secreted urine. The formation of urine took place through alimentation of the simplest amidinous matters, ammonia increased the secretion of urea. Similar to the action of ammonia was that of a carbonate of ammonia, as also when combined with organic acids, while from hydrochlorate, sulphate, and mineral acid salt, the ammonia did not become transformed into urea. On perusing the literature of the subject, Dr. Weyl found that in all experiments the ammonia was never wholly transformed into urea, but that there was always a residue of from 10 to 40 per cent. which was not represented in the urine. This residue of ammonia, he conjectured, was consumed in the animal body, and he therefore made search in animals to which he had given ammonia, for the presence of nitric acid. Rabbits not being adapted for precise experiments in connection with the transmutation of matter, he experimented on dogs, but always failed to discover any nitric acid in their urine. Even when he had given these animals nitrates, no nitrates could be found in their urine. He now tried experiments on men, and soon ascertained that in their case nitric acid was a perfectly normal product of secretion. The quantitative determinations, even where no nitrate was administered, yielded from 400 to 600 mgr. of nitric acid in the contents of the urine. The quantity of nitric acid varied with the nourishment, and by the use of vegetables could be considerably increased. To test the accuracy of his conjecture regarding the fate of the ammonia not converted into urea, he took with a uniform regulated diet citrated ammonia in doses of from six to eight grammes, and found in two series of experiments a very marked increase of the nitric acid in the urine—in one case, for example, of from about 500 to over 800 mgr. This constant presence in no inconsiderable quantities of nitric acid in the urine of man ought, in experiments connected with the change of matter, to be carefully attended to. Historically, Dr. Weyl observed that more than thirty years ago Bence Jones had made the assertion that in the animal body ammonia was oxidised into nitric acid. He was, however, unable to substantiate this proposition without raising objections.—Prof. Kronecker reported on the discovery of a coordination centre in the movements of the ventricles of the heart, made by Herr Schmey, a student in his department of the Physiological Institute, and which he (Prof. Kronecker) had repeatedly verified. In an examination of the changes in the dimensions of the heart in the process of contraction, needles were thrust in the most various directions into the heart of a dog after it had been laid bare, an operation which, as was known by experience, had no influence on the movements of the heart. When in this operation the needle came upon a certain small spot on the lower border of the upper third of the *septum cordis*, the ventricles of the heart at once ceased to beat, and, diastolically dilated, fell into fibrillar convulsions, which were soon followed by the death of the ventricles of the heart. It was not possible by any appliances to restore the ventricles to their normal action. The vestibules continued to beat normally, but the ventricles no longer discharged their blood, and soon, in consequence of the palsy of the heart, general death set in. This instantaneous death of the heart through a prick in a particular part of the septum—the stoppage thereby produced of each coordinate contraction of the muscles of the heart—was up to the present wholly without analogy. What approached nearest to this fact was the well-known phenomenon that a compression of the coronary artery produced in a short time a cessation of pulsation and fibrillar convulsions. On withdrawing the compression, however, the pulsations of the ventricle were resumed. In the case of a prick, on the other hand, the effect followed altogether much more quickly, quite instantaneously in fact, and the ventricles, not able again to discharge their functions normally, were for ever motionless. This phenomenon Prof. Kronecker explained in the following manner. By the prick of the needle a coordinating centre in the movements of the ventricles of the heart, having its seat at the spot in question in the septum, was touched and destroyed. The finding of this centre afforded the physiological key to the riddle not unknown in surgery, that many very slight heart-wounds, pricks of needles, for example, which did not even penetrate, produced sudden death. It was now the task of anatomical investigation to demonstrate the existence of this centre now experimentally proved to exist. Prof. Kronecker and Herr Schmey have demonstrated this important experiment to the satisfaction of the Society.

VIENNA

Imperial Academy of Sciences, January 17.—M. Tüllig, on a new mode of telephonic transmission of sound (sealed packet).—J. Kachler and F. V. Spitzer, on Jackson's and Menke's method of preparing borneol from camphor.

January 31.—W. Biedermann, contributions to general nerve and muscle physiology (xiv. communication), on the heart of *Helix pomatia*.—G. von Niessl, on the astronomical relations at the meteoric fall of Mocs (Transylvania) on February 3, 1882. —L. Koller, on some general laws relating to knot-combinations.—A. Lustig, on the degeneration of the olfactory epithelium of rabbit after destruction of the olfactory lobes.—F. Zehden, attempt to explain the sunspots.—J. Hann, on the results of the meteorological observations made by Major von Machow at Pungo Andongo and Malunge in the interior of tropical South-West Africa in the years 1879-80.

February 7.—J. Odstrzil, on the mechanism of gravitation and inertia.—R. Benedikt and K. Hazura, on morin.—E. Goldstein, on the influence of conducting surfaces within the second stratum of the kathode light of Geissler's tubes.—S. Exner, on the innervation of the larynx.

February 14.—E. Hering, contributions to general nerve and muscle physiology (xv. communication), on the positive after-variation (*Nachschwankung*) of the nerve-current after electrical stimulation.—J. Klemencic, researches on the relation between electrostatic and electromagnetic measure.—F. von Hochstetter, seventh report of the Prehistoric Commission on its work during the year 1883.—R. von Wettstein, on the laws of growth of plant organs.

March 6.—J. Singer, contribution to a knowledge of the motor functions of the lumbar cord of the pigeon.—J. Redtenbacher, synopsis of the larvæ of Myrmeleoideæ.—J. H. List, on calyx-cells in the vesicle epithelium of the frog.—K. Zalkowsky, on coloured combinations of phenol with aromatic aldehydes.—F. von Hochstetter, reports of the Prehistoric Commission on the researches carried out in Moravia by J. Szombathy and W. Müller.—E. von Marenzeller, contribution to a knowledge of Adriatic annelids (iii. paper).—V. von Ebner, on the planes of solution of calcareous spar and aragonite.—H. Pitsch, on the value of Fermat's rule for the propagation of light in double refracting media.—Von Barth and M. Kretschy, on picrotoxin.—J. Herzig, studies on quercetin and its derivatives. —E. Häckel, gramina nova, vel minus nota.—A. Rosoll, contributions to the histochemistry of plants.—A. Adamkiewicz, on new stainings of the spinal cord.—F. K. Ginzel, researches on eclipses, especially on ascertaining empiric corrections of the orbit of the moon.

March 13.—E. Hering, contributions to general nerve and muscle physiology (xvi. communication), on the variations of nerve-current caused by unipolar stimulation in tetanisation.—C. Puschl, on the second axiom of mechanical theory of heat and on the behaviour of water.—K. Olzewski, on the liquefaction of hydrogen.—On the density of liquid oxygen, by the same.—On the point of solidification of some gases and liquids, by the same.—G. Adler, on the energy in the electrostatic field.—C. Goldstein, on the passing of electricity through vacua.

CONTENTS

THURSDAY, APRIL 10, 1884

STOKES ON LIGHT

Burnett Lectures. On Light. First Course, On the Nature of Light. By G. G. Stokes. (London: Macmillan, 1884.)

BYRON once wrote about a work of art:—

> "What nature could, but would not, do,
> And beauty and Canova can."

A dozen, or more, years ago, the scientific world was excited by the announcement that a treatise on *Light* was to be published by Prof. Stokes, as a companion volume to Clerk-Maxwell's remarkable *Theory of Heat.* The announcement was, however, ultimately withdrawn. Nature could, but would not, do it.

But Beauty and Canova, in the form of a Conservative Government and its *Endowed Institutions (Scotland) Act* of six years ago, did it:—and we now have, as a result, the first of a series of three volumes by Prof. Stokes!

The Burnett foundation, now about a century old, was essentially of a Teleological character. It had been applied, in accordance with the Founder's will, at intervals of 40 years, to the award of prizes for Essays:—the competition being perfectly open. Those who know what Teleology was, half-a-century ago or more:—even at its very best, as in the once-celebrated *Bridgewater Treatises*:—will probably be of opinion that the Commissioners, under the Act referred to, did real good by their modification of the terms of the Burnett Endowment.

True:—it is still possible that the Trustees may some day appoint to the Burnett Lectureship a rabid Teleologist of the old school. Even this might be defended on the ground of even-handed justice; though an ill-informed, but zealous, champion of such a cause is probably more dangerous to it than is a declared enemy. But the appointment of Prof. Stokes, as the first holder of the new office, augurs well for the future. Beside his scientific qualifications, he is possessed of that calm, judicial, mind which is absolutely required in so delicate a position:—where, indeed, to say too little might involve the charge of luke-warmness, if not of positive unbelief; while to say too much would display that presumption which is usually characteristic of ignorance.

As the title of the work implies, the subject is the nature and extent of the present evidence in favour of the Undulatory Theory of Light. The reader is supposed to have an elementary acquaintance with the simpler facts of geometrical optics, nothing further. Hence the work is, in the true sense, a popular one; suited to any reader of average intelligence and information. The language is simple and, as far as possible, devoid of technicalities:—while it "goes without saying" that the author does not condescendingly patronise the assumed weakness of his reader, nor does he anywhere attempt to escape from a difficulty by the use of mysterious or indefinite expressions.

As the book will, undoubtedly, find its way into the hands of every one who desires to see an important and difficult subject brought by a Master to the level of the understanding of any ordinary reader, we will content ourselves with a few selections. These have been made on a very catholic principle, some to exhibit novelties of matter or treatment, some for their historical bearing, and one to show how the special difficulty of the Lecturer's position has, so far, been met.

First, we have the two rival theories of Light compared, with the chief arguments for and against each:—

"*Primâ facie* there is much to be said in favour of the theory of emission. It lends itself at once to the explanation of the rectilinear propagation of light, and the existence of rays and shadows. It falls in at once with the law of aberration. The laws of reflection and refraction admit of an easy explanation in accordance with it; at least if we accept the existence of both reflection and refraction; for according to this theory we should rather have expected beforehand that light would have been *either* reflected or refracted, according to circumstances, not that incident light should have been *divided* into a portion reflected and a portion refracted.

"The theory of undulations on the other hand presents at the outset considerable difficulties. In the first place it requires us to suppose that the interplanetary and interstellar spaces are not, strictly speaking, a vacuum but a plenum; that though destitute of *ponderable* matter they are filled with a substance of some kind, constituting what we call a *medium*, or vehicle of transmission of the supposed undulations. When I speak of this medium as a substance, or as material, I mean that it must possess that distinctive property of matter, inertia; that is to say, a finite time must be required to generate in a finite portion of it a finite velocity."

Then the special difficulty which made Newton abandon the wave-theory:—

"The necessity of assuming the existence of some kind of substance in what we commonly speak of as a vacuum, does not appear to have been a serious preliminary difficulty in the way of the reception of the theory of undulations. A far more formidable difficulty appeared at first to be presented by the existence of rays and shadows. It was this that led Newton to adopt the theory of emission, though even he was led in the course of his researches on light to suppose that there was some sort of medium through which the particles of light moved, and in which they were capable in certain cases of exciting a sort of undulation. But the supposition of particles darted forth seemed to him necessary to account for shadows."

How, mainly by the marvellous insight of Young, this difficulty has been, not merely got over but, converted into one of the strongest arguments in favour of the Undulatory Theory:—

"There is no difference of explanation as regards light and as regards sound, save what depends on the difference of scale entailed by the difference of wave-length. Take as regards light the case of a small circular hole, say the tenth of an inch in diameter, and of distances from the luminous point to the screen in which the hole is pierced, and from that again to the screen on which the light is received, of say 8 feet 4 inches, or 100 inches, each. In this case, regarding the luminous patch on the screen as a whole, there would be no great diffusion of light, but the phenomena of diffraction would nevertheless be fairly pronounced. There ought to be a corresponding case of diffraction for sound; but on what scale? Take 50 inches as the length of a wave of sound, which would correspond to a musical note of moderate pitch. Taking as before the 1/50000 part of an inch as the wave-length for light, the length of the wave of sound will be two-and-a-half million times as great as the wave-length of light. Consequently to obtain the corresponding case of diffraction for sound, our 'small' circular hole would be obliged to have a diameter of rather more than four miles, say four miles, and the distances from the source of sound to the hole through which it passes, and from that again to the place where the sound is listened to, would have to be 4000 miles each.

"It is remarkable that the existence of rays, which formed the great stumbling-block in the way of the early reception of the theory of undulations, is now shown to belong to a class of phenomena, those of diffraction, the complete and marvellously simple explanation of which afforded by the theory of undulations now forms one of the great strongholds of that theory."

In connection with the Lecture on the *Senses*, by Sir W. Thomson, which has recently appeared in NATURE (vol. xxix. pp. 438, 462) we may take the following passage. [At the same time it may be well to remark, in passing, that Sir W. Thomson omits altogether the Sense of *Rotation*, which seems to be fully established by the researches of Crum Brown, De Cyon, Flourens, Mach, &c. He also distinguishes between the Senses of Touch and of Heat, making the so-called Muscular Sense a case of the former; while it seems more probable that Touch and Heat are the same sense, and the Muscular sense an independent one.]

"As regards the mode of perception, while there are analogies between sound and light there are at the same time notable differences. In sound, the tympanum of the ear is thrown mechanically into vibration, and the nerves of hearing are mechanically affected, as a mechanical disturbance of a point on the surface of the body is made known by the sense of touch. But in light, just as we have seen reason to believe that it is the disturbance of the ultimate molecules, or of their constituent parts, by which the vibratory motion which constitutes light is in the first instance communicated from ponderable matter to the ether, so we have reason to think that when light is absorbed what takes place is that the disturbance of the ether is communicated, not to portions of matter regarded as forming portions of a continuous elastic body, but to the ultimate molecules of which matter consists, or to their constituent parts. It may be that temporary chemical changes are thereby produced in the ultimate filaments of the nerves of the retina, in which case the sense of sight would be more analogous to the sense of taste than to that of touch."

As a specimen of the firm, yet cautious, way in which the Lecturer meets the grand difficulty of his position, take the following :—

"In studying this subject, one can hardly fail to be struck with the combination of these two things :—the importance of the ends, the simplicity of the means. When I say the importance of the ends, I use a form of expression which is commonly employed as expressing design. And yet on that very account we must be on our guard against too narrow a view. When we consider the subject of vision in its entirety, the construction of the recipient organ as well as the properties of the external agent which affects it, the evidence of design is such, it seems to me, as must to most minds be irresistible. Yet if I may judge of other men's minds by my own, it is rather in the construction of the recipient organ than in the properties of the agent that affects it that the evidence of design is so strongly perceived. And the reason of this may be that we are here dealing with what more nearly resembles design as we know it in ourselves. Man takes the laws of matter as he finds them; the laws of cohesion, of the conversion of liquid into vapour, of the elasticity of gases and vapours, and so forth; and in subserviency to those laws he constructs a machine, a steam-engine for instance, or whatever it may be; but over the laws themselves he has absolutely no control. Now when we contemplate the structure of the eye we think of it as an organ performing its functions in subserviency to laws definitely laid down, relating to the agent that acts upon it, laws which are not to be interfered with. We can, it is true, go but a little way towards explaining how it is that through the intervention of the eye the external agent acts upon the mind. Still, there are *some* steps of the process which we *are* able to follow, and these are sufficient to impress us strongly with the idea of design. The eye is a highly specialised organ, admirably adapted for the important function which it fulfils, but, so far as we can see, of no other use; and this very specialisation tends to make the evidence of design simpler and more apparent. But when we come to the properties of the external agent which affects the eye, we begin to get out of our depth. These more nearly resemble those ultimate laws of matter over which man has no control; and to say that they were designed for certain important objects which we perceive to be accomplished in subserviency to them, seems to savour of presumption. It is but a limited insight that we can get into the system of nature; and to take the very case of the luminiferous ether, while as its name implies it is all-important as regards vision, the present state of science enables us to say that it serves for one object of still more vital importance; we seem to touch upon another; and there may be others again of which we have no idea."

At the end of the work we are told that the two volumes, which are to follow this, are to deal with

II. *Researches in which Light has been used as a means of investigation*, and

III. *Light, considered in relation to its beneficial effects.*

The former of these we may hope to have in a year from the present time; for the final volume we must wait a year longer. But in the meantime let us be thankful for the first instalment, which is a masterpiece of simplicity and strength; and be grateful to the Commission, and the Trustees, to whom we are so very directly indebted for it. And, above all, let us lay to heart the valuable lesson which the Author has drawn from the story of the two rival theories of Light, and of their chief supporters, a lesson good for all time :—

"It may be said, If the former theory is nowadays exploded, why dwell on it at all? Yet surely the subject is of more than purely historical interest. It teaches lessons for our future guidance in the pursuit of truth. It shows that we are not to expect to evolve the system of nature out of the depths of our inner consciousness, but to follow the painstaking inductive method of studying the phenomena presented to us, and be content gradually to learn new laws and properties of natural objects. It shows that we are not to be disheartened by some preliminary difficulties from giving a patient hearing to a hypothesis of fair promise, assuming of course that those difficulties are not of the nature of contradictions between the results of observation or experiment and conclusions certainly deducible from the hypothesis on trial. It shows that we are not to attach undue importance to great names, but to investigate in an unbiased manner the facts which lie open to our examination."

On this it would be impertinent to make any farther comment. P. G. TAIT

OUR BOOK SHELF

Absolute Measurements in Electricity and Magnetism. By Andrew Gray, M.A., F.R.S.E. (London: Macmillan and Co., 1884).

THIS book, which is mainly a reprint of a series of papers on absolute measurement of electric currents and potentials which appeared in these columns a short time ago, but with some additional matter, must, from the clear explanation of the principles involved in the different methods of measurement, take a high position as an educational work, and, from the care with which details of manipulation are in many parts described, form a valuable laboratory guide.

The author begins by explaining Gauss's method of finding the horizontal intensity of the earth's magnetism. Instead of describing an "instrument-maker's" magnetometer, and showing how with this expensive luxury *H* may be determined, he gives simple, clear, and full directions for constructing, with such common materials as are to be found in any laboratory, all that is necessary for making this determination with great accuracy.

A description of the tangent galvanometer in some of its forms and an explanation of some of the units naturally follow. Here, by treating each unit separately with many illustrations depending on the aspect from which they are viewed, the author has succeeded in giving them a reality which students often find it difficult to believe they possess.

The next two chapters are devoted to a description of the construction and graduation of Sir W. Thomson's "Graded Galvanometers." These instruments possess so great a range, and are, when used carefully in the laboratory, so accurate and convenient, though rather delicate for an engine-room, that an exact description from head-quarters of their construction, of the precautions which must be observed in their use, and of the means of graduating them is especially valuable.

The various methods employed in measuring any resistance from that of a thick copper rod to that of a piece of gutta-percha are given, and in many cases explained by numerical examples.

The methods by which the energy due to direct or to alternating currents may be measured is explained—in the latter case on the assumption that the current strength varies harmonically with the time.

The chapter on the measurement of intense magnetic fields is especially interesting, for the methods given, depending on the use of suspended bits of wire attached by threads to pendulum weights, or equally simple and easily contrived devices, show how the experimenter may in many cases be independent of the elaborate work of the instrument-maker. C. V. B.

Field and Garden Crops of the North-Western Provinces and Oudh. By J. F. Duthie, B.A. F.L.S., Superintendent of the Saharanpur Botanical Gardens, and J. B. Fuller, Director of Agriculture, Central Provinces. Part 2. With Illustrations.

As a work of reference it will be very valuable, for it contains well-arranged details of some of the more important crops under cultivation, and the information is well and systematically arranged. Care has been taken in each case to secure a complete but still a concise statement, which is sufficient to guide the cultivator in all the specialities of management necessary to secure successful results. A good drawing illustrates each crop treated of, and its several cultivated varieties, and with these we have carefully-prepared descriptions of each plant in succession, and its general history. The districts within which the cultivation can be successfully extended are also set forth with great clearness and precision. For accuracy of details, in a very accessible form, this work leaves little to be desired.

A Treatise on Higher Trigonometry. By the Rev. J. B. Lock. (Macmillan, 1884.)

This is the promised complement to the same writer's "Treatise on Elementary Trigonometry," which we noticed very favourably in these pages at the time of its appearance (vol. xxvi. p. 124). It is concerned principally with series, the errors which arise in practical work, and the use of subsidiary angles in numerical calculations.

A short chapter on the use of imaginaries is justified by the position this subject holds in the London University Examinations, and no apology is needed for the space assigned to an account of, and a collection of exercises upon, the hyperbolic sine and cosine. We have read the text carefully, and though almost of necessity there are numerous typographical mistakes, only one or two (for $2a \cos 2\theta$, p. 127, line 3, read $a \cos 2\theta$) will inconvenience a student. In addition to the numerous examples in the text, there are fourteen specimen papers from Cambridge and other examinations.

The only article to which we take exception is § 9, the proof of which may be, if we mistake not, considerably simplified. The book can be confidently recommended to the use of advanced pupils in our schools, and will meet the wants of most students in our Universities.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Teaching Animals to Converse

You did me the honour some weeks ago (January 3, p. 216) to insert a letter of mine, containing suggestions as to a method of studying the psychology of animals, and a short account of a beginning I had myself made in that direction.

This letter has elicited various replies and suggestions which you will perhaps allow me to answer, and I may also take the opportunity of stating the progress which my dog "Van" has made, although, owing greatly no doubt to my frequent absences from home, and the little time I can devote to him, this has not been so rapid as I doubt not would otherwise have been the case. Perhaps I may just repeat that the essence of my idea was to have various words, such as "food," "bone," "water," "out," &c., printed on pieces of cardboard, and after some preliminary training, to give the dog anything for which he asked by bringing a card.

I use pieces of cardboard about 10 inches long and 3 inches high, placing a number of them on the floor side by side, so that the dog has several cards to select from, each bearing a different word.

One correspondent has suggested that it would be better to use variously coloured cards. This might no doubt render the first steps rather more easy, but, on the other hand, any temporary advantage gained would be at the expense of subsequent difficulty, since the pupil would very likely begin by associating the object with the colour rather than with the letters; he would, therefore, as is too often the case with our own children, have the unnecessary labour of unlearning some of his first lessons. At the same time the experiment would have an interest as a test of the condition of the colour-sense in dogs. Another suggestion has been that, instead of words, pictorial representations should be placed on the cards. This, however, could only be done with material objects, such as "food," "bone," "water," &c., and would not be applicable to such words as "out," "pet me," &c.; nor even as regards the former class do I see that it would present any substantial advantage.

Again, it has been suggested that "Van" is led by scent rather than by sight. He has no doubt an excellent nose, but in this case he is certainly guided by the eye. The cards are all handled by us, and must emit very nearly the same odour. I do not, however, rely on this, but have in use a number of cards bearing the same word. When, for instance, he has brought a card with "food" on it, we do not put down the same identical card, but another with the same word; when he has brought that, a third is put down, and so on. For a single meal, therefore, eight or ten cards will have been used, and it seems clear, therefore, that in selecting them "Van" must be guided by the letters.

When I last wrote I had satisfied myself that he had learnt to regard the bringing of a card as a request, and that he could distinguish a card with the word "food" on it from a plain one, while I believed that he could distinguish between a card with "food" on it, and one with "out" on it. I have no doubt that he can distinguish between different words. For instance, when he is hungry he will bring a "food" card time after time until he has had enough, and then he lies down quietly for a nap. Again, when I am going for a walk and invite him to come, he gladly responds by picking up the "out" card and running triumphantly with it before me to the front door. In the same way he knows the "bone" card quite well. As regards water (which I spell phonetically so as not to confuse him unnecessarily), I keep a card always on the floor in my dressing-room, and whenever he is thirsty he goes off there, without any suggestion from me, and brings the card with perfect gravity. At the same time he is fond of a game, and if he is playful or excited will occasionally run about with any card. If through inadvertence he brings a card for something he does not want, when the corresponding object is shown him he seizes the card, takes it back again, and fetches the right one.

No one who has seen him look along a row of cards and select the right one can, I think, doubt that in bringing a card he feels that he is making a request, and that he can not only perfectly distinguish between one word and another, but also associate the word and the object.

I do not for a moment say that "Van" thus shows more intelligence than has been recorded in the case of other dogs; that is not my point, but it does seem to me that this method of instruction opens out a means by which dogs and other animals may be enabled to communicate with us more satisfactorily than hitherto.

I am still continuing my observations, and am now considering the best mode of testing him in very simple arithmetic, but I wish I could induce others to cooperate, for I feel satisfied that the system would well repay more time and attention than I am myself able to give. JOHN LUBBOCK

High Elms, Down, Kent

"The Unity of Nature"

I REGRET that the Duke of Argyll should have been led by anything that I have written to make some of the remarks which appear in this week's issue of NATURE (p. 524). If a reviewer in a signed review cannot express freely his opinion upon a book without its being suggested that he is actuated by secondary and sinister motives, I fancy that few men of common honesty would care to continue the work of reviewing. Moreover, in the present instance the imputation of animus seems to me specially unjustifiable. I had almost forgotten the correspondence in NATURE to which the Duke alludes, but on now referring to it again I can only see that, if it was provocative of animus, there was assuredly no reason for the animus to have arisen on my side (see NATURE, vol. xxiv. pp. 581 and 604; vol. xxv. pp. 6 and 29). But, to ignore so unworthy a charge, and one which I can only suppose to have been made under a sense of irritation, I must explain that the Duke is under a wrong impression when he assumes that my objection to his advocacy of Theistic belief is due to what he regards as my aversion to Theism. As I have never been in the habit of "using your columns for the purpose of inculcating personal beliefs and disbeliefs on subjects which lie outside the boundaries of physical science," I shall not do so now. But in view of the slender grounds on which the Duke has felt himself entitled to infer that I "hold that the highest aim of the human intellect is to prove the mindlessness of nature," I feel it is desirable to correct the inference. For this purpose it is not needful that I should publish my "personal beliefs and disbeliefs." It is only needful to say that my previous remarks will be found to have been directed, not against the cause of Theism, but against its champion in the Duke of Argyll. Had my sympathies been more on the side of the materialists than they happen to be, the Duke of Argyll might not have found so much reason to quarrel with my "dislike" of his advocacy.

I may now turn to the Duke's remarks on those of my criticisms which he deems legitimate. Taking first the case of rudimentary organs, I quite agree with the statement that the question whether any particular structure now dissociated from use is to be regarded as "on the stocks or on the wane" is "a question of evidence from associated facts." Therefore it was that I said in my review that no illustration could be more unfortunate than the one which was chosen by the Duke as an example of rudimentary structures possibly on the stocks. For if the rudimentary organs which occur in the Cetacea admit of being supposed of doubtful interpretation in this matter, it is clear that in no case could the "evidence from associated facts" of structure and affinity be of any value. But in reality this evidence is nearly always so cogent that the difficulty suggested by the Duke is of a purely imaginary kind: evolutionists have no need ever to be puzzled in deciding whether a given structure is on the stocks or on the wane. Thus, for instance, let us take the cases which are adduced by the Duke himself. No evolutionist could be insane enough to imagine that the papillæ on the roof of the mouth of the giraffe are the remnants of whalebone, seeing that the whole structure and all the affinities of the animal are opposed to the inference that its ancestors were aquatic mammalia. Or, if we take the case of webbed feet, even if the dipper had begun to develop them, no evolutionist in his senses would infer that these incipient structures were remnants of structures once more fully developed, seeing that all the other structures and affinities of the bird prove that it belongs to a non-aquatic family. Cases of this kind actually occur in such birds as the grebe and the coot, where even apart from structure and affinity it is easy to see that the little piece of web must be regarded as a growing and not a dwindling organ, seeing that the birds are so strongly aquatic in their habits.

Considering next the Duke's remarks on instinct, I did not attempt to deal with the argument to which he refers, because I could not perceive that there was any argument to be dealt with. His view is a mere assumption to the effect that instincts are divinely implanted intuitions independent of experience; and to deny that experience, *in successive generations*, is the source of instinct is not to meet, by way of argument, the enormous mass of evidence which goes to prove that such is the case. Even within the limits of my review I should have thought there was evidence enough to have disposed of this denial.

As for the special case of the dipper, I only mentioned it in my review because the Duke lays great stress upon it in his book. No doubt better cases occur of newly-acquired instincts not yet associated with correlated structures, and in all such cases (whether good, bad, or indifferent), it is not a *non sequitur* mode of argument to say that, on the theory of the transmutation of instincts, the appropriate organs have not been developed, because, looking to the affinities of the animal, we are entitled to infer that time enough has not yet been allowed for their development. Again, I deny that it is for me, or for any other evolutionist, to prove that the ancestors of the dipper did not present those lesser modifications of structure which, according to the Duke, are now correlated with the aquatic instincts.[1] By "proof" he no doubt means the display of the ancestral form, and not the study of allied species. Proof of this kind is not attainable, but neither is it required. The question whether instincts are fixed intuitions or admit of being modified by accumulative experience with natural selection—*i.e.* whether they are or are not subject to evolution—is a question that does not require to be settled on the narrow basis of any one particular case. And if we take a broad view of all the instincts known to us, the combined weight of their testimony to the fact of transmutation is simply overwhelming.

London, April 4 GEORGE J. ROMANES

The Remarkable Sunsets

THE remarkable *red sunsets* and after-glows, about which so much has been written of late, still continue here, but in a less intense form. A remarkable one occurred last night, and while watching it I determined to send you a brief account of my experiences in the matter. It is of little use going into descriptions of the appearances which are now well known, but the one which occurred last evening was unusually fine. It was a stormy wild evening, with black clouds all around, except in the west, where, from about 10° above the horizon to near the zenith, it was quite clear, and of a pale orange glow. A quarter of an hour after sunset three immense rays through rifts in the cloud bank sprang up almost suddenly, and took quite an intense crimson lake colour, which lasted about ten minutes.

Our brightest displays occurred in October and November last, and frequently bathed the whole landscape in a deep

[1] I say "according to the Duke," because, according to Mr. Darwin, "in the case of the water-ouzel the acutest observer, by examining its dead body, would never have suspected its sub-aquatic habits" ("Origin of Species," 6th ed., p. 142).

crimson glow. These skies were often still more gorgeous in the morning, and on some occasions were so wonderful as to be styled *frightful* by some observers. I witnessed one of these sunrises from an altitude of 3000 feet in January, and it was almost an *awful* sight. The view to the east was over about thirty miles of plains to distant mountains; a low mist hung over the low ground, and the surface appeared slightly rolling as seen from above. The sky half an hour before sunrise was so intensely red, almost to the zenith, that it gave this mist the appearance of a sea of blood. Every object, tree-trunks, fern-trees, bushes, rocks, and the cottages about the hills, was of a similar lurid colour; still there was not yet sufficient light to read by comfortably. This display reminded me of the wonderfully red aurora witnessed in Australia on April 5, 1870, when the red light was so intense that ordinary newspaper type could be read by it at ten o'clock on a moonless night, the type appearing as if set in a blood-red sheet. This was the first time I recorded the *red spectrum line* of the aurora, and I think was one of the earliest observations of this fact.

Some of the recent sunsets have looked very much like an aurora in the west, and faint traces of stratification lent additional similarity; indeed on one night early in December, the *after-glow* merged into a beautiful aurora, and silver streamers were seen before all the red glow had disappeared.

From all over Australia reports of wonderful sunsets and sunrises have been sent to me. In one case the *red glow* was reported as margined by an immense *black bow* stretching across from north-west to south-west. On several occasions these glows prolonged the twilight considerably, and a correspondent at Urana, in New South Wales, described one occasion where approaching darkness after one of these sunsets at length compelled him to leave off watering his garden, but suddenly the light increased again sufficiently to induce him to resume his work; and he states that a similar accession of light—each time fainter—occurred on that same evening.

The season over the south of Australia especially, but all over the continent, has been remarkable, and, so far as this colony is concerned, unprecedented in my thirty-three years' knowledge of the climate. January, February, and March are usually our dry, hot months; this year they have been wet and cold ones. The average rainfall for January has been 1·60 inches; this year it was 4·75 inches. For February the average is 1·95 inches, and up to this date (the 27th) it has been also 1·95 inches. The mean temperature for January was 3°·5 below the average, and for February 2° below. Stormy, squally, wintry weather has predominated, with now and then a very hot or a tropical day for a change.

Even before the Krakatoa outburst the northern parts of Tasmania had become subject to prolonged *earth tremors*, with now and then a decided earthquake shock. These disturbances still continue, and appear to be extending northwards, for on the 15th of this month a shock was felt at Gabo Island, at the south-east extremity of Australia, and a very severe one again on the 17th, when a curious and sudden barometric disturbance, not unlike that at the time of the Java catastrophe, was shown on our barographs.

While on this subject it may be as well to state that Mr. Barrachi, one of my assistants, while at Port Darwin determining the difference of longitude between that place and Singapore in March 1883, saw sunsets, followed by after-glows, which prolonged the usual short twilights to a very considerable extent, and he states they were equally remarkable with those witnessed here. They only occurred either just before or just after very heavy rains.

Referring to the various hypotheses which have found their way into print explanatory of the unusual phenomena attending sunrise and sunset since August 1883, the belief that they have been in some way brought about by the Krakatoa eruption appears to be generally accepted, and while some doubt may be thrown on this assumption by records of equally remarkable chromatic effects at both sunrise and sunset and about the sun at other times of the day prior to the eruption, it must be admitted at present that the volcanic eruption has strong claims to credence.

There can be no doubt that, whatever the prime cause, the effects are due to the presence in the higher regions of our atmosphere of a *form of matter* not usually there, at least to such an extent. Now this matter, or *form of matter*, may, as far as we know, be due to Krakatoa, to the earth's orbit traversing streams or regions pervaded with extremely fine meteoric dust, or to any other cause that might either introduce new or alter the form of existing matter.

It is well known in the laboratory that certain chemical combinations and mechanical mixtures will exist as such, but in a most unstable form,—a concussion or sharp sound, an electric spark, &c., either breaks them up or brings about a change of form so as to present altogether different physical properties. Now it is also well known that at the time of the Krakatoa eruption barometric pressure was spasmodically affected all over the world. Everywhere where barographs have been recorded this fact appears. This atmospheric shudder, undoubtedly originating at Krakatoa, was, I have reason to believe, conveyed rapidly from the centre through the higher and more tenuous regions of atmosphere, but affected the lower strata in its passage. This would perhaps account for the immense distance—thousands of miles—over which, it has been widely reported, explosions were heard about the time of the occurrence of the outburst.

Now if we assume that on the peripheral regions of our atmosphere *gases* and *forms of matter* exist in not very stable combinations or mixtures, it requires no great stretch of our imagination to picture the result of this great atmospheric shudder bringing about an alteration in the form or proportion of matter, and consequently such a change in its optical properties as to produce the unusual and remarkable effects which have been so universal. ROBT. J. ELLERY

Melbourne Observatory, February 27

UNDER date of January 14 I named the bark *C. Southard Hurlburt* as having observed the glow on September 3. She was dismasted in a cyclone August 8, and came to Honolulu for repairs. On the former date she was in about lat. 17° N., long. 125° W. The captain's wife, Mrs. Davis, described the phenomena to me as extremely brilliant.

Only last week I learned from Hon. H. M. Whitney, Postmaster-General, that on September 5 Mrs. Whitney and himself distinctly observed the sun's disk before setting to be *green*. His residence was an exception to most of ours in Honolulu, from which trees cut off a view of the horizon. My wife spoke much that night of a strange green cumulus, seen by her ten minutes before calling me to observe the portentous masses of colour pouring out all over the sky.

I beg special attention to my former remark of the "earth-shadow sharply cutting off" the upper rim of the first glow. This was very manifest in the strong heavy glows of September, showing clearly that the first glow directly reflected the sun's rays, while in the after-glow which had no defined upper rim, but continued much longer, the haze reflects only the light of the first glow. This bears on estimates of the height of the haze.

Observers here are well agreed that during November there was a very great abatement of the glows, amounting almost to a cessation, although the whitish corona was always well developed through the day. Early in December the glows were renewed, and for six weeks continued quite as brilliant as during October. They are now somewhat abated, although quite uniform nightly. In September and October they were extremely unequal, as well as varying in position of greater colour, south or north of west.

As this revival of our glows closely followed their general diffusion over Europe and the United States, I suggest that this was the arrival in force by slow marches of the main body constituting the great *cone* of vapours, which, falling into the atmosphere in September, covered like a pall the Indian Ocean and Peninsula, down the extended western slope of which cone the light upper vapours were sent by the westward thrust of the earth's rotation, to find speed in their downward slide to carry them at once around the tropical belt as a light advance guard (as set forth in my letter of January 14). As the September haze became gradually dissipated, so the later December arrivals are wasting away. S. E. BISHOP

Honolulu, January 30

AT Fanning's Island, long. 159° 22′ W., lat. 3° 52′ N., on September 4 last, the proprietor, Mr. Greig, states that the sun and sky had an extraordinary appearance; the sun "looked like a copper kettle." Lurid colours covered the sky. Great fears were felt for the safety of his schooner, the *Jennie Walker*, which sailed three days before.

From the master of the *Jennie Walker* I learn that on September 4 he was in long. 155° 28′ W., lat. 8° 20′ N., sailed from Fanning's Island three days before. At 5 p.m. noticed strange appearance in the sun, which was greenish. Strange colours over the west and around the sky at sunset. The sun was green at setting. Thought bad weather was portended. Never saw such appearances before.

Both parties are positive that the schooner was *three* days out when their fears were thus excited. She sailed September 1. No entry in ship's log of the above phenomena.

Honolulu, February 20 S. E. Bishop

ANOTHER note relative to these phenomena:—"*August* 20, 1861.—Earthquake at Naples. At Castellamare the water is so discoloured, that although the calm has been complete, we fear some subterranean perturbation. The heat is intense. At the same time the atmosphere presented a very peculiar appearance. There are no clouds, and during the whole week a thick mist has enveloped the city and coast, and *the sun when setting is as red as blood*."—(*Moniteur* du 29 Août, 1861.)

J. P. O'Reilly

Royal College of Science for Ireland,
Stephen's Green, Dublin

Meteorological Bibliography

I REJOICE to see the well-earned tribute which you have paid to Dr. Hellmann's excellent "Repertorium der Deutschen Meteorologie," and as a worker in the same field I trust that you will permit me to add that I agree with every word which your reviewer has said as to its excellence.

My object in writing is merely to point out that, thanks to the liberality of the United States Government, we may hope soon to have, not a perfect catalogue, but one which will be extremely useful, especially if, as I hope, the United States Government adopt my suggestion and endeavour to arrange with Dr. Hellmann for the incorporation of the first part of his "Repertorium" with the materials already forwarded to them.

Your reviewer is perfectly right in urging the absolute necessity of steps being taken to index and classify the multitudinous publications now appearing. Dr. Hellmann in his "Repertorium" says that 800 publications upon meteorology appear annually, or more than two each day, hence the impossibility of any one keeping abreast of the entire literature.

As regards the catalogue which I had the pleasure of sending to the United States last autumn, I annex an abstract of the description which I gave at the Southport meeting of the British Association in case you may think it of sufficient importance to be worthy of a place in NATURE. Dr. Hellmann's "Repertorium" only reached me just before my catalogue was shipped, hence the absence of reference to it in the annexed paper.

62, Camden Square, N.W., April 4 G. J. Symons

On the Completion of the European Portion of the Preliminary Meteorological Catalogue, by G. J. Symons

The author commenced by giving a few illustrations of the large amount of time and energy which has been wasted by meteorologists, owing to their not knowing what had previously been done, sometimes even in their own country, but most frequently in other parts of the world; and he pointed out that with the modern development of meteorological work and of meteorological literature, some effort, upon a large scale, to deal with this evil was imperatively necessary.

Mr. Symons described the catalogue which he had formed during the last twenty or twenty-five years, by extracting (from many thousand catalogues issued by dealers in second-hand books in most of the capitals of Europe) all the titles of works on meteorology or kindred subjects. He also described the important publication, by the Royal Society, of its "Catalogue of Scientific Papers," and showed wherein the two agreed, and how largely each supplemented deficiencies in the other.

He then explained the steps which Prof. Cleveland Abbe had taken in preparing his card catalogue, and the arrangements whereby a copy of Mr. Symons's catalogue was to be prepared and forwarded to the United States for incorporation with Prof. Abbe's.

Mr. Symons then stated the additions which had been made to the original proposal, and that the following catalogues had been subsequently incorporated, each giving *approximately* the number of titles set against it, viz.:—

Prof. A. Poëy's	MS.	6000
Ronald's	Printed	3000
Struve's Pulkova	Printed	3000
Meteorological Society	MS. and printed ...	2000
Houzeau's Belgian	Printed	2000
Soc. Météor. de France ...	MS.	1500
Royal Observatory, Greenwich	MS.	500
Fineman's Swedish...	Printed	500
	Total about	18,500

Of course a great many of these were duplicates, but every catalogue contained titles which were not in any of the others, and altogether they have undoubtedly added very largely to the value of the work; it is impossible to state how largely, nor is it material in a case wherein the assistance rendered has been almost as great as the catalogue, and as diverse as the languages dealt with.

The precise number of titles forwarded is not known, but is probably about 20,000. Prof. Abbe's catalogue is understood to contain about 10,000, but probably there will be a few thousand common to both catalogues, and therefore the preliminary catalogue, which the United States Signal Office, under the direction of General Hazen, will proceed to prepare for publication, will probably contain the titles of more than 25,000 books and papers upon meteorology.

Mr. Symons remarked, in conclusion, that the catalogue must not be regarded as complete. It was impossible to make it perfect—it could not be perfect as regarded the past until every public and private library in the world had been searched. It could not be perfect for the present, because every day new works appeared in different parts of the world, and all could not be simultaneously inserted. Nor would his part of it bear bibliographical criticism, for he was not a bibliographical expert, and his chief aim had been to give information useful to working meteorologists.

Ice Volcanoes—Mountain Rainbow

THE past winter has been unusually cold and stormy in Ontario, and, as a result, an uneven strip of ice 100 to 200 yards wide has accumulated along the lake shore, sometimes forming mounds twenty or thirty feet high. Many of these mounds are conical, and have a crater-like opening communicating with the water. In stormy weather every wave hurls a column of spray and ice fragments through the opening. The ejecta freeze fast as they fall, and add to the height of the cone. In high winds the coast seems fringed with miniature volcanoes in active eruption. After a time the crater becomes clogged with ice, and the volcano may be looked on as extinct. Often a second crater is formed just to seaward of the first, and growing upon its ruins.

Mr. J. A. Fleming mentions in your issue for January 31 (p. 310) a circular rainbow seen from a hill-top against mist. I saw the same phenomenon three years ago near the Lofoden Islands, as a fog was breaking. It was noticed and admired by other passengers on the steamer also. Each saw his shadow enlarged upon the mist, and with the head surrounded by a brightly coloured halo or rainbow. The beautiful sight disappeared after a few minutes as the fog thickened again.

A. P. Colman

Faraday Hall, Victoria University, Cobourg, Canada

Thread-twisting

IN reply to "Cosmopolitan's" question in NATURE (vol. xxix. p. 525), I have been many years in Orkney, but do not remember to have seen the women twisting thread with "the palm of the hand on the thigh," but the fishermen there twist the short lengths of horsehair line called "snoods," which when united together form fishing lines of different strengths, in this manner.

The women of the North-American Indians always twist the short threads of sinew with which moccasins and leather clothes are sewn in this way: The sinew is torn up or divided into thin filaments slightly moistened by being drawn between the lips, then twisted between palm and thigh. J. Rae

Kensington, April 5

IN reply to "Cosmopolitan's" query as to the occurrence of the habit of thread-twisting with the palm of the hand on the thigh in other lands than India, I may say that I have observed the same mode of operating upon paper in Japan very frequently. The paper used there is tough and fibrous, and a Japanese is never at a loss for card to tie a parcel with if he has paper beside him. I have seen the spindle-whorl in actual use in upland districts, and it was employed even in Tokio very recently.

HENRY FAULDS

Laurel Bank, Shawlands, Glasgow, April 7

Colony of Cats

IT may interest those of your readers fond of cats to know that a colony of cats live and breed under the wooden platform of the Victoria Station of the District Railway. They may be seen crossing the rails right in front of trains, and considering the enormous traffic, and the consequent noise and vibration, it certainly does seem remarkable that such naturally timid animals as cats should live amidst such unnatural surroundings. It may tend to show the plasticity of the animal creation generally in adapting itself to surrounding conditions. A female cat may have taken refuge there originally, and hence the railway domestication of the animals.

GEORGE RAYLEIGH VICARS

London

Earthworms

SEEING the correspondence on this subject, I am led to give the following fact, which affords a further proof of the necessity of a vegetable deposit being formed previous to the existence of earthworms as stated by Mr. Melvin (vol. xxix. p. 502). A field two years ago was converted into a garden, and on account of bad cultivation, and by reason of each crop being altogether removed for several years in succession, no worms were there, but after the application of a large quantity of stable manure worms have appeared by hundreds, and their castings after rain afford ample proof of their activity. TRANSformation of vegetable mould combined with animal refuse into available food for plants is here made evident.

J. LOVELL

Driffield, April 7

"The Axioms of Geometry"

PROF. HENRICI, in NATURE, vol. xxix. p. 453, considers Hamilton's proof of Euclid I. 32 invalid; and asserts that from his reasoning it would follow that the sum of the three angles of a spherical triangle equals two right angles. I venture to differ from him for the following reason:—The only thing which Hamilton requires to be granted is that when a moving *straight* line slides along a *fixed* straight line its *direction* is unchanged. This axiom will, I suppose, be granted by every one. Of course it is not true that in every case rotation is independent of translation. But Hamilton's proof does not require it to be true in every case, but only in the case of a *straight* line. Hence I maintain that Hamilton's reasoning is perfectly correct, and his proof valid.

EDWARD GEOGHEGAN

Bardsea, March 26

GEOLOGY OF CENTRAL AFRICA

THE following extract from a letter received by Mr. Geikie from Mr. Henry Drummond, who is at present exploring the Lake region, may interest our readers:—

"*Maramoura, Central Africa, November* 1, 1883

"I have now completed a traverse from the mouth of the Zambesi, by way of the Shire highlands, in a northwest direction, until the line joins Mr. Joseph Thomson's route, about half way between Lakes Nyassa and Tanganyika. I have filled in the geology so far as is possible in a single survey, and hope thus to be able to extend the sketch geological map, begun by Thomson, for some distance south and west. I may still further extend this by an expedition to Lake Bangweolo, after the rainy season, but there are circumstances which may make it necessary for me to leave for home in February or March. Perhaps the most interesting thing I have to note is the discovery here of a small but rich bed of fossils. The strata alluded to consist of light coloured limestones and shales, with beds of fine gray sandstones, and the fossils include plant, fish, and molluscan remains. Plants are the most scarce, but fish-scales and teeth exist in vast numbers. Unfortunately whole fish are extremely rare, and after three or four days' search I have only succeeded in securing two or three indifferent specimens. The mollusks, on the other hand, are obtainable in endless quantity, and are in fine preservation. Indeed there is one small bed of limestone entirely made up of these remains, all, however, belonging to a single species. From the general character of the beds I am inclined to think they are of lacustrine origin. These fossiliferous beds are *the only sedimentary rocks* I have crossed between the mouth of the Shire—say 130 miles from the coast—and the centre of the Nyassa-Tanganyika plateau. At the point where I crossed them they are not more than a couple of miles in breadth, and are flanked on either side by granite and gneiss. They lie at a short distance from Lake Nyassa, and are probably part of the Mount Waller series. This series stretches for some short distance along the north-west shore of the lake, but is apparently of no great extent. These deposits may possibly throw some light on the problem of the lake.

"As regards the controversy between Mr. Thomson and Mr. Stewart about (1) the Livingstone Mountains, and (2) the bed of iron between the lakes, I should say that on both points both explorers are right from their own point of view.

"Mr. Stewart had only been dead a few days when I reached the north end of Nyassa. It was a great disappointment and blow to me, as I looked forward to much help from him. No one living possesses anything like his knowledge of the physical geography of this part of the interior."

CHINESE PALÆONTOLOGY

PALÆONTOLOGY is not a study that commends itself to the attention of Chinamen. With archæology the case is different. That is a pursuit which within historical limits the Chinese follow with enthusiasm. Every one who possesses any pretensions to culture, and who can afford to indulge the inclination, collects all that is old from cracked china to coins. So prevalent is this taste, and so keen is the competition for objects bearing the stamp of age, that a flourishing trade, such as rivals the celebrated traffic in "antiquities" carried on at Jerusalem, exists in fabricated antiques for the benefit of inexperienced native collectors and foreign purchasers. But natural antiquities are, speaking generally, left unnoticed, or if thought of for a moment are hastily explained by random conjectures. Topsy's celebrated explanation of her existence is about on a par with the guesses which are hazarded by the most learned Chinamen to account for palæontological phenomena. Science has always a borderland of unsolved questions, but in China this borderland exceeds in extent the territory of knowledge in the possession of the people. They have no aptitude for palæontology, and few writers make any reference to it. Among the rare exceptions to this rule is Ch'ên Kwah of the Sung Dynasty (A.D. 960-1127), who, in an interesting work entitled "Notes from a Dreamy Valley," has collected a number of facts on natural antiquities as well as on other matters. His knowledge is not deep, but when we remember that Voltaire accounted for the presence of marine shells on the top of the Alps by supposing that pilgrims in the Middle Ages had dropped them on their way to Rome, a great deal may be forgiven a Chinese writer of the eleventh century.

The Chinese have so completely lost sight of the possibility of the existence in China of any civilisation but their own that when they meet with traces of earlier man they attribute them either to blind chance or to supernatural causes. In this way when Ch'ên Kwah met in the course of his investigations with flint and bronze implements he at once adopted the common opinion of his countrymen, which is the same as that which was prevalent in Europe a couple of centuries ago, that they were thunderbolts shot down by the God of Thunder in the explosions of his wrath. In confirmation of this theory Ch'ên states that though these implements are found all over the country they are more plentiful in districts, such as Lui-chow in the province of Canton, where thunderstorms are more than usually prevalent. In shape, he tells us, they resemble axes, knives, small hammers several pounds in weight, skewers or nails, and other pointed implements. In colour they vary, some being yellow, some green, and some black. Some of the axe-shaped stones are bored with two holes, but the majority are not pierced, and implements of the same shape are found in bronze and iron.

Speaking within his own knowledge he only describes the circumstances of the discovery of two stone axes, both of which he tells us were found beneath trees. In one case, at Sin-chow, in Hupeh, after a severe thunderstorm in which, like Prospero, the God of Thunder had

"rifted Jove's stout oak,
With his own bolt,"

a stone axe was found at its roots; and on another occasion at Sui-chow, under precisely similar circumstances, a shepherd-lad found a "fire stone in the shape of an axe." As in the only two cases about which Ch'ên speaks from personal knowledge the axes were found beneath trees, it is not unnatural to suppose that they are more frequently found in that position than elsewhere; and this becomes interesting when we find it stated by Mr. Rivett Carnac in a valuable paper published in vol. lii. of the *Proceedings* of the Bengal Branch of the Royal Asiatic Society, that it is the custom in Central India for the finder of a stone axe or other stone implement to place it "under the village pipul tree," and sometimes to sanctify it with a daub of red paint, and thus to constitute it a Mahadeo. A somewhat similar practice exists, according to Chinese historians, in a country vaguely described as being to the west of the Yuh Pass in Chinese Turkestan, where "thunder stones" when found are deposited in the temples. May not this Indian practice have also been the custom of some of the aboriginal tribes of China? and may not the fact that in the two instances mentioned above the axes were found at the roots of riven trees be evidence of the antiquity of the custom, as in cases described by Mr. Rivett Carnac, in which the roots of the trees and the surrounding soil had in course of years so completely grown over the axes that they could only be cut and dug out with difficulty?

Stone arrow-heads do not seem to have come within Ch'ên's range of observation, although from historical references we know that they are to be met with in China. In the "Book of History," which is said to have been compiled by Confucius, mention is made of tribute, consisting of iron, silver, steel, and stone arrow heads, having been presented to the Chinese Court by the tribes on the Yellow River about the year 2200 B.C. The story is told also that on one occasion, as the Prince of Ch'ên (495 B.C.) was walking in the palace grounds, a bird fell dead at his feet, pierced through by a stone-headed arrow. As the kind of bird was unknown to the prince and his courtiers, Confucius was called in to give his opinion upon it. The bird he pronounced to be a species of sparrow-hawk from Northern Tartary, and he explained t at the stone head which pointed the dart was similar to that which Wu Wang (B.C. 1122) presented to his prince. It appears also that stone arrow-heads were used in ancient times as emblems of authority, and that they have very commonly been presented to sovereigns as objects of curiosity and value.

The biographical dictionaries tell us that in course of his official duties Ch'ên was called upon to direct extensive irrigating works; and no doubt the excavations and cuttings which he then superintended led him to take an interest in the fossil remains with which the country abounds. On this subject he has many notes. In one he tells us that at a certain spot on the Yellow River, the banks having fallen away for a considerable distance, a fossil bamboo grove was disclosed, a fact which excited his surprise, as the district is not one in which bamboos grow at the present day, and he contrasts with this the fossil peach-stones, roots of rushes, snakes and crabs, which are found at the Kin-hwa Mountain, all of which things are still indigenous in the neighbourhood. At Tsêh-chow in Shansi, he states, a man, when digging a well, suddenly unearthed a "lizard resembling a dragon." At sight of the monster the man fled in terror, but observing from a distance that it remained motionless, he ventured to return, when, to his relief, he found that it was petrified. Philistine-like, his neighbours broke it to pieces, and only one bit of it was preserved. Another kind of fossil has long been a puzzle to the philosophers, from the great and wise emperor, K'ang-hi (1661-1720), downwards. Adventurous travellers who have braved the northern frosts have from time to time brought back accounts of the mammoths which are found in the frozen cliffs of Siberia. Deceived by a mistaken analogy, the Chinese wiseacres have arrived at the conclusion that these monsters must be huge ivory-producing rats, and, misinterpreting their continued preservation, have formed the opinion that darkness is necessary to their life, and that exposure to the outer air produces instant death. Their ivory is considered to be softer than elephant ivory, and in the hands of skilful chemists their flesh is said to make up into a highly invigorating tonic.

Speaking of the neighbourhood of the Loh River, Ch'ên mentions the discovery of ancient Troglodyte dwellings in which were found coins, and in one case a stone chest bearing on the outside fine tracings of flowers, birds, and other objects. On the lid were inscribed upwards of twenty characters, which were of such an archaic form that they were undecipherable. But the contents were easily understood, and were at once recognised as pieces of pure gold.

Constant mention is made by Ch'ên of meteoric stones, which in popular imagination are said to assume various strange and uncanny forms. Of the descent of one such stone which fell in the province of Kiang-su in the year 1064, he gives certain particulars on the authority of a Mrs. Heu. This lady, when in her garden one day, was startled by an explosion like a peal of thunder, and saw a large "star nearly as big as the moon" pass across the sky from south-east to south-west, and eventually fall within a few yards of the place where she was standing. On going to the spot she observed a deep hole, at the bottom of which was the "star shining brightly." By degrees the light died away, and eventually at a depth of three feet she dug up a round stone of the size of a man's fist, and of the weight and appearance of iron. Altogether Ch'ên's work is well worthy of the study of those who can read Chinese and who are interested in the palæontology of China.

ROBERT K. DOUGLAS

ON THE FORMATION OF STARCH IN LEAVES

IN a recent communication to the *Arbeiten des botanisches Institut* in Würzburg (Bd. iii.), Prof. Sachs gives the results of his work during the past summer in connection with the above subject. The investigations were made with the object of determining the formation and disappearance of starch in the leaves of plants growing in the open, and under normal conditions of vegetation, and were carried on chiefly during the months of June, July, and August on a large number of Dicotyledons from various families. Some twenty-two years ago Prof. Sachs showed that the presence of starch in chlorophyll grains can readily be detected by means of the now well-known iodine test, a modification of which was employed in these researches.

If fresh green leaves are plunged into boiling water for ten minutes or so, certain soluble substances are extracted, but the starch and colouring matter of the chlorophyll grains remain in the still unbroken cells of the mesophyll. A short immersion in alcohol now removes the green colouring-matter and certain bodies soluble in alcohol, leaving the starch behind in the colourless tissue. The presence of acids affects the degree of whiteness of the decolorised leaf; and the decolorisation proceeds more rapidly in sunlight or warm alcohol than in the dark and cold. Leaves of *Tropæolum* may be rendered completely white, like writing paper, in two or three minutes.

If the decolorised leaf be now placed in a strong solution of iodine in alcohol, the presence or absence of starch may be demonstrated in a few minutes. If no starch is present, the cellular tissue simply presents the well-known yellow colour; if a large quantity of starch exists in the cells, the tissue appears blue-black, the venation appearing as a pale network in the dark ground. Paler colours result if but little starch is present at the time of the experiment.

It will readily be seen how useful the above method is for the purpose of demonstrating the absence of starch from etiolated leaves, the white portions of variegated foliage, &c., and the sequel shows that the method affords means of obtaining far more delicate results, without the trouble of a microscopic examination.

In the first place, the same leaf may be found to contain very different quantities of starch at different periods of the day, or according to the weather; and secondly, the increase and decrease of the quantities of starch in a given leaf may be very rapid.

Sachs showed long ago that if a plant is placed in the dark, the starch disappears from the leaves; and it has also been known for some time that if a piece of tinfoil is placed on a leaf, the covered portion forms no starch, although the parts exposed to light may become filled with that substance. Moreover, Kraus showed how very rapidly starch can be formed in direct sunlight.

Sachs now demonstrates on a number of plants that the starch formed in the leaves during the day may disappear completely during the night, and that the leaves shown to be full of starch in the evening may be quite empty of starch next morning. This depends upon the temperature and health of the plant, but occurs normally during the summer in plants growing in the open. A large number of experiments are given in support of this, and showing how the rapidity and completion of the process depends upon the weather.

The experimental proof is very simple. A leaf is halved longitudinally at night, after a fine sunny day, and the excised half is shown to be filled with starch by the iodine test described; the remaining half is tested early next morning, and shows at once if any material diminution has occurred during the night. A simple and obvious modification of this experiment gives an idea of the quantity of starch formed between sunrise and sunset. The half leaf tested before sunrise shows no trace of starch: the other half, left on the plant during the day, is found to become more and more filled with starch towards the afternoon.

Some curious results were arrived at as to the effect of growing parts on the rapidity of the emptying of the leaves; some of these matters still require investigation.

Differences in the weight of leaves and in the intensity of the colour produced by the iodine test, as well as some other observations, lead to a better understanding of a fact already known generally, viz. that the starch disappears from the leaves in the form of glucoses, which travel by way of the vascular bundles into the stems, and thus pass to the places where they are used up in growth.

Some very telling observations were made in this connection, and the dependence of the processes on temperature again show forth clearly.

These results lead to the conclusion that the process of metamorphosis into glucoses and translocation of the products of assimilation are also going on during daylight, though they are less evident, because more starch is then being formed and accumulated than is abstracted at the time. Moll proved that such is the case by exposing leaves to the sunlight, but in an atmosphere devoid of carbon dioxide; the starch already in the leaves disappeared, and no more was formed to replace it. Sachs repeated Moll's experiments, and proved the correctness of his conclusions by means of the iodine test. Half leaves were shown to be full of starch; the companion halves were put into closed atmospheres, deprived of carbon dioxide by means of potassium hydrate, and exposed to sunlight. In an hour the latter halves were tested, and found to be nearly emptied of starch. Other experiments proved that depletion occurred in a few hours, the time depending on the temperature.

Further experiments demonstrate that the starch travels in the form of glucoses in all the above cases; but it is not proved whether the metamorphosis is effected by forces in the chlorophyll grains themselves, or by means of diastatic ferments in the cells of the leaf. A few hints are here given showing a field for further research.

Perhaps the most ingenious part of the paper is that which now follows. It is well known that Weber's patient and thorough researches on the energy of assimilation led to two important results, among others: (1) that the quantity of starch formed by a certain area of leaf-surface in a certain time may be relatively very large; and (2) that different plants probably differ specifically as to the quantities of starch formed in their leaves.

Sachs proposes to apply his method to the solution of this question, *i.e.* how much starch is produced in, say, one square metre of leaf-surface by assimilation during, say, ten hours' bright sunlight? The great difficulties in Weber's researches were connected with the enormous labour necessary to measure the leaf-surface accurately.

Sachs resolved the matter in a manner which we may summarise thus:—He cut off portions of large leaves found to be empty of starch, measured them rapidly by laying them on pieces of board cut to the size of one square metre, and killed, dried, and weighed the measured portions very rapidly. Certain precautions as to the area of fibro-vascular bundles, the possibilities of absorbing hygroscopic moisture, &c., may here be passed over. Supposing these portions of the leaves to be estimated in the morning, a quantity of the same leaves of equal area gathered in the evening was then compared, and the increase in weight gives the quantity of starch formed in the interval. By weighing large areas, and frequently, and by paying attention to the times and other circumstances, a large number of results were obtained, showing that the quantities given by Weber, for instance, are within the mark. Of course these results are not absolute. Starch is being changed into glucose, and passing away during the day, and some must be burnt off in respiration; moreover a certain minute quantity of mineral ash should be allowed for. Of course, it is an assumption that equal areas of mesophyll of the same leaves contain approximately the same amount of substance: nevertheless, if a large number of experiments are made, the error is probably small.

Experiments were made to show both the quantities of starch which disappear during the night and the quantities formed during the day. A few of the numbers may be given. In *Helianthus*, 9·64 grms. of starch disappeared in ten hours from one square metre of leaf-surface.

In the same plant 9·14 grms. were formed in the same time by the same area of leaf-surface.

In another case *Helianthus* was used, but the leaves were removed from the stem to prevent the passage back of the starch from the mesophyll into the stems.

A square metre was found to produce starch at the rate of 1·648 grms. per hour.

By combining his experimental results and taking note of all the circumstances, Sachs concludes that twenty to twenty-five grms. of starch per day may be produced by one square metre of leaf-surface as an ordinary occurrence; and these numbers are not only not excessive, but experiments show that there are plants which produce much more than those investigated here.

Some remarkably interesting and important results follow from the consideration of these experimental data.

They explain why plants are so vigorous during warm nights following upon hot bright days. The more readily the products of assimilation (formed in large quantities during the day) can pass into the growing organs, the better these are nourished, and so forth.

Leaves used for fodder, &c., must differ in nutritive value to a very great extent if their starchy contents vary so largely during the day and night: it thus becomes of primary importance whether such leaves are gathered in the morning or the evening, in cold or warm weather, &c. The same applies to *Tobacco* and *Tea*, &c. It must make a vast difference to the smoker whether his tobacco abounds in carbohydrates or is relatively richer in the alkaloids. It appears that tobacco is habitually cropped in the morning in some countries, a fact which suggests that experience has already shown that a difference in the quality exists; it will be interesting to inquire further into these matters.

Sachs's results will also materially affect the physiological value of the analyses of leaves. Some of us know how great are the variations met with in analyses of the ash contents of leaves of the same plant. It is clear that, in addition to the age of the leaf, the soil, manure, &c., it is important to know the amount of starch present. It cannot but happen that the mineral matters ebb and flow as well as the starch. The analyses of leaves will also be more valuable for the purposes of physiology if the numbers are stated, not in simple percentages, but in terms of one square metre of the leaf-surface.

The above brief summary of the results obtained by Prof. Sachs by no means does justice to the beauty of his methods, and the masterly way in which they were carried out: it must be admitted by all who understand the value and importance of this work that it is worthy of the great pioneer of vegetable physiology. Moreover, it suggests several matters which require further investigation, and would no doubt yield valuable results to those fortunate enough to have a botanical garden at hand.

H. MARSHALL WARD

Botanical Laboratory, Owens College

TELEPHONY AND TELEGRAPHY ON THE SAME WIRES SIMULTANEOUSLY

FOR the last eighteen months a system has been in active operation in Belgium whereby the ordinary telegraph wires are used to convey telephonic communications at the same time that they are being employed in their ordinary work of transmitting telegraphic messages. This system, the invention of M. Van Rysselberghe, whose previous devices for diminishing the evil effects of induction in the telephone service will be remembered, has lately been described in the *Journal Télégraphique* of Berne by M. J. Banneux of the Belgian Telegraph Department. Our information is derived from this article and from others by M. Hospitalier.

The method previously adopted by Van Rysselberghe, to prevent induction from taking place between the telegraph wires and those running parallel to them used for telephone work, was briefly as follows:—The system of sending the dots and dashes of the code—usually done by depressing and raising a key which suddenly turns on the current and then suddenly turns it off—was modified so that the current should rise gradually and fall gradually in its strength by the introduction of suitable resistances. These were introduced into the circuit at the moment of

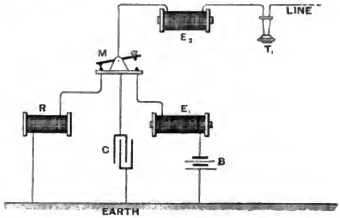


Fig. 1

closing or opening by a simple automatic arrangement worked exactly as before by a key. The result of the gradual opening and gradual closing of the circuit was that the current attained its full strength gradually instead of suddenly, and died away also gradually. And as induction from one wire to another depends not on the strength of the current, but on the rate at which the strength changes, this very simple modification had the effect of suppressing induction. Later Van Rysselberghe changed these arrangements for the still simpler device of introducing permanently into the circuit either condensers or else electromagnets having a high coefficient

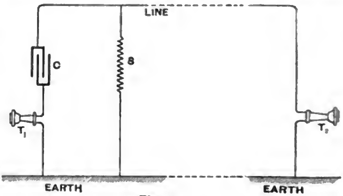


Fig. 2

of self-induction. These, as is well known to all telegraphic engineers, retard the rise or fall of an electric current; they fulfil the conditions required for the working of Van Rysselberghe's method better than any other device.

Having got thus far in his devices for destroying induction from one line to another, Van Rysselberghe saw that, as an immediate consequence, it might be concluded that, if the telegraphic currents were thus modified and graduated so that they produced no induction in a neighbouring telephone line, they would produce no sound in the telephone if that instrument were itself joined up in the telegraph line. And such was found to be the case.

Why this is so will be more readily comprehended if it be remembered that a telephone is sensitive to the changes in the strength of the current if those changes occur with a frequency of some hundreds or in some cases thousands of times *per second.* On the other hand, currents vibrating with such rapidity as this are utterly incompetent to affect the moving parts of telegraphic instruments, which cannot at the most be worked so as to give more than 200 to 800 separate signals *per minute.*

The simplest arrangement for carrying out this method is shown in Fig. 1, which illustrates the arrangements at one end of a line. M is the Morse key for sending

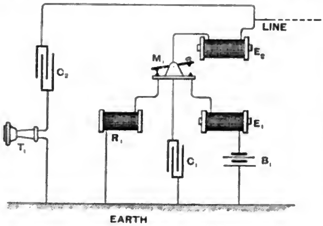


Fig. 3

messages, and is shown as in its position of rest for receiving. The currents arriving from the line pass first through a "graduating" electromagnet, E_2, of about 500 ohms resistance, then through the key, thence through the electromagnet R of the receiving Morse instrument, and so to the earth. A condenser, C, of 2 microfarads capacity is also introduced between the key and earth. There is a second "graduating" electromagnet, E_1, of 500 ohms resistance introduced between the sending battery B and the key. When the key M is depressed in order to send a signal, the current from the battery must charge the condenser C, and must magnetise the cores of the two electromagnets E_1 and E_2, and is thereby retarded in rising to its full strength. Consequently no sound is heard in a telephone, T, inserted in the line-circuit. Neither the currents which start from one end nor those which start from the other will affect the telephones inserted in the line. And, if these currents do not affect telephones in the actual line, it is clear that they will not affect telephones in neighbouring lines. Also the telephones so inserted in the main line might be used for speaking to one another, though the arrangement of the telephones in the same actual line would be inconvenient. Accordingly M. Van Rysselberghe has devised a further modification in which a separate branch taken from the telegraph line is made available for the telephone service. To understand this matter one other fact must be explained. Telephonic conversation can be carried on even though the actual metallic communication be severed by the insertion of a condenser. Indeed, in quite the early days of the Bell telephone, an operator in the States used a condenser in the telegraph line to enable him to talk through the wire. If a telephonic set at T_1 (Fig. 2) communicate through the line to a distant station, T_2, through a condenser, C, of a capacity of half a microfarad, conversation is still perfectly audible provided the telephonic system is one that acts by induction currents. And since in this case the interposition of the condenser prevents any continuous flow of current through the line, no perceptible weakening will be felt if a shunt, S, of as high a resistance as 500 ohms and of great electro-magnetic rigidity, that is to say, having a high coefficient of self-induction, be placed across the circuit from line to earth. In this, as well as in the other figures, the telephones indicated are of the Bell pattern, and if set up as shown in Fig. 2, without any battery, would be used both as transmitter and receiver on Bell's original plan. But as a matter of fact any ordinary telephone might be used. In practice the Bell telephone is not advantageous as a transmitter, and has been abandoned except for receiving; the Blake, Ader, or some other modification of the microphone being used in conjunction with a separate battery. To avoid complication in the drawings, however, the simplest case is taken. And it must be understood that instead of the single instrument shown at T_1 or T_2 a complete set of telephonic instruments in-

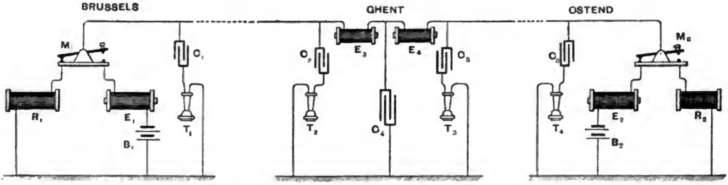


Fig. 4

cluding transmitter, battery, induction-coil, and receiver or receivers, may be substituted. And if a shunt, S, of 500 ohms placed across the circuit makes no difference to the talking in the telephones because of the interposition of the separating condenser C, it will readily be understood that a telegraphic system properly "graduated," and having also a resistance of 500 ohms, will not affect the telephones if interposed in the place of S. This arrangement is shown in Fig. 3, where the "graduated" telegraph-set from Fig. 1 is intercalated into the telephonic system of Fig. 2, so that both work simultaneously, but independently, through a single line. The combined system at each end of the line will then consist of the telephone-set T_1, the telegraph instruments (comprising battery B_1, key M_1, and Morse receiver R_1), the "graduating" electromagnets E_1 and E_2, the "graduating" condenser C_1, and the "separating" condenser C_2. It was found by actual experiments that the same arrangement was good for lines varying from 28 to 200 miles in length. A single wire between Brussels, Ghent, and Ostend is now regularly employed for transmission by telegraph of the ordinary messages and of the telemeteorographic signals between the two observatories at those places, and by telephone of verbal simultaneous correspondence for one of the Ghent newspapers. A still more interesting arrangement is possible, and is indicated in Fig. 4. Here a separating condenser is introduced at the intermediate station at Ghent between earth and the line, which is thereby cut into two independent sections for telephonic purposes, whilst remaining for telegraphic purposes a single undivided line between Brussels and Ostend. Brussels can telegraph to Ostend, or Ostend to Brussels, and at the same time the wire can be used to telephone between Ghent and Ostend, or between Ghent and Brussels, or both sections may be simultaneously used.

It would appear then that M. Van Rysselberghe has made an advance of very extraordinary merit in devising these combinations. We have seen in recent years how duplex telegraphy superseded single working, only to be in turn superseded by the quadruplex system. Multiplex telegraphy of various kinds has been actively pursued, but chiefly on the other side of the Atlantic rather than in this country, where our fast-speed automatic system has proved quite adequate hitherto. Whether we shall see the adoption in the United Kingdom of Van Rysselberghe's system is, however, by no means certain. The essence of it consists in retarding the telegraphic signals to a degree quite incompatible with the fast-speed automatic transmission of telegraphic messages in which our Post Office system excels. We are not likely to spoil our telegraphic system for the sake of simultaneous telephony, unless there is something to be gained of much greater advantage than as yet appears.

NOTES

WE are pleased to be able to announce that Prof. Flower's title is to be "Director" of the Natural History Museum, South Kensington, not "Superintendent," as Prof. Owen was styled. According to the Civil Service Estimates for the present financial year his staff consists of four keepers of departments (Botany, Geology, Mineralogy, and Zoology), two assistant keepers (Geology and Zoology), eleven first-class assistants, and fourteen second-class assistants. Large as this number may seem, it is notorious that in the Zoological Department at least a considerable reinforcement is required before the work can be expected to be efficiently performed.

WE regret to learn from the *Times* that M. Dumas, the venerable *Sécrétaire Perpétuel* of the Academy of Sciences, is lying in a critical state at Cannes.

POPE LEO XIII. has erected at his own expense at Carpineto-Romano, his native city, a meteorological observatory. It has been placed at the top of the castle of the Pecci family. The directorship of this establishment, which will be one of the most important in the whole Italian system, has been given to Count Lodovico.

WE are pleased to receive the first official publication issued from the Hong Kong Observatory by Dr. Doberck, giving the results of observations during the month of January. We are sure the establishment of this institution will be of the greatest service both to navigation and to science.

THE first International Ornithological Congress ever held was on Monday festively inaugurated at Vienna by its patron, the Crown Prince Rudolph—himself a noted ornithologist. In his opening speech, the Prince dwelt upon the great importance of those studies in natural history which characterise this century, a remark which was doubtless meant as a reply to the vehement attacks on modern science recently made by the Clerical Deputy Greuter in the Austrian Parliament. Germany and Austria have sent hither all their ornithological celebrities; but the Congress also includes delegates from the Russian and French Governments, and members from Switzerland, Holland, and Sweden. Even Siam and Japan are represented, while England is conspicuous by her absence. The Congress began its deliberations with the question of International Protective Legislation for Birds.

THE sixth Archæological Congress will be held at Odessa from August 27 to September 1.

A SOMEWHAT novel feature in connection with the International Health Exhibition this year will be the establishment of a library and reading-room, a home for which the executive council have assigned in a large double room in the Albert Hall, overlooking the conservatory. Steps have been taken to secure a representative collection of works on vital statistics; of reports and regulations relating to public health; of regulations with reference to injurious trades and of works thereon; and of reports, statistics, and other works on the science of education. Foreign powers have been invited to lend their cooperation in this effort to create an international library of works of reference bearing on the two divisions of the Exhibition, and several responses have already been received. India and the Colonies have also been asked to contribute towards the same end. Publishers and authors have likewise been invited to forward copies of their works. In addition to the library of reference, there will be a reading-room, to which the current numbers of periodical publications of a sanitary or educational character will be admitted. All books and periodicals sent to the library and reading-room will, under certain regulations, be arranged for the use of visitors, and not merely for exhibition. The books will be submitted to the jurors, and a full catalogue will be issued. All parcels for the library and reading-room should be addressed, carriage paid, to the Secretary of the Library Sub-Committee, Royal Albert Hall, London, S.W. The following handbooks are being written in connection with the Exhibition:—"Healthy Villages" (illustrated), by H. W. Acland, C.B., M.D., F.R.S.; "Healthy Bed-Rooms and Nurseries, including the Lying-in Room," by Mrs. Gladstone; "Healthy and Unhealthy Houses in Town and Country" (illustrated), by Mr. W. Eassie, C.E., with an appendix by Mr. Rogers Field, C.E.; "Healthy Furniture and Decoration" (illustrated), by Mr. R. W. Edis, F.S.A.; "Healthy Schools," by Mr. Charles Paget, M.R.C.S.; "Health in Workshops," by Mr. J. B. Lakeman; "Manual of Heating, Lighting, and Ventilation" (illustrated), by Capt. Douglas Galton, C.B., F.R.S.; "Food," by Mr. A. W. Blyth, M.R.C.S.; "Principles of Cookery," by Mr. Septimus Berdmore; "Food and Cookery for Infants and Invalids," by Miss Wood, with a preface by R. B. Cheadle, M.D., F.R.C.P.; "Drinks, Alcoholic," by John L. W. Thudichum, M.D., F.R.C.P.; "Drinks, Non-Alcoholic and Aërated," by John Attfield, Ph.D., F.R.S.; "Fruits of all Countries" (illustrated), by Mr. W. T. Thiselton Dyer, M.A., C.M.G.; "Condiments, including Salt," by the Rev. J. J. Manley, M.A.; "Legal Obligations in respect to Dwellings of the Poor," by Mr. Harry Duff, M.A., Barrister-at-Law, with a preface by Mr. Arthur Cohen, Q.C., M.P.; "Moral Obligations of the Householder, including the Sanitary Care of his House," by G. V. Poore, M.D., F.R.C.P.; "Laboratory Guide to Public Health Investigation" (illustrated), by W. W. Cheyne, F.R.C.S., and W. H. Corfield, M.D., F.R.C.P., M.A.; "Physiology of Digestion and the Digestive Organs," by Prof. Arthur Gamgee, F.R.S.; "Fermentation," by Dr. Duclaux, with a preface by M. Louis Pasteur, Membre de l'Institut; "Spread of Infection," by Mr. Shirley F. Murphy; "Fires and Fire Brigades" (illustrated), by Capt. Eyre M. Shaw, C.B.; "Scavengering and other such Work in Large Cities," by Mr. Booth Scott; "Athletics," Part I. (illustrated), by the Rev. E. Warre, M.A.; "Athletics," Part II., by the Hon. E. Lyttleton, M.A., and Mr. Gerard F. Cobb, M.A.; "Dress in relation to Health and Climate" (illustrated), by Mr. E. W. Godwin, F.S.A.; "The

Ambulance" (illustrated), by Surgeon-Major Evatt, M.D., A.M.D.; "The Influence of Schools of Art on Manufacturing Industry," by John Sparkes; "The Homes of the Poor," (author not yet settled).

LADY SIEMENS has placed at the disposal of the Council of the Society of Arts a sum of 20*l.*, to provide a prize, to be called the Siemens Prize, to be offered for the best application of gas to heating and cooking in dwellings (Class 24 in the International Health Exhibition). The prize will consist of a gold medal or 20*l.*, and will be awarded under the same conditions as the prizes announced in the *Journal of the Society of Arts* of the 14th inst.

THE Senkenberg Natural History Society at Frankfort has had a legacy of 40,000*l.* left to it by the late Countess Bose.

A HUMAN skull has just been discovered in a bed of clay near Podbaba in the neighbourhood of Prague. A few days previously a mammoth tusk was found in the same locality. The colour of the skull proves that it was lying in yellow diluvial loam. It is remarkable on account of its very flat forehead and the thickened eyebrow bones, thus closely approaching the well-known Neanderthal skull. Its facial angle seems to be even smaller than that of the latter, although an exact measurement is impossible on account of the absence of part of the jaw-bones. Further details on the subject will be published in the *Transactions of the Bohemian Academy of Sciences.*

THE first number has just been issued of a new Italian quarterly, entitled *La Nuova Scienza, Rivista dell' Istruzione Superiore*, edited by Prof. Enrico Caporali of Todi, Umbria. As implied by the title, the aim of this periodical is to popularise scientific subjects, and to chronicle the progress of discovery in Italy and abroad. The editor invites communications in the chief European languages, and declares that his efforts will be mainly directed to promoting the unification of the sciences with a view to the ultimate constitution of an exact philosophy. To the present number he contributes two spirited and learned papers on "Modern Thought in Italy," and on "The Pythagorical Formula of Cosmic Evolution." The appearance of such a publication in a small provincial town is itself a striking illustration of the general revival of serious studies since the establishment of political unity in Italy.

THE much discussed question as to the purification of water in rivers "by itself," that is, by the mere fact of its motion, seems to have entered into a new phase. Dr. Pehl, at St. Petersburg, has recently made a series of bacterioscopic measurements on the waters of the capital, which are summed up in the last issue of the *Journal of the Russian Chemical Society*. The water of the Neva itself appears to be very poor in bacteria, namely, 300 germs in a cubic centimetre. After heavy rains this number rises to 4500, and to 6500 during the thawing of the river. The canals of St. Petersburg, on the contrary, are infected with bacteria, their number reaching 110,000 in a cubic centimetre, even during good weather. The same is true with regard to the conduits of water for the supply of the city. While its chemical composition hardly differs from that of the Neva (by which they are supplied), the number of bacteria reaches 70,000, against 300 in the water freely taken from the river; and the worst water was found in the chief conduit, although all details of its construction are the same as in the secondary conduits. Dr. Pehl explains this anomaly by the rapidity of the motion of water, and he has made direct experiments in order to ascertain that. In fact, when water was brought into rapid motion for an hour, by means of a centrifugal machine, the number of developing germs was reduced by 90 per cent. Further experiments will show if this destruction of germs is due to the motion of the mass of water, or to molecular motion. The germs, among which Dr. Pehl distinguishes eight species, are not killed by immersion into snow. As the snow begins to fall it brings down a great number of germs, which number rapidly diminishes (from 312 to 52 after a three hours' fall of snow, on January 21, 1884), while their number on the surface of the snow increases, perhaps in consequence of the evaporation of snow or of the condensation of vapour on its surface.

IT is proposed, *Science* states, to establish a monthly *American Meteorological Journal*. It will begin with from twenty-four to thirty-two octavo pages, and will be enlarged as rapidly as is justified by the support given it. The first number will probably appear about May 1. It will be published in Detroit by Dr. W. H. Burr, and edited by Prof. M. W. Harrington of Ann Arbor.

IT is stated that the earthquakes of March 25 in Southern Hungary were also severely felt at Essegg, at Winkowze, and at Fünfkirchen. At Djakovar many houses were injured. Another earthquake was remarked at Ischia on March 28. The shock was but a slight one and of short duration.

FROM the Report for 1883 of the Glasgow Museum we see that it had 223,129 visitors during the year. There were large additions to the Natural History Department during the year.

WE have already noticed M. Erkert's anthropological measurements in the Caucasus. He publishes now in the *Isvestia* of the Tiflis Geographical Society (vol. viii.) his further measurements and conclusions. The different nationalities appear as follows with regard to their cephalic indexes:—Only the Aderbaijan Tartars are mesocephalic (79·4), all others being brachycephalic, the indexes being 80·9 with the Kalmucks, 81·4 with the Ossets, 81·9 with the Adighe and Chechenes, 83·2 with the Little-Russians, 83·7 with the Georgians, and 85·6 with the Armenians. A high index was found for the Lezghines, but the number of measurements was only three. As to the height of the skull the Aderbaijan Tartars have the highest and longest heads; the Armenians the shortest and highest (71·1); the Kalmucks the longest but lowest (62·0); while the Little-Russians, the Adighe, and the Georgians afford intermediate types, the heights of their skulls varying from 67·6 to 66·7. All the above nationalities have relatively low and broad or chamäprosopous faces, there being, however, a number of individuals with long or leptoprosopous faces, especially among the Tartars. In connection with the above it may be worth noticing the measurements of M. Chantre of Lyons, published in the *Bulletin de la Société d'Anthropologie de Lyon* for 1883. It results from his measurements made on 137 Kurd men and 21 women, that their cephalic index is 81·4; they are thus brachycephalous, and sometimes mesaticephalous. The index increases with those Kurds who live close by Armenians, and decreases with those who live close by Bedouins. Altogether the memoir of M. Chantre ("Aperçu sur les caractères ethniques des Anshariés et des Kourdes") is an important addition to our knowledge of Kurdistan, as well as his second memoir, published in the same serial, on the Stone and Bronze Ages in Western Asia, Syria, Mesopotamia, Kurdistan, and the Caucasus.

IT appears from the Caucasian *Isvestia* that the Russian Amu-daria Expedition has arrived at the following conclusions:—The I han branch of the delta of the Amu could be easily made navigable; as to the possibility of bringing the water of the Amu to the Caspian, General Glukhovsky's Commission does not yet give a definite answer, but it considers it most probable. The immense and deep depression of Sary-kamysh could be turned by the canal; the necessary inclination of level exists; and the immense desert west of Khiva could be irrigated without difficulty and without loss to the oasis of Khiva.

IN the letter signed "O. S." last week (p. 525), under the heading "Remarkable Sunsets," the French term should be *pelure d'oignon* and not *velure*.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. F. Mortimer; two Secretary Vultures (*Serpentarius reptilivorus*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Blue-and-Yellow Macaw (*Ara ararauna*) from South America, presented by Mr. H. W. Kingdom; two Common Peafowls (*Pavo cristatus* ♂ ♀) from India, presented by Mr. R. F. J. Cobbett Allen; a Common Viper (*Vipera berus*, black variety) from Hampshire, presented by Lord Londesborough, F.Z.S.; a Yaguarundi Cat (*Felis yaguarundi*) from South America, a Leuhdorf's Deer (*Cervus leuhdorfi* ♂) from Amoorland, two Jardine's Parrots (*Paeocephalus gulielmi*) from West Africa, three Rhinoceros Hornbills (*Buceros rhinoceros* ♂ ♀ ♀) from the Malay Peninsula, two Nepal Hornbills (*Aceros nepalensis* ♂ ♂), a Green Cochoa (*Cochoa viridis*), two Nepal Tree Pies (*Dendrocitta nepalensis*), a Gray-headed Thrush (*Turdus castanea*) from Nepal, three Bronze Fruit Pigeons (*Carpophaga ænea*), two White-breasted Gallinules (*Gallinula phœnicura*) from India, two White-backed Pigeons (*Columba leuconota*) from the Himalayas, seven Waxwings (*Ampelis garrulus*), two Proteus (*Proteus anguinus*), European, purchased; a Lucian's Parrakeet (*Palæornis luciani*) from China, a Geoffroy's Dove (*Peristera geoffroii* ♂) from Brazil, received in exchange.

OUR ASTRONOMICAL COLUMN

COMET 1884 *a*.—The comet notified by telegram from Mr. Ellery as having been discovered in the constellation Grus, appears to have been detected by Mr. Ross, a young amateur astronomer residing at Elsterwick, near Melbourne, on January 7. Observations were commenced at Melbourne on January 12, and were continued to February 4, when the comet had become very faint. The positions, as first communicated to the *Astronomische Nachrichten*, contained more than one obvious error, and generally (according to a comparison made by Dr. Kreutz with an orbit since received from Melbourne) appear to be strangely inaccurate, a circumstance that will probably have caused useless expenditure of time to computers. We subjoin the Melbourne orbit with one calculated by Mr. Hind from the observations on January 12 and 28 and February 4, as they are printed in *Astron. Nach.*, No. 2579:—

	Melbourne		Hind
Perihelion passage, 1883,	Dec. 25·7838 Melb. M.T.	...	Dec. 25·4998 G.M.T.
	° ′ ″		° ′
Longitude of perihelion	125 15 55	...	124 14·4
,, ,, ascending node	265 12 15	...	265 56·5
Inclination	64 53 16	...	64 59·7
Log. perihelion distance... ...	9·502384	...	9·51838

Motion—Retrograde.

It is to be remarked that Dr. Kreutz, calculating from the Melbourne orbit, does not reproduce the extreme positions stated to have been employed in its computation.

VARIABLE STARS.—On comparing the late Prof. Julius Schmidt's determinations of the times of minima of *Algol* in 1883 with the formula given by Prof. Schönfeld in his second catalogue of variable stars, it will be found that, by a mean of the observations between August 14 and December 4, the formula gives the minimum too late by fifty-eight minutes. The mean annual errors for the period 1876–83 have shown irregularity, but the separate results within the same year differ considerably.

Mr. Baxendell has worked out new elements for R Arietis from his own observations 1859–81. He finds for—

			Days
Maximum	...	Epoch 1866, Sept. 1·3 +	186·71 E.
Minimum	...	Epoch 1870, Jan. 2·3 +	186·63 E.

The mean interval from maximum to minimum is 99·0 days, and from minimum to maximum 87·7 days.

THE OBSERVATORY, CINCINNATI.—The seventh part of the publications of this Observatory has appeared. Parts 4, 5, and 6 were devoted by Mr. Ormond Stone to the double-star measures made with the 11-inch refractor in the years 1877–80. In the new part are given the observations of comets in the years 1880–82, including numerous physical observations as well as observations for position. There is a comparison with theory of the phenomena in the tail of the great comet of 1882. In a number of plates are illustrated the telescopic and naked-eye appearance of the great comets of 1881 and 1882 and of the first comet of the latter year.

Mr. H. C. Wilson is in temporary charge of the Cincinnati Observatory, Mr. Ormond Stone having been appointed Professor of Astronomy in the University of Virginia, and Director of the Leander McCormick Observatory.

THE "ASTRONOMISCHE GESELLSCHAFT."—The fourth part of the eighteenth volume of the *Transactions* of this Society is issued. It contains the proceedings at the meeting held in Vienna in September last and the usual critical notices of recent astronomical publications; also reports on the progress of the zone-observations from thirteen observatories. It was decided to hold the next meeting at Geneva in 1885; Prof. Auwers was chosen president for the second time, with Prof. Gyldén as vice-president, and Profs. Schönfeld and Seeliger (now at Munich) as secretaries.

PHYSICAL NOTES

THE transition-resistance supposed by Poggendorff to exist in electrolytic cells between the surface of the electrode and that of the electrolyte in contact with it has lately been investigated with great care by Prof. J. Gordon Macgregor in solutions of very pure zinc sulphate, using electrodes of amalgamated zinc. The conclusion arrived at was that such a transition-resistance, if it exists at all, is less than 0·0125 of an ohm.

IN another paper which appears in the *Transactions of the Royal Society of Canada* Prof. Macgregor describes an ingenious arrangement devised by him for measuring on Wheatstone's bridge the resistances of electrolytes. He employs alternate currents produced by a rotating commutator inserted in the circuit of two Daniell's cells; and in order to use with this arrangement an ordinary mirror-galvanometer, he recommutes the currents in the galvanometer circuit by means of a second commutator rotating on the same axle as the first.

THE annual *conversazioni* of the Société de Physique, of Paris, will be held this year on April 15 and 17 respectively, the former being limited strictly to the members of the Society. These meetings will, by the invitation of Admiral Mouchez, be held in the Observatoire.

A NOTE on Hall's effect was recently read at a meeting of the Physical Society of London by Prof. S. P. Thompson and Mr. C. C. Starling. They find that when a large sheet of foil is used, and placed symmetrically in a concentrated field between pointed magnetic poles, so that the junctions and connections are quite outside the influence of the field, Hall's effect is not produced. They find, however, an alteration in the equipotential lines of the current in the strip where it is magnetised, and have traced this effect to a change in the resistance. Strips of gold and tin show a decrease, strips of iron a slight increase of resistance when subjected to a strong magnetic field.

ANOTHER paper on Hall's effect appears in the current number of the *Journal de Physique* from the pen of M. Leduc. In this article M. Leduc draws a diagram of the equipotential lines, as, according to his ideas, they will be found to lie between the two "parasitical" electrodes. It does not appear whether he has verified his views by actual determinations of the position of the lines of equal potential.

ROWLAND'S famous experiment demonstrating the magnetic action of electric convection has been called in question by Dr. E. Lecher of Vienna. In Rowland's original experiment the electrified rotating disk was horizontal, and the magnetic needle, protected from electrostatic influences by being inclosed in a metallic case, was held over the disk at a point near the circumference. Dr. Lecher, in attempting to repeat the experiment, placed the rotating disk in a vertical plane, its axis being horizontal; the magnet needle was placed parallel to the plane of the disk and in the axis of its rotation in fact relatively as the coil and needle of a Gaugain galvanometer. Disks of brass and of *papier-maché* covered with graphite were used, and charged from a Holtz machine to potentials of about 5000 volts as measured on an absolute electrometer. The velocity of rotation was about 200 revolutions per second. The astatised needle was protected within a metal case, and was observed in the usual way by a mirror. No deflection was observed either when the disk was still or when it rotated. Dr. Lecher intends to repeat Rowland's experiment with the original horizontal disposition of the disk.

Dr. Lecher has also made another experiment of great interest. A ray of light was divided, as in many experiments on interference, into two parts, which, after passing through two parallel glass troughs, were caused to reunite, giving the usual interference-bands. The troughs contained strong solutions of nitrate of silver. By means of electrodes of silver an electric current of 6 amperes strength was carried in opposite directions along the troughs so that in one trough the current flowed *with* the light, and in the other against it. But in no case was any displacement of the fringes observed. Dr. Lecher concludes that the velocity of light is not influenced by a current flowing through the medium.

Dr. Lecher has made a third and still more interesting experiment, attended, however, like the preceding, with a negative result. This was an attempt to prove whether Faraday's famous experiment of rotating the plane of polarisation by an electric current could be inverted. He has attempted to generate currents by rotating the plane of polarisation of light. The arrangement was as follows:—A ray of plane-polarised light was sent through the interior of two powerful helices of wire situated at some distance from one another. Through the first of these a powerful alternate current was sent, which impressed upon the ray a rapid oscillation of its plane of polarisation. The second helix was connected to a sensitive receiving telephone in the hope that sounds might therein be heard, as would be the case if the rapid rotations in the plane of polarisation of the ray were capable of setting up currents in the surrounding wire. Absolutely nothing was, however, heard.

BACTERIA

A very distinguished audience assembled at the Parkes Museum on Thursday evening, March 27, to witness Mr. Watson Cheyne's demonstration of pathogenic micro organisms. The chair was taken by Sir Joseph Lister, Bart. After stating that the great group commonly called Bacteria might most conveniently be subdivided into four classes—(1) Micrococci (round bodies), (2) Bacteria (small oval or rod-shaped bodies), (3) Bacilli (large rod-shaped bodies), and (4) Spirochætæ and Spirilla (rods spirally twisted), and dwelling on the great variety as well as importance of the various parts played by this great group in the economy of nature, Mr. Watson Cheyne demonstrated numerous micro photographs taken by Dr. Robert Koch, as well as some drawings by means of a limelight apparatus. He observed that great differences existed among the various bacteria in their behaviour towards the human body: some could be injected without causing any injury, others could not grow in the living body, but could develop in dead portions of tissue and the secretions of wounds, giving rise to poisonous products. The true pathogenic organisms were able to attack the living body and multiply in it; they included the organisms which found entrance through some wound, giving rise to the traumatic infective diseases, and others which could obtain entrance without observable wound. Further, certain organisms, such as the *B. anthracis*, were capable of growing outside the body in dead organic substance, while others, such as the *B. tuberculosis*, were apparently only capable of development in the living organism or under artificial conditions which reproduced to some degree those existing in the tissues of warm-blooded animals, though capable of long retaining their vitality in the dry state. With regard to the traumatic infective diseases, he thought that the most absolute proof had been furnished that the bacteria found in them, and nothing else, were the causes of these diseases. To establish such a proposition it was necessary that an organism of a definite form and with definite characteristics should always be found in the blood or in the affected part. The blood or the affected part when inoculated into another animal of the same species must produce the same disease. When the blood or the affected part was inoculated on a suitable soil outside the body, the micro-organisms grew, and must be indefinitely propagated on similar soil. When in this manner the organisms had been separated from the remains of the materials in which they were embedded, their inoculation in an animal must produce again the same disease, the same organisms being found in the diseased parts. These conditions had now been fulfilled with regard to anthrax, septicæmia of the mouse, erysipelas, tuberculosis, glanders, and acute pneumonia. With regard to typhoid fever, relapsing fever, cholera, and ague, the evidence was very strong, but not conclusive. Mr. Watson Cheyne concluded by dwelling on the importance of surrounding circumstances, chiefly those summed up in the phrase unhygienic conditions, as concomitant causes of disease by preparing the blood for the attacks of these micro-organisms.

The chairman, Sir Joseph Lister, dwelt upon the important fact that the organisms which produced particular diseases were only able to develop under very special conditions, instancing the bacillus which caused septicæmia in the house mouse, but which was unable to produce any deleterious effect on the field mouse. He thought this fact, which showed that the very slight difference in the blood of these two animals was sufficient to alter the conditions favourable to the development of the bacteria, might prove of very great interest, as it was possible to conceive that by the administration of some medicines, sufficient alteration might be produced in the blood of the human system to kill off or to prevent the development of any special bacteria on the first appearance of the symptoms of the disease in the patient. Sir Joseph Lister concluded by referring at some length to the importance of Pasteur's researches on modified virus.

Prof. Humphry paid an eloquent tribute to the great work which Sir Joseph Lister had already achieved, and looked forward with a large hope to the future of medicine.

THE STABILITY OF SHIPS

Professor Elgar has recently made two important contributions to this important question; the first was read before the Royal Society on March 13 last. The main object of the paper was to exhibit the manner in which the stability of a ship varies with changes of load and draught of water such as merchant steamers are liable to. None of the properties possessed by a ship is more vital to her safety and efficiency than that of stability. At the same time none is dependent for its existence and amount upon so many or such diverse and variable circumstances as it. The stability of a ship, both as regards moment and range, is affected not only by the position of her centre of gravity, which largely depends upon stowage, but also by draught of water. If the centre of gravity be kept fixed in position at various draughts of water, the stability will still vary very considerably with the draught, and often in a manner that contains elements of danger.

The usual practice in investigating a ship's stability is to calculate a curve of metacentres, and one or more curves of stability at certain fixed draughts of water and with given positions of centre of gravity. The curve of metacentres gives the height at all draughts of water above which the centre of gravity cannot be raised without making the ship unstable when upright, and causing her to lie over more or less to one side. The ordinates of the curve of stability represent the lengths of the righting arms, which, multiplied by the weight of the ship, give the righting moments at all angles of inclination from the upright. The stability of numerous vessels, both of the Royal Navy and mercantile marine, have been investigated in this manner for certain draughts of water, and a great amount of information obtained respecting the variation of stability with inclination at such draughts, and the angle at which the stability vanishes in many classes of ships. The peculiar dangers attaching to low freeboard, especially when associated with a high centre of gravity, have been fully discussed and made known.

Curves of stability have been chiefly constructed for deep and moderate draughts; the character of the stability which is often to be found associated with very light draught, appears to have hitherto escaped attention. As a matter of fact, light draught is often as unfavourable to stability as low freeboard, and in some cases more so. The general opinions that have till recently prevailed upon the subject appear to have been based upon a vague impression that so long as a vessel has a high side out of water, and any metacentric height, she will have great righting moments at large angles of inclination and a large range of stability. It was shown at the *Daphne* inquiry, held by Sir E. J. Reed in

July last, that these opinions largely prevailed and were erroneous.

Prof. Elgar was called upon to make some investigations respecting the stability possessed by the *Daphne* at the time of the disaster which happened to her, and to give evidence respecting the same. He afterwards pointed out, in a letter to the *Times* of September 1 last, some of the considerations which obviously apply to light draught stability. The first, which it appears had never before been stated, is that any homogeneous floating body which is symmetrical about the three principal axes at the centre of gravity—such as a rectangular prism or an ellipsoid—will have the same moment of stability at equal angles of inclination, whether floating at a light draught with a small volume below water, or at a deep draught with a similar volume above water. For instance, if a homogeneous prism of symmetrical cross-section 5 feet high float at a draught of 1 foot, it will then have precisely the same moment of stability at equal angles of inclination, and consequently the same curve of stability throughout, as if it were loaded—without altering the position of the centre of gravity—till it had 4 feet draught of water, and 1 foot of free board. From this it follows that, in such elementary forms of floating bodies, lightness of draught has the same effect upon stability as lowness of freeboard; and if a low freeboard is unfavourable to stability, so also, and precisely to the same extent, is a correspondingly light draught of water. This proposition can be made still more general, as it applies to homogeneous bodies of any form of cross-section which revolve about an horizontal axis fixed only in direction. From this may be deduced the results given by Atwood in his papers read before the Royal Society in 1796 and 1798 respecting the positions of equilibrium and other peculiarities connected with the stability of floating bodies.

In considering the stability of a ship at various draughts of water, and comparing it with that of the class of figures above described, modifications require to be made for the departure from symmetry of form, and for the extent to which the vertical position of the centre of gravity differs from what it would be if the external surface inclosed a homogeneous volume. Prof. Elgar has done this with great fullness of detail in his paper, and shows, by means of curves, how the stability varies with draught of water at constant angles of inclination in various geometrical forms of floating bodies, and in a large passenger steamer of ordinary type. The curves thus dealt with are curves of righting moments, and not merely curves of lengths of righting arm. The ordinary curve of stability is usually made for lengths of righting arm, because the displacement is constant, and the same curve therefore gives upon different scales, either lengths of righting arm or righting moments. In the vertical or cross curves of stability, however, such as are now being dealt with, draught, and therefore displacement, is one of the variable quantities, and curves of righting moments are of a very different character from curves of righting arm. Complete cross curves for a ship, from which ordinary curves of stability can immediately be obtained for any draught of water and position of centre of gravity, can be constructed in a few days with the aid of Amsler's mechanical integrator.

Prof. Elgar shows conclusively the necessity in many cases of regarding the stability of a ship from the point of view of variation of righting moment with draught of water, the angle of inclination being constant, instead of from that of variation of righting moment with angle of inclination, the draught being constant, as is usually done; or rather of considering the subject from both points of view instead of almost exclusively from the latter. He also shows that it is necessary to investigate, more fully than has formerly been done, the moments and range of stability of ships and other structures that may be intended to float at very light draughts of water.

Prof. Elgar's second paper was read last week at the meeting of the Institute of Naval Architects; its title was "The Use of Stability Calculations in Regulating the Loading of Steamers."

The stability of ships, Prof. Elgar went on to say, is a subject that has received a considerable amount of theoretical investigation during recent years. The general character of the stability of certain classes of ships, and the circumstances which affect it, have been largely ascertained and made known; while the methods of performing the requisite calculations—especially when large angles of inclination are being dealt with—have been greatly improved. Curves of stability have been constructed and made public for numerous ships of various classes, both for war and mercantile purposes.

The results of the investigations that have thus been made are of great value to naval architects and men of science, and enable them to know much more respecting the actual stability often possessed by ships than was possible with the imperfect data available in former years. In the case of ships that are built for purely war and some other special purposes, the ordinary stability calculations enable instructions to be readily framed respecting the stability they possess under ordinary working conditions, or in such critical circumstances as may possibly occur during their career. Any risks of instability that may exist, or arise in certain contingencies, may be ascertained, and the precautionary measures necessary for counteracting them devised and pointed out.

The problem that has to be dealt with in advising those in charge of war ships how to effectually guard against instability, is well within the grasp of the naval architect. In such vessels the loading is mainly of a permanent character, while that part of it which is subject to variation, such as coals, stores, ammunition, &c., varies in a manner which can be readily taken into account in the calculations. Curves of stability that are constructed for war ships for three leading conditions, viz. (1) the fully-laden condition; (2) the same, but with all the coals consumed; and (3) the light condition with all coals, ammunition, and consumable stores expended, are usually sufficient to enable full instructions to be framed for the prevention of instability. In some war ships there are other critical conditions which may require consideration, such as the possible injury and laying open to the sea, of compartments not protected by armour; but in all these cases the conditions are comparatively fixed, and may be allowed for in the calculations. When curves of stability have once been constructed for a war ship to represent the various critical conditions to which she may be subjected, they are always applicable, and may be relied upon to furnish, at any time, a safe guide to her stability.

In the case of mercantile steamers, however, except such as carry no appreciable weight of cargo, the problem of how to apply the results of stability calculations to the guidance of those who have to work and stow them is of an entirely different character. The naval architect cannot control, or even estimate, the amounts and positions of centre of gravity of the various items of weight that make up the loading to anything like the same degree of certainty as in war ships. There are many steamers afloat in which the cargo is nearly or quite twice the total weight of the vessel, together with her machinery and equipment. In such cases the naval architect can only control in the design about one-third of the total weight of the vessel and her cargo, leaving the remaining two-thirds in the hands of the owner, master, or stevedore. It is obvious, therefore, that whatever may be the qualities of the empty vessel in respect of stability, these may be greatly modified or entirely altered by the manner in which she is loaded. It is the loading to which we must look in the large proportion of cargo-carrying steamers for the due preservation of such stability as is necessary for safety at sea.

It is in this direction also that we have to look for the cause of a great many of those losses which have occurred at sea during recent years, and to which attention was first prominently called by Mr. B. Martell, the Chief Surveyor of Lloyd's Register Society, in a paper read before this Institution in 1880 upon the causes of unseaworthiness in merchant steamers. Mr. Martell attributed, and quite rightly so, a great many of the losses of steamers to instability; and there can be no doubt that this cause of loss still continues to operate very largely. The evidence given at Board of Trade inquiries in cases of missing steamers is constantly pointing to instability as the cause of loss, although the full meaning and weight of the evidence may not always be fully and accurately appreciated at these inquiries. It often diverts attention from the main cause of loss to say that it occurred because the ship was unstable. The fact is, that the ship has frequently so little to do with the matter, and the stowage so much, that it is the latter which should be blamed for the instability, and not the ship herself. When a ship is built for a particular trade and for the purpose of carrying certain specific cargoes she may then, of course, be so designed as to be quite stable, in all conditions, while thus employed; but when vessels are built, as they often are, to dimensions fixed by owners, for general trading purposes, it is seldom possible for the designer to provide against instability arising in some possible or conceivable circumstances of loading. The due preservation of stability in such cases requires to be watched and provided for by those who control the loading.

It is erroneous to suppose, as appears to be sometimes done, that a cargo-carrying steamer should be so constructed and proportioned as to run no risk of becoming unstable, however she may be laden. If this idea were acted upon, such a mode of preventing instability, however easy and plausible it may at first sight appear to be, would only defeat the desired object of promoting safety at sea, because it would make many vessels dangerously stiff when laden with some classes of cargo. The true and reasonable mode of procedure is not to attempt to construct a ship so that she will be stable however she may be laden, but to see that any tendency she may have towards instability—if any such exist—is understood by those in charge of her, and that she is always laden with careful reference to it. There are no steamers afloat, whatever tendency they may have towards instability as sometimes laden, that they may not be kept perfectly safe if treated with full knowledge of what their stability is, and the stowage regulated accordingly. One great problem that the mercantile naval architect has just now to solve is, how any dangerous features of a ship's stability are to be made clearly known to those in charge of her, and in what manner they can be best taught to regulate the loading in cases where special care may be required.

It is sometimes supposed that owners and masters are not only negligent, but indifferent in this matter; and that they deliberately refrain from any consideration of it. It has been stated that there are no owners who avail themselves of the knowledge of stability now readily obtainable as a guide in the stowage and safe working of their ships. These are views which my experience does not enable me to indorse. I have found, on the contrary, that many of our leading owners of passenger and cargo steamers are extremely anxious about the matter; and not only anxious, but they adopt all means that lie within their power of dealing practically with it. The great stumbling-block they usually meet with, however, is the intrinsic difficulty of the subject.

Owners and masters have their own modes of thought and their own practical methods of ascertaining and regulating the stability of their ships, which are often quite sufficient for the purpose. They can very well comprehend whether a vessel will stand up when light without ballast, and, if not, how much it will require to make her do so. They can also understand if she is too stiff when laden with heavy dead-weight cargoes placed low down in the hold; or if she becomes unduly tender when laden with light cargoes of which more than a certain quantity is placed in the 'tween decks. They have not, however, had the technical training and experience which is requisite to enable them to understand and deal with metacentres, centres of gravity, and curves of stability; and to make all those allowances for constant variations in draught of water and position of centre of gravity which the different cargoes they carry render necessary. Some owners have recently obtained curves of metacentres and curves of stability for their ships, constructed for certain draughts of water and descriptions of cargo. These curves, as a rule, are put to no real practical use by them, as they find themselves unable to apply stability information in this highly specialised form to the accurate and reliable treatment of the various questions that arise in loading, or to compare it with the results of heir own judgment and experience.

The above course has lately been taken in many cases because of the opinions which have been expressed that the way to prevent ships being lost through want of stability is to supply the nasters with particulars of the metacentric height and a curve or urves of stability. The Wreck Commissioner advocates this ourse, and appears to entertain no doubt as to its desirability nd practical efficacy. His object is a most praiseworthy one, ut I do not believe it to be possible to carry it out in the way e suggests. The advice he gives is based upon the belief that hipmasters and others who have to do with the loading of ships an readily be made to understand what curves of stability represent, and to use them correctly in practice. I have during the st two or three years frequently tried to carry out this view, but ave never yet met with a shipmaster—and I have had to do ith some of the most capable and intelligent of the class—who uld be got to understand curves of stability sufficiently well to trusted to work with them in practice, or who would even ofess that he could do so.

If mercantile steamers could always be loaded in a uniform anner, it might be possible to represent their stability in all conditions with sufficient accuracy and completeness for all working requirements by means of a curve or curves; but as regards the vast bulk of merchant shipping there are no curves of stability which could possibly be constructed, except that for the absolutely light condition, which would be likely to represent the actual stability of the ship except on a very few occasions during the whole of her career. The only use to which any curves of stability that might be furnished could, as a rule, be put is to furnish data for enabling the stability under different conditions from those for which they were constructed to be estimated. This is an operation which masters of ships cannot perform, and which would only be likely to confuse and mislead them if they were to attempt it.

The Wreck Commissioner laid great stress upon the use it would have been to the captain of the *Austral* at the time of the accident if he had been in possession of curves of stability and calculations which had been constructed for that condition, and laid before the Court. It does not appear to have been seen that, whatever particulars of calculations and curves of stability had been supplied to the captain, he could not by any possibility have had those which related to the condition of the ship at or somewhat prior to the time in question. Her stability on that occasion was determined by the amount of weight she happened to have in her, and the position of its centre of gravity; and this was the result of a chance state of things which only existed at that precise moment, and which may hardly occur again during the existence of the ship. If we assume that this information would have taught the captain more about her stiffness than he already knew through his previous experience of the vessel, still it could not have been supplied to him beforehand by any one. All that could have been done was to supply him with particulars of the stability at other draughts and with other positions of the centre of gravity, leaving it to him to estimate from these what it would be at the time in question if he thought it desirable to do so.

I need hardly say again that the operation of constructing curves of stability for a particular draught of water, and position of centre of gravity from the results of calculations made in the usual way for certain other draughts of water and positions of centre of gravity, is an operation which requires a well-trained naval architect to perform. No one knowing the subject can suppose that masters of vessels have had either the training or the experience to qualify them for performing such an operation, or can help fearing that the result of their attempting it might be misleading. As I have already said, I have never been able to discover a shipmaster who could be safely trusted to do it, or who cared for it to be supposed that he could. It is hopeless, at present, to expect either shipowners or shipmasters to use metacentric heights and curves of stability as a practical guide in stowage; and it is necessary to put stability information before them in a simpler form, and one which fits in better with their own ideas and modes of procedure, if it is to be utilised in furnishing any real guide towards safety in loading. It is quite unnecessary for us to require such persons to become specialists in the science of naval architecture before applying the results of scientific calculations to safeguarding the stability of their ships. I have myself been obliged to give up all attempts to deal satisfactorily with the question by supplying curves of stability and other information of that class.

The method which I have adopted is the following, and I now lay it before the Institution, chiefly for the purpose of eliciting opinions upon the subject, and as a suggestion to others who may be working in the same direction and have experienced similar difficulties with myself. In advising upon how a steamer should be treated and loaded so as to be kept safe in respect of stability, I state (1) the quantity of ballast, if any, that is required to enable her to stand up when quite empty, without water in boilers or tanks, coal in bunkers, and with a clean-swept hold, and to be stiff enough for all working requirements in dock or river; (2) if she is to be employed in carrying homogeneous cargoes, what proportion of the space in the 'tween decks it is safe to fill with such cargo, after the holds are full, and what weight of ballast is required in the bottom to enable the vessel to be loaded to her maximum draught with such cargo; (3) if required to carry two or more kinds of homogeneous cargo, such as grain and cotton, grain and wool, grain, meat, and wool, &c., the best mode of stowage, and whether or not the space in the 'tween decks can be filled with the lightest of the cargoes, and in what circumstances ballast, and how much of it, will be required; (4) if not intended for homogeneous cargoes, but for general cargoes, or partly homogeneous and partly general, the average densities of the general goods for various ports is arrived at after a little experience, and the same system adopted. The main point is, to state what space, if any, must be left unfilled in the 'tween deck cargo spaces, with the different descriptions of cargo, and what ballast, if any, is necessary if the vessel is to be loaded to her maximum draught; (5) if the consumption of the coal diminishes the stability materially, as is often the case in some classes of steamers, to call prominent attention to this fact, in order that the captain may not be misled by finding his ship appear to be rather stiff on commencing a voyage. The possible consumption of coal is, of course, taken into account in fixing upon the limits that should be imposed upon the stowage in all the conditions named; and (6) if there appear to be any circumstances in which a tendency towards instability may arise they are described, and suitable precautions suggested. I believe that Lloyd's Register Society, in fixing a load-line for vessels that may in some conditions be laden so as to have insufficient stability, describe the stowage that is requisite for safety in somewhat similar terms to the above.

General particulars, such as these, respecting the character of a ship's stability in different conditions, may be made to convey all the information that is necessary for the effective prevention of instability, and I find that they are appreciated by owners and masters, and actually used as a guide in the loading of ships. They may be made to fully define all the essential points upon which stability depends, and are expressed in a form and language that is understood by those who have to use them. This is shown by the fact that telegrams are sometimes received from foreign ports respecting ships which are to be laden with cargoes somewhat different from those to which the specific instructions apply, describing the cargoes that are to be carried, and asking whether any different arrangement of ballast or proportion of weight in the 'tween decks from what has been prescribed for some other cargo is necessary. Such inquiries show that intelligent use is being made of the information supplied, and that it is being utilised for practical guidance in loading.

One of the main reasons why it is better to give information in this simple form is that it obviously fits in with a shipmaster's own practical modes of thought and ideas respecting stability. It is a mistake to suppose, because owners and masters cannot express their views respecting the stability of ships in scientific language, that they therefore have no views that are worth anything. The fact is, that the masters of ships very often have quite correct ideas respecting the stability of their vessels and how to load them. If they see a vessel quite empty in dock, and observe the effect of moving weights in and out when light, they often acquire as much knowledge of her stability in the light condition as is requisite for all purposes of safety and efficient working. They also, by means of experience obtained in loading, frequently get to know as much about the stability of certain classes of vessels in the laden condition as is necessary for practical purposes, and certainly for all purposes of safety. Whether sufficient knowledge can be gained in this way or not for all possible requirements depends largely upon the type and peculiarities of a vessel. As a rule, it is all that is applied to the purpose, and there can be no doubt that in many cases it may be sufficient. It is in vessels which contain elements of danger that cannot be discovered in this practical manner that a different and more scientific mode of treatment becomes requisite.

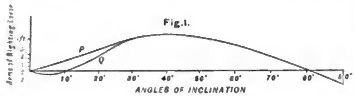
The proper use of stability calculations is not to supersede or interfere with that knowledge of a vessel's qualities which may be gained by experience but to supplement and complete it in certain cases where it may be necessary. As an illustration I may refer to the small range of stability sometimes found to be possessed by deep vessels of low freeboard. The discovery of the dangers to which such ships are liable may perhaps be successfully made in some instances by simply observing their behaviour at sea; but probably it is more often made only when the ship capsizes. Then, again, many ships become unstable at sea through the consumption of their bunker coal, particularly when a large portion of such coal is carried, as it sometimes is, in a reserve bunker under the lower deck. There are cases in which the metacentric heights of cargo-carrying steamers are reduced by 1½ feet by the mere consumption of the bunker coal. In such cases instability may very readily arise at sea in a manner of which the captain is unable to form any accurate conception when merely judging by the results of his own experience. This is particularly likely to be the case when alterations are made in bunkers, or when portions of the hold are added as reserve bunkers for enabling voyages of longer duration to be made than have previously been contemplated. I certainly believe, as the result of an examination of the stability of many mercantile steamers, that a great number of vessels are lost at sea from each of these causes, viz. through capsizing on account of low freeboard and consequent small range of stability, and also through loss of stability by reason of the consumption of coal. In both of these classes of cases the danger is aggravated if the ships are flush-decked, without any or with but small water-tight erections above the upper deck.

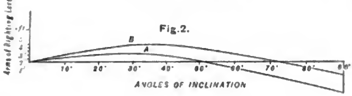
It is very difficult to make a complete analysis of the various causes of loss at sea, and to show conclusively what is the relative mortality of vessels of various types and different descriptions of cargo. The difficulty is due to the fact that the Board of Trade returns are not compiled in a manner which enables all the necessary information to be extracted from them. So far as it is possible to judge, however, by the particulars available, it appears that the types of steamers that are least subject to mysterious losses at sea are those which have long ranges of water-tight erections on deck, and are therefore least liable to become unstable. I believe that the comparative immunity against loss which appears to be possessed by many efficiently built and protected "well-deck" steamers, is largely due not only to their comparatively low centre of gravity of cargo, but to the righting power furnished at large angles of inclination by their extensive deck erections. This is undoubtedly the case, notwithstanding the fact that seas may break into the well, and often fill it with water. It may be somewhat startling to persons familiar with the loading of flush-decked steamers, to find many well-decked vessels making voyages across the Atlantic with portions of their decks so near to the water as they sometimes carry them; but a little examination suffices to show that the fact of the water entering a properly constructed and fitted and moderately sized well cannot do much to endanger the safety of the ship. Any effect it may have upon the stability is only at small angles of inclination.

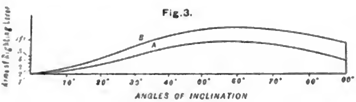
In order to show how small is the effect of water in the well of an ordinary first-class steamer of this type upon her stability, I have given two curves of stability in Fig. 1 for such a vessel. That marked P is for the condition of no water being in the well till the vessel is inclined sufficiently for the edge of the deck to become immersed, and that marked Q for the condition of the well being filled with water before the inclination commences. Mr. Martell was good enough to have these curves calculated for me, in order that I might have them in time for the reading of this paper. They are for a raised quarter-deck vessel 257 feet by 35 feet 6 inches by 18 feet 6 inches, with a well 60 feet in length, and bulwarks over 5 feet high; the freeboard amidships to the main deck being 2 feet 2 inches. Prior to the water entering the well the vessel is assumed to be at her usual trim of about a foot by the stern, and a correction is made for the change of trim caused by the filling of the well. No allowance is made for the quantity of water that would be thrown out of the well by the movements of the ship, but it is assumed to be possible to completely fill it with water to the height of the rail at the fore end of the bridge, and for no other way of escape to exist for the water but that of pouring over the rail as the vessel inclines. The freeing ports and scuppers are not assumed to have any effect in clearing the deck of water. The weight of water which the well will hold when the vessel is upright is 186 tons, but when she is inclined to 10° it will only hold 98 tons, and when inclined to 20° it becomes reduced to 28 tons. These figures and the curves in Fig. 1 show that water in the well of such a vessel cannot materially affect her stability after a small angle of inclination has been reached, and that so far as stability is concerned the well cannot be regarded as a serious element of danger.

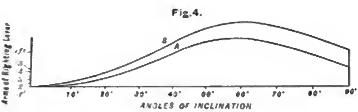
A practical point of great importance in determining the amount of stability a ship should possess at sea is the minimum metacentric height that may be regarded as sufficient for safety. Different types of vessels have quite different characteristics in respect of stability. War ships, and some classes of merchant steamers, require large metacentric heights in order to insure sufficient righting moments at moderate angles of inclination, and a safe range of stability. The curves of stability given in Fig. 2 apply to such a case. Those curves belong to a typical three-decked steamer, without any water-tight deck erections, 280 feet by 34 feet 6 inches, by 24 feet 6 inches. The mean load draught is 22 feet 6 inches, and displacement 4400 tons; the freeboard being 5 feet 4 inches. The metacentric height is 6 inches for the curve A, and 1 foot for the curve B. It is obvious that, in judging of the safety of small metacentric height for such a vessel, the range of stability is an important factor to be considered. The range necessary for seaworthiness largely determines and often fixes the limit below which the metacentric height should not be reduced in such a type of vessel and in many others.

But there are very large numbers of steamers, such as passenger liners and cargo steamers, of the spar and awning-deck classes, which generally have very large ranges of stability, and large righting moments at great angles of inclination, whatever the metacentric height may be; and in many cases, even with no metacentric height at all. In such cases the minimum metacentric height which is essential to safety and efficiency has to be determined by entirely different considerations from those which apply to war ships, and those classes of mercantile steamers whose stability is of the character shown by the curves in Fig. 2. When we have to deal with vessels which even with no metacentric height will return to the upright, provided water does not get into the ship, and no large weights shift, whatever angle of inclination may be reached, the conditions of the problem are entirely changed. The principal object which then has to be









considered is to prevent too easy an inclination from the upright by the action of the wind and other forces which may operate upon her; and the question mainly turns upon what may fairly be considered sufficient for this purpose.

Many persons have been surprised on first learning how little metacentric height many high-sided mercantile steamers are in the habit of working with in safety. There are many steamers of the spar and awning-deck classes employed in carrying homogeneous cargoes, which have been performing their work for years, not only with perfect safety but without showing any signs of what nautical men call tenderness, the metacentric heights of which, during certain periods of their voyages, are frequently not more than 8 inches or even 6 inches. The latter figure may probably be regarded as about the minimum which such vessels approach without indicating to those on board that they are becoming unduly tender: but it is quite certain that many never show any such signs, and appear to be perfectly safe with 8 inches of metacentric height.

Vessels of this class have curves of stability of which those shown in Figs. 3 and 4 are types. The curves in Fig. 3 are for a spar-decked steamer 318 feet by 40 feet by 22 feet. The load draught is 23 feet 6 inches, and displacement 5760 tons; the freeboard being 8 feet 6 inches. Those in Fig. 4 are also for a spar-decked steamer 220 feet by 30 feet by 23 feet. The load draught is 16 feet, and displacement 2000 tons; the freeboard being 8 feet 6 inches. The curves marked A in each of these figures are constructed for 6 inches of metacentric height, and those marked B for 1 foot, in order that they may be compared with the corresponding curves in Fig. 2. The metacentric height of 6 inches is about what each of these vessels would have if laden to the draughts named with homogeneous cargoes, such as they frequently carry; and the metacentric heights of 1 foot are obtained by leaving a portion of such cargo out of the 'tween decks, and replacing it by an equal weight of ballast in the bottom.

It will be seen that the increase of righting moment in Figs. 3 and 4 continues up to a very large angle of inclination. This increase of righting moment tends to prevent dangerous inclinations being reached, while the smallness of the metacentric height causes such vessels to be very easy and comfortable in a seaway. Some steamers whose stability is of this character are vessels which carry cargoes liable to shift, such as grain or coals, and it may be thought that with cargoes of this class a small metacentric height is particularly unsafe, and that considerable initial stiffness is necessary to prevent any danger arising through shifting of cargo. Any opinions that may be formed upon this point are necessarily more or less speculative, as we have but little exact information to go by; but it should be borne in mind, in considering the question of initial stiffness in connection with shifting cargoes, that, although such stiffness increases the resistance to inclination, it increases at the same time the tendency to roll, and to displace or shift the cargo.

The question of the minimum metacentric height which may be regarded as consistent with safety in those types of ships where it is not governed in any degree by the necessity of providing range of stability, as shown by Figs. 3 and 4, is a subject which has never been much discussed, and which, on account of its important and immediate bearing upon the safety of many vessels at sea, is, in my opinion, deserving of the consideration of this Institution. If any of the remarks contained in this paper should serve to elicit opinions, information, or facts bearing upon the subject, my purpose in making them will be answered.

I may add, in conclusion, that the following are the main points which I have desired to lay before the Institution in this paper:—(1) The form in which the results of stability calculations can be put before owners and masters of mercantile steamers, so as to be of the greatest practical use in loading such steamers, and regulating their stability in accordance with the requirements that may arise; (2) the fundamental difference which exists between the relation of righting moments at large angles of inclination and range of stability to metacentric height in the various types of steamers, as shown by Figs. 2, 3, and 4, such relation making it necessary to fix the minimum metacentric height that should be allowed with due regard to the righting moments at large angles of inclination in some cases and unnecessary to do so in others; and (3) the minimum metacentric height that may be regarded as consistent with safety in cases where range of stability and the righting moments at large angles of inclination are so ample as not to call for consideration. The two latter points are so intimately connected with the first that they naturally require to be considered along with it.

THE INSTITUTION OF NAVAL ARCHITECTS

THE Institution of Naval Architects held its twenty-fifth Session at the Rooms of the Society of Arts on April 2, 3, and 4, Lord Ravensworth in the chair. Whilst the papers read were of course mainly on technical questions of naval construction, equipment, &c., some of them possessed points of general scientific interest, of which a brief account may be given. The President's address dealt mainly with what may be called the economic side of the shipping industry, dwelling on such points as the Merchant Shipping Bill, the length of time occupied in building ships of war, the depression of the carrying trade, &c. Passing on to the papers contributed, the first read was by Mr. J. D. Samuda on the *Riachuelo*, a steel armour-clad twin screw turret-ship of 6000 tons displacement, and 6000 horse-power, lately built by his firm for the Brazilian Government.

The second paper, by Mr. A. F. Yarrow, was on an Electrical Launch tried last year both on the Thames and on the Danube, and already mentioned in these columns. It dealt with the question from a practical and not an electrical point of view, and is so far valuable as presenting a fresh aspect of the question. On the whole the author's conclusions are satisfactory. He considers that there is even now a field for electrical launches in cases where the conditions are favourable, such as having a supply of cheap motive power for recharging the batteries; and that they are pre-eminently adapted for torpedo boats, owing to their being always ready for action, and their complete noiselessness when in motion. On the whole the advantages and disadvantages as compared with the steam-launch are summed up by Mr. Yarrow as follows, beginning with the former:—

1. Entire absence of noise.
2. Great cleanliness.
3. The whole of the boat is available for passenger accommodation, the midship or best part of it not being occupied by machinery.
4. When once charged it is ready for use at a moment's notice.

The points against it are:—

1. Difficulty and delay from frequent charging.
2. Greater first cost.
3. Greater cost of working in those cases where an engine has specially to be laid down for the purpose of charging.

The third paper read was on the Vibration of Steam-vessels, by Mr. Otto Schlick, which dealt with the shaking so well known to passengers on screw steamers from the practical and theoretical point of view. It is shown clearly that the phenomenon is merely due to the fact that the ship, considered as an iron girder, has one or more fixed periods of vibration depending on her length, her width, and other dimensions. With regard to the practical means of overcoming such vibrations, it is pointed out that anything which causes the engine to run at a different speed, for instance, the putting in of a new propeller, will probably have a favourable effect. The shifting of the screw to a different angle with regard to the cranks is recommended as often giving a good result, inasmuch as two of the forces causing the vibration may be balanced one against the other. An ingenious apparatus for measuring such vibrations is described by the author.

The morning of April 3 was occupied during the whole period of five hours by the reading and discussion of three papers on the burning question of Stability. One of these, on the Use of Stability Calculations in Regulating the Loading of Steamers, by Prof. Elgar, we print at length. Another, on Cross Curves of Stability, was read by Mr. W. Denny, the well-known shipbuilder of Dumbarton. He observes that stability curves are required for at least four draughts of any steamer, viz. the launching condition, the condition completely finished, but without any cargo, coals, &c., on board, the fully loaded condition, and the condition with the coals consumed. If the stability curve be also calculated for an intermediate draught between the second and third of these, five points will be obtained at each angle, by means of which a cross curve of stability can be produced. It is therefore of great importance to work out such cross curves and to find a method by which they can be readily constructed from the ordinary curves of stability. A method for doing this with the assistance of Amsler's Integrator has been devised, and when drawn the curves are also represented by means of a solid model. These cross curves are each for a given angle, and have the length of the righting arm varying with the draught or displacement. With such cross curves in number sufficient to cover angles at intervals of 10°, 15°, and 20°, and each ranging through all the draughts from the launched to the loaded condition, ordinary curves at any draught and with any height of centre of gravity can be easily obtained, and with great rapidity. The method employed is fully described, as is also another method due to Mr. Couwenberg. Tables are also given showing the results obtained for the same steamer by the two methods, which, though worked out separately, were found to agree very closely.

The third paper was on a New Method for Calculating the Stability of Ships, by M. Daymond. This is an elaborate paper of a theoretical character, illustrated with numerous diagrams. It gives the history of the means adopted for calculating stability, especially the method invented by M. Ferranti. The author's own method is an improvement on this. Having made for various ships numerous drawings which showed on the vertical section of the ship, in length and in direction, the arms of the righting levers, for various draughts and inclinations, he conceived the idea of joining by continuous lines the extremities of these arms corresponding to the same angle of inclination. Taking such angles at intervals of 10°, he thus obtains a curve which he calls the "pantocarène isocline," and from these curves he obtains at once with complete accuracy and for all possible cases the usual curves of statical stability. The paper gives the principal properties of these curves, together with the mode of their calculation and various examples of working. The paper had been translated by Sir E. J. Reed, who may therefore be considered to have lent his authority to the value of the method proposed. The discussion on these papers turned mainly on unimportant and to some extent personal questions, and, though animated, does not need production here.

On Thursday evening, April 3, the most important paper was one by Mr. James Howden on Combustion of Fuel in Furnaces and Steam Boilers by Natural Draught and by Supply of Air under Pressure. The object of it was to describe a new boiler on which the author was experimenting, and which, if his account be correct, is likely to realise very important advantages in the way of economy of fuel. The experiments are not concluded, but the author considers them to justify him in claiming a most extraordinary economy as compared with ordinary marine boilers. Taking the instance of the Oregon, the latest-built of the swift Atlantic liners, he professes that the coal consumption might be reduced from 31,000 to 19,000 lbs. per hour, with an equal supply of steam and with a diminution in the fire-grate surface from 1512 to only 641 square feet. In the discussion which ensued very grave doubts were expressed as to the reality of such a saving, and it would probably have been more wise if the author had completed his experiments before claiming so very large a step in advance.

The next paper, by Mr. A. B. Broun, on the Application of Hydraulic Machinery to the Loading, &c., of Steamships, gave an interesting account of a complete hydraulic system applied to all the work required in an ordinary vessel, but did not raise any theoretical questions. A paper was then read by Mr. J. F. Hall, on Cast Steel as a Material for Crank Shafts. The author, who belongs to the well known firm of Messrs. Jessop of Sheffield, advocated the making of these important parts of a ship by the ordinary method of casting steel, without any subsequent hammering or working. His view is that such hammering can never reach the centre of a large mass of steel, such as an ingot; and that even if it did it would not completely weld up and remove the cavities which are not infrequently found in that region. In fact his view was that forging actually did harm by consolidating the outer layers and preventing them from contracting subsequently, as the hotter interior shrank in its cooling. By using ordinary methods of casting, and taking care to have a sufficient head or column of metal standing up above the casting itself, he considered that all fear of cavities within the latter was removed. Any unsoundness would be found only within the column, which would of course be cut off when the casting was cool.

The remaining papers, read on Friday, will not require any extended notice. That of Mr. P. Jenkins, on the Construction of Metacentric Diagrams, was a theoretical paper, dealing with the problem of stability, and chiefly devoted to establishing the following theorem:—"For any position of the centre of gravity the initial righting moment is either a maximum or a minimum when the water plane is so placed that the centre of curvature of the curve of flotation is at the same height in the vessel as the centre of gravity." Another contribution to the same problem, that of stability, was read by Mr. S. Benjamin, and described a model or apparatus enabling a shipowner to determine the position of the centre of gravity of his vessel for any loading before she is loaded, and also the alteration of its position due to any subsequent change in the loading. Yet another paper, by Dr. A. Amsler, described the application of the integrating apparatus which bears that name to such calculations as those of the curves already mentioned in Mr. Denny's paper. Mr. J. E. Spence described a form of diagram exhibiting in a simple shape all the data depending on the form of a ship which are required for determining her stability, and also a simple and direct method of graphic calculation for attaining these data. Mr. Thomas Phillips read a paper on the comparative safety of the particular class of vessels known as "well-decked" steamers. These were formerly treated with some suspicion by underwriters, but great improvements have lately been made, some of which were described in the paper, and with these the vessel appears to be even safer than what are called "flush" ships. Lastly, Mr. A. Taylor described a special instrument invented by him, and called a Stability Indicator, for determining the initial stability and stowage of ships at any displacement.

Mr. H. H. West read a paper on the Riveting of Iron Ships, giving tables for calculating the plate and rivet area for double-riveting, treble-riveting, and quadruple-riveting. He referred to the researches of Sir Edward Reed, the Institution of Mechanical Engineers, and others, but did not mention the modification of treble-riveting proposed some years ago, and lately carried into effect by a firm in Holland. On this system, in the middle row of the three rows of rivets, the rivets are spaced only half the distance apart of the two outer rows, the result being to increase very largely the proportion of strength. Capt. Heathorn described an arrangement called by him a Water-brake, for stopping the way of a ship in cases of collision or otherwise; and finally, Mr. J. E. Liardet described an apparatus for indicating the position of a ship's helm.

On the whole the Institution is to be congratulated on the interest and importance of the papers provided for it, and still more on the vigour and ability with which they were discussed by the very eminent engineers and shipbuilders who thronged the rooms of the Society of Arts for the purpose.

SCIENTIFIC SERIALS

Bulletin de l'Académie R. de Belgique, January 5.—On the existence of a fourth species (*B. borealis*) of the genus Balænoptera in the North Atlantic and Arctic Oceans, by M. Guldberg.—On the action of chlorine on combinations of sulphur, and on organic oxysulphurets, third communication, by M. W. Spring.—Researches on spermatogenesis in the Selacians (*Scyllium catulus, Sc. canicula, Raja clavata*), the salamander and mammals, by Prof. A. Swaen.—Essays on the political history of the last three centuries, by M. Van Praet.—Biographical notice of the painter Michael Van Cocxyen of Mechlin, by M. Castan.

Atti della R. Accademia dei Lincei, January 20.—Letter from King Humbert announcing an additional annual grant of 400*l*. for the promotion of biological studies, to be distributed in prizes in any way the Academy may think fit.—Some philological remarks on the 104th Psalm, by Guidi Ignazio.—Notice of an unpublished work of Prince Federico Cesi, entitled "De Laserpiteo et Laserpitii pluvia," in the library of the Botanic Institute at Padua, by Prof. A. Favaro.—Note on the antiquities discovered at Ventimiglia, Montefiascone, Naples, Pompeii, and other parts of Italy during the month of December 1883, by S. Fiorelli.

February 3 and 4.—Notice of some unpublished writings of Galileo Galilei in the National Library of Florence, by Prof. Favaro.—Report on Prof. Bellonci's work "On the Segmentation of the Egg of the Axolotl," by S. Trinchese.—Report on Dr. G. Frattini's work "On Some Propositions in the Theory of Substitutions," by S. Battaglini.—Report on Dr. L. Macchiati's work on the chemical nature of chlorophyll, by S. Cannizzaro.—Observations of the solar spots and faculæ made at the Observatory of the Collegio Romano during the year 1883, by Pietro Tacchini.—On the temperature corresponding to the Glacial period, third note, by Pietro Blaserna.—On the extraordinary crepuscular phenomena observed during the last few months, by Lorenzo Respighi.—Contributions to the study of the carbopyrolic acid *a*, by G. L. Ciamician and Paolo Silber.—Remarks on the Veronese Chelonian (*Protosphargis veronensis*) discovered in 1852 in the Upper Chalk near St. Anna di Alfaedo in Valpolicella, by Giovanni Capellini.—Geological observations on the islands of the Tuscan Archipelago, by B. Lotti.—Reports on the competition for the Royal Prizes for Physics, History, and Geography for the year 1882, by Signors Cantoni and Villari.—Reports on the Ministerial prizes for the Philosophical, Social, and Natural Sciences for the year 1883, by Signors Bonatelli and Trinchese.

February 17.—Obituary notices of the late Pietro Canal and Edoardo Laboulaye, Members of the Academy, by the President.—On the practice of burying human bones stripped of the flesh in Neolithic times, by Luigi Pigorini.—Note on the antiquities discovered at Felonica, Este, Imola, and in other parts of Italy during the month of January 1884.—Remarks on some codices in the Angelica Library connected with patristic theology, by Enrico Narducci.—Note on the parabolic orbit of the comet (*e*) discovered by Hartwig at Strasburg on August 24, 1879, by E. Millosevich.—On a remarkable disposition of the isogonic lines of terrestrial magnetism observed in the eastern districts of the Valley of the Po (two illustrations), by Ciro Chistoni.

Rivista Scientifico-Industriale, February 15 and 29.—Description of a new apparatus for the measurement of electro-motor forces (four illustrations), by E. Reynier.—Mathematical demonstration and value of the angle of least deviation described by a ray of light in its passage through a prism (one illustration), by Giuseppe Vanni.—Practical determination of the metallic resistance and chemical reaction of an electrolytic circuit, by Eugenio Marchese.—On the causes of the remarkable after-glows witnessed in Italy and elsewhere in 1883-84, by Prof. Carlo Marangoni. The author compares these phenomena with others of an analogous character observed in various parts of Europe in the year 1869. On several grounds he infers that the pink and red glows could not have been produced by moisture disseminated in the atmosphere in the solid, liquid, or gaseous state. He concludes that they are due to the presence of dust or minute particles of sand, which absorb the coloured rays in the central region of the solar spectrum while transmitting the extreme colours—that is, red and violet. The paper, which is to be continued, offers no suggestion as to the possible origin of the particles of dust to which the phenomena are attributed.—Note on the extinct and living mollusks of the Gardone district, by Prof. Strobel.—On the fossil insects of the Carboniferous schists of Commentry, by S. Brongniart.—Note on the limits of diatomaceous vegetation in marine basins, by Count A. F. Castracane.

Rendiconti del Reale Istituto Lombardo, February 21.—Biographical notice of Carlo Tenca and his times, by Prof. Giovanni Cantoni.—Some reflections on the results of the recent examinations in the Italian language and literature in the higher schools of the Peninsula, by Prof. C. Baravalle.—Fresh researches on the oxidation of sulphur, with some remarks on the oxidising power of the so-called atomic oxygen and of ozone, by Prof. E. Pollacci.—On some cases of subcutaneous nervous affections caused by the presence of Oscyuris, Tænia, Solium, and other parasites, by Prof. A. Scarenzio.—On the relations between the malady known as "bronze skin," and the changes in the supra-renal blood capsules, by Prof. G. Sangalli.—Meteorological observations made in the Brera Observatory, Milan, during the month of February 1884

SOCIETIES AND ACADEMIES

London

Royal Society, March 27.—"On the Electro-chemical Equivalent of Silver, and on the Absolute Electromotive Force of Clark Cells." By Lord Rayleigh, D.C.L., F.R.S.

The investigations upon this subject which have been carried on by Mrs. Sidgwick and myself during the last year and a half, though not yet quite finished, are so far advanced that no doubt remains as to the general character of the results; and as these results have application in the daily work of practical electricians, it is thought desirable to communicate them without further delay.

The currents are measured by balancing the attraction and repulsion of coaxal coils against known weights, as described before the British Association in 1882, a method which has fully answered the favourable expectations then expressed. To what was said on that occasion it will be sufficient for the present to add that the readings are taken by *reversal* of the current in the fixed coils, and the difference of weights thus found (about 1 grm.) represents the double force of attraction free from errors depending upon the connections of the suspended coil, and other sources of disturbance.

The difficulties which have been experienced, and which have been the cause of so much delay, have related entirely to the behaviour of the silver voltameters, of which never less than two, and sometimes as many as five, have been included in the circuit of the measured current. In order to render the deposit more compact, and thus to diminish the danger of loss in the subsequent manipulations, *acetate* of silver was added in the earlier experiments to the standard solution of nitrate. Experience, however, has shown that the principal risk is not in the loss of metal, but in the obstinate retention of salt within the fine pores of the deposit, leading to an over-estimate of the amount. When the texture is very compact, this danger increases, and deposits from a solution containing acetate are often decidedly too heavy, even after the most careful and protracted washings. On heating to low redness a portion, at any rate, of the retained salt is decomposed NO_2 is driven off, and a loss of weight ensues. With pure nitrate, to which we finally recurred, the risk is much less.

The actual weights of deposited silver were usually from 2 to 3 grms., and, so far as the mere weighings are concerned, should have been correct to 1/10,000. Discrepancies three or four times as great as this are, however, actually met with, whether due to retention of salt or to loss of metal it is difficult to say. The final number, expressing in C.G.S. measure the electro-chemical equivalent of silver, is a little lower than that ($1 \cdot 119 \times 10^{-2}$) given on a previous occasion (*Cambridge Proceedings* for November 26, 1883). It approximates closely to $1 \cdot 118 \times 10^{-2}$, and is thus in precise agreement with the number announced within the last few weeks by Kohlrausch, viz. $1 \cdot 1183 \times 10^{-2}$. Its substantial correctness can therefore hardly be doubted, more especially as it does not differ very much from the number (1·124) obtained by Mascart. In terms of practical units, we may say that the ampere current deposits per hour 4·025 grms. of silver.

When we are provided with means for the absolute measurement of currents, the determination of electromotive force is a very simple matter if we assume a knowledge of absolute resistance. A galvanic cell is balanced against the known difference of potentials generated by a known current in traversing a known resistance. The difficulty relates entirely to the preparation and definition of the standard cells. A considerable number of Clark cells have been set up and tested at intervals during the last six months, and their behaviour has been satisfactory, the extreme range after the first ten days) not much exceeding 1/1000. A modified form of cell, in which the solid zinc is replaced by an amalgam, is at present under trial.

In Mr. Latimer Clark's own determination the B.A. unit is assumed to be correct, and the E.M.F. of the cell at 15° C. was found to be 1·457 volt. *On the same assumption* we obtain the not greatly differing value 1·453 volt. If we take the true value of the B.A. unit as ·9867 ohm, 1·453 will be replaced by 1·434.

Experiments are also in progress to determine in absolute measure the rotation of the plane of polarisation of light in bisulphide of carbon under the action of magnetic force. Of the results obtained by Gordon and Becquerel, differing by about 9 per cent., our preliminary measurements tend rather to confirm the former.

Mathematical Society, April 3.—Prof. Henrici, F.R.S., president, in the chair.—The Rev. A. C. E. Blomfield was admitted into the Society.—The following communications were made:—On double algebra, by Prof. Cayley, F.R.S.—On the homogeneous and other forms of equation of a plane section of a surface, by J. J. Walker, F.R.S.—A direct investigation of the complete primitive of the equation $F(x, y, z, p, q) = 0$, with a way of remembering the auxiliary system, by J. W. Russell.—On electrical oscillations and the effects produced by the motion of an electrified sphere, by J. J. Thomson.

Chemical Society, March 31.—Anniversary Meeting.—Dr. W. H. Perkin, F.R.S., president, in the chair.—The President read his annual address. The number of Fellows is at present 1324. During the past twelve months the Society has lost by death nineteen Fellows, including Sir C. W. Siemens, Messrs. W. Spottiswoode, J. T. Way, and J. Young. After briefly alluding to the more important advances in chemical science, the president drew attention to the fact that the number of original papers read before the Society had steadily decreased since 1881, notwithstanding the steady increase in the number of Fellows, and the greater facilities for the study of chemistry now offered by the numerous laboratories recently opened. The Longstaff Medal was awarded to Mr. O'Sullivan. The following Officers and Council were elected:—President: Dr. W. H. Perkin, Ph.D., F.R.S.; Vice-Presidents: Sir F. A. Abel, Warren De La Rue, E. Frankland, J. H. Gilbert, J. H. Gladstone, A. W. Hofmann, W. Odling, Sir Lyon Playfair, H. E. Roscoe, A. W. Williamson, P. Griess, G. D. Liveing, E. Schunck, T. E. Thorpe, A. Voelcker, W. Weldon; Secretaries: H. E. Armstrong, J. Millar Thomson; Foreign Secretary: H. Müller; Treasurer: W. J. Russell; Members of Council: E. Atkinson, H. T. Brown, T. Carnelly, M. Carteighe, R. J. Friswell, W. R. E. Hodgkinson, D. Howard, F. R. Japp, R. Meldola, R. Messel, C. O'Sullivan, C. Schorlemmer.

Geological Society, March 22.—Prof. T. G. Bonney, F.R.S., president, in the chair.—The Rev. Frank Ballard, M.A., was proposed as a Fellow of the Society.—The following communications were read:—On *Rhytidosteus capensis*, Owen, a Labyrinthodont Amphibian from the Trias of the Cape of Good Hope, by Sir Richard Owen, K.C.B., F.R.S. The author first noticed the discovery of certain forms of Amphibia belonging to the genera *Labyrinthodon*, *Brachyops*, *Petrophryne*, and *Rhinosaurus*, and called attention to certain typical peculiarities in the structure of the teeth, the form of the bony palate, and the double occipital condyle. An imperfect cranium of the species now described as *Rhytidosteus capensis* was procured by Mr. Heer in the Orange Free State from the Trias of Swanopol, Beersheba, and deposited by him in the Bloemfontein Museum. This specimen, which was brought to England and submitted to the author by Dr. Exton, consists of the anterior portion of the skull with part of the mandible attached. The general form is batrachoid, and one of the hinder palato-vomerine teeth, on being examined microscopically, exhibited the characteristic labyrinthodont structure. The surface of the skull, and the characters of the premaxillary, nasal, frontal, and prefrontal bones were described. The parietals and postfrontals are imperfect, the hinder part being lost. The rami of the mandible are also imperfect behind, but a broken fragment shows the articular surface. The vomerine bones were also described, with the posterior nostril and the teeth before and behind this opening. The breadth of the bony palate at its hinder fractured border is 5 inches; the length of the part preserved 4¼ inches; the mandible, when perfect, was probably from 11 inches to a foot in length. The author also gave an account of the dentition wielded by the premaxillary, maxillary, vomerine, palatine, and mandibular bones. The author pointed out that the type of air-breathing vertebrates to which the present genus belongs reached its highest development in the Triassic period in Britain, Russia, North America, Hindostan, and South Africa. The only known antecedent form from which the labyrinthodont structure of tooth might have been derived is a genus of fishes named *Dendrodus*, in the Old Red Sandstone. The Liassic Ichthyosaurs also show some similarity in tooth-structure; but in them there is far greater simplicity.—On the occurrence of antelope-remains in Newer Pliocene beds in Britain, with the description of a new species, *Gazella anglica*, by E. Tulley Newton, F.G.S.—A comparative and critical revision of the Madreporaria of the White Lias of the Middle and Western Counties of England, and of those of the Conglomerate at the base of the South-Wales Lias, by Robert F. Tomes, F.G.S.

Zoological Society, April 1.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—Prof. Flower exhibited and made remarks on a series of skulls of the Bottle-nosed Whale (*Hyperoodon rostratus*), illustrating the various stages presented by this animal as regards the conformation of its skull in the different ages of both sexes. Prof. Flower also exhibited, on behalf of Messrs. Langton and Bicknell, a specimen of spermaceti obtained from the head of the *Hyperoodon*.—Mr. Sclater exhibited and made remarks on specimens of the eggs of two species of Testudinata (*Testudo elephantopus*, and *Chelys matamata*) recently laid by animals living in the Society's Gardens.—Mr. R. Bowdler Sharpe exhibited and made remarks on a Red-throated Pipit (*Anthus cervinus*) caught near Brighton in March last. Mr. Sharpe exhibited at the same time an example of the true Water-Pipit (*Anthus spinoletta*) captured at Lancing, in Sussex, in March 1877.—Prof. E. Ray Lankester, F.R.S. exhibited and made remarks on a large living Scorpion (*Buthus cyaneus*) from Ceylon.—A communication was read from Prof. T. Jeffrey Parker, being the first of a series of studies in New Zealand Ichthyology. The present paper gave a description of the skeleton of *Regalecus argenteus*. The species was founded on a specimen cast ashore at Moeraki, Otago, in June 1883.—A communication was read from Viscount Powerscourt, F.Z.S., containing an account of the origin and progress of the herd of Japanese Deer at Powerscourt.—A communication was read from Mr. G. A. Boulenger, giving the diagnoses of some new Reptiles and Batrachians from the Solomon Islands, collected and presented to the British Museum by Mr. H. B. Guppy, of H.M.S. *Lark*.—A communication was read from Mr. C. O. Waterhouse, containing an account of the coleopterous insects collected by Mr. H. O. Forbes in the Timor-Laut Islands.—Mr. F. D. Godman, F.R.S., read a paper containing an account of the Lepidoptera collected by the late Mr. W. A. Forbes on the banks of the Lower Niger, the Rhopalocera being described by Messrs. F. D. Godman and O. Salvin, and the Heterocera by Mr. H. Druce. The species of butterflies were fifty in number, and comprised representatives of all the families of Rhopalocera hitherto known from Tropical Africa, except the Erycinidæ, a group but feebly developed in this region.—Mr. R. Bowdler Sharpe read the description of three rare species of Flycatchers, viz. *Alseonax minima*, *Lioptilus abyssinicus*, and *Lioptilus galinieri*. Mr. Sharpe also described an apparently new species of Nuthatch discovered by Mr. John Whitehead in the mountains of Corsica, and proposed to be called *Sitta whiteheadi*.—Mr. G. E. Dobson, F.R.S., read a paper on the myology and visceral anatomy of *Capromys melanurus*, of which rare mammal specimens had been lately obtained for him by Mr. F. W. Ramsden, H.M.'s Consul at St. Jago de Cuba. The well-known division of the hepatic lobes into minute lobules in *C. pilorides* from the same island was shown not to exist in *C. melanurus*, which otherwise closely resembled the former species, and this character could therefore no longer be considered a generic one.

EDINBURGH

Royal Society, March 3.—Sir W. Thomson, hon. vice-president, in the chair.—Sir W. Thomson communicated a paper on the efficiency of clothing for maintaining temperature. He showed that if a body be below a certain size, the effect of clothing will be to cool it. In a globular body the temperature will only be kept up if the radius be greater than $\frac{k}{2e}$, where k is the conductivity of the substance and e its emissivity.—Prof. J. Thomson read a paper on the law of inertia, the principle of chronometry, and the principle of absolute clinural rest and of absolute rotation. In this paper the author proceeded to discriminate between what men can know, and what men cannot know, as to rest and motion in unmarked space. For example, men have no means of knowing or imagining whether a ball existing in space is in motion or at rest; nor have they any means, if it be in motion, of knowing or imagining any one direction, rather than another, as being the direction of the straight line from the place that was occupied by its centre at any past instant to the place occupied by that centre at present. There is then an essential difficulty as to our forming a distinct conception either of rest or of rectilinear motion through unmarked space. He discussed, in connection with this, the statement set forth by Sir Isaac Newton, under the designation of the first law of motion, that *every body continues in its state of resting or of moving uniformly in a straight line, except in so much as, by applied forces, it is compelled to change that state.* A most important truth in the nature of things, perceived with more or less clearness, was, he said, at the root of that enunciation; but the words, whether taken by themselves, or in connection with Newton's accompanying definitions and illustrations, were inadequate to give expression to that great natural truth. He proceeded to explain the character of mutual motions, which can in any sense be regarded as uniform rectilinear mutual motions. He gave, under the title of the law of inertia, an enunciation which he offered as setting forth, by a better expression, all the truth which is either explicitly stated, or is suggested by the first and second laws of motion in Sir Isaac Newton's arrangement. In connection with the law of inertia he gave further statements bringing out expressions of the principle of chronometry and the principle of "directional fixedness" or of absolute clinural rest, and of absolute rotation.—Sir W. Thomson described a modification of Gauss's method for determining the horizontal component of terrestrial magnetic force and the magnetic moments of bar magnets in absolute measure.—Mr. Thomas Muir gave a paper on the phenomenon of greatest middle in the cycle of a class of periodic continued fractions.

March 17.—Robert Grey, vice-president, in the chair.—Messrs. Peach and Horne, of the Geological Survey of Scotland, communicated a paper on the Old Red Sandstone volcanic rocks of Shetland.—Mr. P. Geddes gave the first two parts, mathematical and physical, of a paper on the principles of economics.—Prof. Crum Brown communicated a paper by Prof. Michie Smith on an integrating hygrometer.

DUBLIN

University Experimental Science Association, March 18.—On the boiling-points of the haloid ethers, by F. Trouton.—On a new test for gallic acid, by A. E. Dixon, B.A. The crimson-red colour which Dr. Sidney Young had noticed on adding a solution of cyanide of potassium to a solution of gallic acid, and which a few minutes' rest or gentle warmth causes completely to disappear, is probably due to oxidation. For although when shaken in contact with the air the colour reappears, it will not do so when shaken in an atmosphere of hydrogen, nitrogen, or carbon dioxide. On re-exposure to the air, with agitation, the colour may be brought back. The red colour is not dissolved out by alcohol, ether, or chloroform; neither does it afford any characteristic absorption-spectrum.—On Ayrton and Perry's electrometers, by G. F. Fitzgerald, F.R.S.—An electro-magnet for use in analysis was exhibited by J. Joly, B.E. The electro-magnet is sealed into a test-tube to enable it to be dipped into solutions containing perruginous particles.

PARIS

Academy of Sciences, March 31.—M. Rolland in the chair.—Remarks on the third volume of the "Annals of the Bureau of Longitudes," presented to the Academy by M. Faye.—On a proposed classification of comets according to their direct or retrograde motion, by M. Faye.—Note on the form of the nucleus of the Pons-Brooks comet, by M. Faye.—On the specific heat of gaseous elements at very high temperatures, by MM. Berthelot and Vieille.—Note on the origin of sugar of milk, by M. Paul Bert. From experiments made on goats the author infers that the sugar of milk is produced by the mammary secretion of the superabundant sugar formed by the organisms after parturition, most probably in the liver.—On a new species of fossil Sirenian found in the Paris Basin, by M. A. Gaudry.—On the correspondence between two different species of functions of two systems of quantities correlated and equal in number, by M. Sylvester.—Separation of gallium; separation from organic substances, by M. Lecoq de Boisbaudran.—On a modified form of lightning-conductor, by M. A. Callaud.—Results of experiments with a new ventilating system worked by centrifugal force, by M. L. Ser.—Observations made at the Meudon Observatory on the planet Mars, by M. E. L. Trouvelot.—Approximate calculation of the thrust and surface of fracture in a homogeneous horizontal mass of earth supported by a vertical wall, by M. J. Boussinesq.—On Gyldén's differential equation:—

$$\frac{d^2x}{dt^2} = \phi_0 + x\phi_1 + x^2\phi_2 + \ldots + x^m\phi_m + \ldots$$

in which the ϕ's are trigonometrical series, by M. Poincaré.—Distribution of the potential in a rectangular plate traversed by an electric current with permanent *régime*, by M. A. Chervet.—On the electric phenomenon of the transport of ions and its relation to the conductivity of saline solutions, by M. E. Bouty.—On the resistance of the carbons employed in the electric light of the French lighthouses, by M. F. Lucas.—Note on the verification of the laws of transverse vibration in elastic rods, by M. E. Mercadier.—The general theory of dissociation deduced from the general data furnished by the mechanical theory of heat, by M. Isambert.—Note on the measurement of the tension of dissociation in the iodide of mercury, by M. L. Troost.—On the phenomenon of the crystalline superheating of sulphur, by M. D. Gernez.—On the non-existence of the hydrate of ammonium, by M. D. Tommasi. The author's experiments lead him to the conclusion already arrived at by Thomsen, that hydrate of ammonium does not exist in ammoniac water.—On the decomposition by water of the combinations of cupreous chloride with the chloride of potassium and chlorhydric acid, by M. H. Le Chatelier.—On the composition of pitch-blende, by M. Blomstrand. From his analysis the author concludes that this substance is a mixture of uranine, silicates, carbonate of lime, and sulphuret of iron, its formula being:—

$$2U_7Pb(O_6U_3) + 5(R_2O_4Si, 2Aq) + 7(CaO_2CO) + \tfrac{1}{2}\,Fe_7S_8.$$

—Note on the quantitative analysis of the phosphoric acid in arable lands, by M. G. Lechartier.—Heat of formation of the fluoride of silver, of magnesium, and of lead, by M. Guntz.—Thermochemical study of hydrofluosiliceous acid, by M. Ch. Truchot.—On the glyoxalbisulphide of soda, by M. de Forcrand.—On the influence of cerebral lesions on the temperature of the body, by M. Ch. Richet.—On the special distribution of the motor roots of the brachial plexus in the human system, by MM. Forgue and Lannegrace.—Description of a gigantic Dictyoneura (*D. monyi*) found in the Carboniferous measures of Commentry (Allier), by M. Ch. Brongniart. This remarkable insect must have been at least fifty centimetres long.—On the origin of the roots in the ferns, by M. Lachmann.—On the causes which may modify the effects of the action of light in directing the motion of plants, by M. E. Mer.—On the diffusion of christianite in the ancient lavas of the Puy-de-Dôme and the Loire Basin, by M. F. Gonnard.—Note on the origin of certain phosphates of lime found in mass in the limestones of the Secondary series, and of certain iron ores belonging to the class of globular ores, by M. Dieulafait.—On the solar halos observed at Saint Maur on the morning of March 29, by M. E. Renou.—Note on the presence of manganese in the wines of Grave, by M. E.-J. Maumené.

BERLIN

Physical Society, March 7.—Prof. Neesen, by means of different glass tubes, demonstrated certain phenomena of Kundt's dust figures produced by experimenting with deep tones. Busied with an examination into the cause, not yet explained, of the transverse ridgings in sounding-tubes, Prof. Neesen has, instead of the high tones of longitudinally-vibrating tubes, tested deeper tones, which are kept up in the column of air of the glass tubes by an electric tuning-fork. In the course of this investigation he made very beautiful observations in many tubes of dust-whirls roaming hither and thither, now to one side, now to the other. In other tubes, again, these whirls came to light either with great difficulty or but imperfectly. It would therefore appear that the material of the tubular wall exercised some influence on the production of those whirls. The speaker had yet, however, come to no definite result respecting the cause of the transverse ridges.—Dr. Kœnig supplemented the experiments he communicated at the last sitting of the Society, on the sensitiveness of normal eyes for variations of colour between the wave-lengths of 640 and 430. This he had so far done, inasmuch as he had tested the influence of light-intensity on the sensibility in question. Seeing, as was well known, that light-intensity, in this part of the spectrum especially, mounted very rapidly from the line C to the line D, and again sank from the maximum beyond D down to F, it would be possible that the differentiating sensibility arrived at in the former experiments was in large part conditioned by the differences of intensity. The cooperation of intensity was now in the new experiments partly excluded as a factor in this way, that the spectrum was observed through an absorbing medium whose maximum of absorption stood at D, so that the curve of light-intensity between C and D rose with much less rapidity, ran horizontally for some distance, and then sank to D. The measurements, being carried out as in the former experiments, yielded the result that the differentiative sensibility under the conditions mentioned had undergone very little alteration, and that, consequently, light-intensity had no influence on the range that had been arrived at.—Prof. von Helmholtz reported on a theoretic treatise he had laid before the Berlin Royal Academy, in which he had taken in hand the task of explaining, in accordance with mechanical principles, thermal movements, and more particularly Carnot's law. He attained his object by means of the rules bearing on stationary movements, as they were calculated for a vortex revolving without friction and with great velocity, or for a fluid moving without friction in a closed circular canal. The equations for these stationary movements derived from mechanics corresponded with those derived from Lagrange's law for thermal movements.

Physiological Society, March 14.—Prof. Lucae gave an address on the subject of subjective auricular sensations and their treatment. He showed by examples that the idea that subjective auricular sensations, and in particular the generally known one of singing in the ears, had a somatic cause, such as stoppage of the external acoustic duct or of the Eustachian tube, was not in accordance with experience. Both on himself and on persons of musical culture he had determined the pitch of the singing or whistling sound, and had found it equal to the proper tone of the external acoustic duct. This circumstance, together with several other facts, led him to the conjecture that the singing in the ears was caused by a tetanus of the tensor tympani, which set the air over the membrane of the tympanum in continuous oscillation. In cases of suffering from this distemper, of which the speaker cited a number of examples, the subjective auricular sensations were to be divided into such as were intensified and such as were abated by external sounds. Both kinds were to be regarded as phenomena of abnormal resonance, and were accompanied by different degrees of hardness of hearing down to deafness. The treatment of these subjective sensations, so far as they were simple tones and noises, and not the subjective hearing of words or of anything outside the hearer (disturbances psychological and beyond the scope of his address) consisted, in the opinion of the speaker, an opinion based on manifold personal experience, in subjecting the sufferers, for progressively longer periods of time, and for as many as two to three minutes at once, to a certain constant tone of the tuning-fork. In such a case Prof. Lucae used deep tuning-forks with such as heard subjective high tones, and *vice versâ*. With the cessation of the subjective noises the deafness also usually disappeared, and the sufferers recovered a permanently normal state in this respect. An explanation of this phenomenon the speaker thought might be found in the analogy of other sensations in which abnormal excitement in one part of the sensory nerves was relieved by the excitement of neighbouring nervous parts.—Prof. Munk reported on a treatise sent for insertion in the *Verhandlungen* by Dr. Gad, a foreign member. Contrary to the opinion on the subject hitherto entertained, Dr. Gad in this treatise proved that in the spinal marrow of frogs, even under the seventh nerve-root, there were reflex centres in operation. By cutting through the spinal marrow below this spot, reflex convulsions from the toes upwards are produced, not only on the same but also on the opposite side. In other experiments on frogs the spinal marrow was cut through beneath the medulla oblongata, and the upper part of the spinal marrow as far as the second vertebra carefully prepared and laid on filtering paper saturated with strychnine. On stimulating the frog at the lower extremities reflex movements were seen to pervade the whole body, but in the region of those sections of the spinal marrow treated with strychnine, flexor spasms were observed, though it is well known to be a special characteristic of the strychnine spasm that it exclusively attacks the extensor muscles. In this way was demonstrated the existence of conducting tracks rising from the reflex centres situated in the lowermost part of the spinal marrow up to its topmost parts. If these latter, again, were electrically stimulated, no flexor movement could be started from the spot which before, under the operation of strychnine, had generated exterior reflections. Between this part of the spinal marrow and the motory nerves there must therefore lie ganglia.—Following up his communication at the last sitting, on the presence of nitric acid in urine, Dr. Wey[illegible] brought before the Society a series of chemical reactions tending to demonstrate that nitric acid could exist and be substantiated in an oxidised solution along with urea.

CONTENTS

THURSDAY, APRIL 17, 1884

SAMOA

Samoa. A Hundred Years ago and long before. By George Turner, LL.D. With Preface by E. B. Tylor, F.R.S. (London: Macmillan and Co., 1884.)

FOR the purposes of comparative ethnology Dr. Turner's new work on Samoa, that group of ten islands in the Pacific which the Frenchman Bougainville named the Navigators' Islands in 1768, is entitled to stand in the same rank with such books as Williams's account of Fiji or Mariner's "Tongan Islands." The careful study of Samoan beliefs and customs for a period of more than forty years confers unusual authority on the writer's statements, whilst his description of their heathen condition derives more than ordinary value from the fact of his having been among the earliest missionaries who visited the islands. Mr. Tylor, in the short preface he has prefixed to the book, speaks with justice of the peculiar interest which attaches to a work that describes Polynesian life as seen in its almost unaltered state before contact with European races had inaugurated a period of rapid change and made what was original and native indistinguishable from what was of foreign importation.

Complete as is the account given by Dr. Turner of Samoan life generally, of the government, social condition, and laws, of the people's food, their houses, or their canoes, the main interest and value of the work lies in the chapters which deal with the religious and mythological ideas of the Samoans. The book in this respect is not only a storehouse of curious myths and legends, but it helps to throw light on the vexed question of the origin of mythology as known in other parts of the world. The whole of Samoan mythology is based on the conception of the male and female nature of all things, such as we still find traces of in the genders of European languages. Thus, according to their cosmogony, from the marriage of the high rocks and the earth rocks sprang the earth, from the marriage of the earth and the high winds sprang the solid clouds, and so on till they come to the gods and chiefs down to the individual who was proclaimed king in the year 1878.

Stories betraying the same rude conception of nature abound. A girl turns into a mountain without difficulty (p. 117); a certain stone is a coward who fled in battle (p. 45); certain trees are transformed men (pp. 119, 219). The important thing is that these and similar stories are spoken of as "seriously believed" by many. "In all these stories the Samoans are rigid literalists and believe in the very words of the tradition" (p. 214).

Samoan ingenuity has its explanation for the origin of most things: of man himself; of the name Samoa as well as of that of all the islands and their chief places; of springs (p. 10); of the sea (p. 12); of pigs (p. 111); and, strangest of all, the story of the origin of cocoa nuts (p. 244).

Dr. Turner reckons the number of Samoan deities that had come to his knowledge at 120, yet there was a time when the Samoans were said to have no religion of any kind. Each individual, each household, each village, had his or its peculiar god, incarnate generally in some creature, but sometimes in a stone, a shell, or even a star. The rules and ceremonies of this fetichistic religion resembled very much those in vogue in America or Africa. A man, while considering it death to cut or injure the incarnation of his own god, would owe no respect to the incarnation of his neighbour's. Illnesses and death were the result of some offence against the gods, and prayers and offerings played in consequence a large part in the daily life of the Samoans.

An ill-defined supremacy among the gods belonged to Tangaloa. He made the heavens and the earth. He was specially prayed to before war, before fishing, or before planting, and thunder was the sign that the prayer was heard (p. 53). Like Zeus, he sometimes was attracted by mortal women, and to obtain the lady who ultimately became his wife he sent down first thunder and storm, then lightning and darkness and deluging rain, and, last of all, a net in which he succeeded in catching her (p. 232).

The souls of dead Samoans started for Pulotu, the spirit-world, through two circular holes near the beach, the larger hole being for the souls of chiefs, and the lesser for those of commoners. They went under the sea till they came to a land where all things were very much as they had been on earth. Chiefs looked forward with pride to the use of their bodies as pillars in the house of the Samoan Pluto (p. 260).

In the Tongan Islands there was the same belief in Boluto as the future world; and Dr. Turner's work is suggestive at every turn of comparisons with the beliefs or customs of remote parts of the world. The Samoan story of the origin of tattooing, turning on a mistake in the delivery of a message (p. 55), recalls the Kaffir and Hottentot account of the origin of human mortality. The story of the turtle and the fowl (p. 218) points the same moral as the classical fable of the tortoise and the hare. The story of the woman and her child who were taken up to the moon, where they may still be seen (p. 203), is precisely similar to the moon myths of European folklore. The custom of artificially flattening the heads of children (p. 80) connects the Samoans in habit with the American tribe who, for doing the same thing, were called the Flathead Indians.

With regard to Samoan customs generally the most interesting allusions in Dr. Turner's work are to the mock burnt-offerings, when for some offence against the gods a man would undergo a counterfeit process of baking in a cold oven (pp. 32, 69); to the ordeals for the detection of theft (pp. 19, 184); to imprecations by taboo, as when the fear of a shark was instilled into a thief by the plaited figure of one (p. 186); to the confession of crimes for the purpose of obtaining divine pardon (pp. 34, 40, 141); to purification before battle by sprinkling (p. 64). It is perhaps to be regretted that in reference to the rules of marriage the information vouchsafed by Dr. Turner is not so full as on the preceding points: we are not told whether the Samoans were endogamous or exogamous, nor to what extent purchase entered into matrimony.

A modified system of communism prevails with regard to property, every man having claims on the general possessions of the clan, so that in building a house or a canoe he can always draw on his relations. Dr. Turner says that this system is a sad hindrance to the industrious; but he also points out that it obviates the necessity of poor laws by making poverty unknown and inconceivable (p. 160).

We miss in Dr. Turner's book any estimate of the progress made by the Samoans since or in consequence of the arrival of the missionaries in 1830; though he makes it clear that before that time they had made some independent advance in the ways of civilisation. Thus he notices the previous mitigation of their penal code (p. 178); and points to tradition as attesting in former times the custom both of cannibalism (pp. 236, 240) and of human sacrifices (p. 201). One would gladly know whether their numbers are increasing or the reverse; whether their wars have stopped; and whether it can still be said of them, as Dr. Turner says of them as heathens, that "few drank to excess."

The last chapter deals with twenty-three islands away from the Samoan group, such as the Gilbert group and the New Hebrides, but in reference to these the writer speaks more on the authority of native teachers than on a prolonged personal residence among them. The most noticeable thing is the frequency of the custom of making infanticide compulsory by law; and the generality of the belief in the original resting of the sky upon the earth and in the necessity of pushing it upwards. Perhaps the most curious custom on these islands is that quoted of the isle Peru, by which a married woman for years after her marriage was prohibited from looking at or speaking to any one but her husband. When she went out she was covered in a mat with only a small hole in it by which she might see her way, and any man who saw her coming was obliged to hide himself till she had passed (p. 298).

Having touched on the chief points of interest in Dr. Turner's work, we cannot do more than commend it earnestly to the attention of all who take interest in the customs of unadulterated heathenism. We may fairly describe it as one of the most important contributions to the science of anthropology that has been published for many years. In matter and arrangement it is a great improvement on the "Nineteen Years in Polynesia" in which Dr. Turner first gave to the world his experiences of Samoa. There is an entire absence, perhaps too much, of personal missionary narrative; nor will any one regret in the present work the long chapter which in the former drew attention to a quantity of more or less trifling resemblances between the customs of the Samoans and the Jews. The similarity is doubtless a real one, but it only shows, as wherever else it appears, not that the people in question had any connection whatever with the Jews, but that the Jews in their evolution from savagery passed through the same stages of thought and custom which still characterise barbarism wherever it exists. The more the customs of remote parts of the world are brought into comparison, the more wonderful in its almost mechanical regularity must appear the history of human development.

J. A. FARRER

VOICE, SONG, AND SPEECH

Voice, Song, and Speech. A Practical Guide for Singers and Speakers, from the Combined View of Vocal Surgeon and Voice Trainer. By Lennox Browne, F.R.C.S. Edin., &c., and Emil Behnke, &c. 8vo, pp. 322. (London: Sampson Low, Marston, Searle, and Rivington, 1883.)

THIS bulky handsome volume of 322 pages seems at first sight to present considerable difficulties to a reviewer, which begin with the very title-page, wherein its contents are said to be derived "from the combined view of vocal surgeon and voice trainer." The latter occupation is fairly definite; but what exactly is the former? It might indeed be thought that the striking photograph, with wide-opened mouth and glaring eyeballs, which faces the title, represents the vocal surgeon in question, seen in the very act of giving tongue. But this explanation turns out to be incorrect; as it is an excellent though not a "combined" view of Mr. Emil Behnke's larynx, taken from nature and untouched by hand. This feature, if indeed the larynx can be correctly called a feature, of the work, is, it may be at once said, the best it contains. The gentleman just named has exhibited remarkable energy and perseverance in obtaining, for the first time, a series of autolaryngoscopic views of the vocal chords in the process of phonation, and in different registers of the voice. Four of these, given on an enlarged scale in the body of the volume, go some way towards settling the long debated question as to the different mechanism of the natural and the artificial or "falsetto" voice. In all other respects the book is very unequal, and contains little that cannot be as well or better obtained elsewhere. It has two prefaces: one of the usual kind, and in the usual place; the other at the opposite extremity of the work, quaintly termed a Preface to Advertisements, in which it is stated that "the authors have stipulated with the publishers that no advertisement whatever should be admitted without their express sanction." The opening chapter is entitled "A Plea for Vocal Physiology," and is followed by others on the laws of sound, the anatomy and physiology of the vocal organ, and on the larynx, which need no special notice except to remark that the nomenclature adopted in the description of the last-named organ, like that employed in another of Mr. Behnke's works, is somewhat un-English and clumsy. The old Greek names thyroid, cricoid, arytenoid, and the like are at least as graceful, and perhaps as easy to retain in the memory as the "ring-shield aperture," the "shield-pyramid muscles," and the "buffer cartilages." In the chapter on vocal hygiene some characteristics, fortunately uncommon, begin to show themselves. We are told that "Better than a respirator is the veil invented by Mr. Lennox Browne, and sold by Messrs. Marshall and Snelgrove." On turning to the selected and expurgated advertisements, we find one from the latter firm, adorned with a fascinating picture of a lady wearing the said invention, of which the price is "5*s*., or by post 5*s*. 2*d*." On pp. 110 and 111 we meet two old friends, again ladies, one with a natural, another with a deformed waist; and to our delight they reappear with farther internal detail on pp. 112 and 113. Four pages having been thus pleasantly got over, we learn with relief on p. 117, that "hygienic corsets, exactly of the kind we describe, can be obtained from Mr. Pratt (surgical mechanist of Oxford Street)." On turning to the advertisements, we, singularly enough, find Mr. Pratt also among the elect. Hutchinson's well-known spirometric experiments are then largely drawn upon, and freely quoted, by which means we reach p. 132, where we find four pages of illustrative cases, including those of the "Rev. Canon G," who "broke down in voice"; "A. B., Esq., M.P.," who "suffered from impediment in speech"; "C. W. P., Esq., Mus. Bac.," who "spoke in a child's treble"; and "Miss D. M.," who "was rapidly losing the upper and middle notes of her voice from faulty production." All these, and others, to the number of eight, even a Scotch precentor among them, were happily cured.

We next pass to the oft-told history of the laryngoscope and its teachings, to find on pp. 163-169 some really good woodcuts of the five registers of the voice, named, according to Mr. Curwen's system, the lower thick, the upper thick, the lower thin, the upper thin, and the small respectively. Farther on two of these, and the falsetto, are reproduced by photography as above stated.

The chapters on voice cultivation, on breathing, on "attack," and on resonance go rather beyond the scope of a scientific paper. As an exercise, the pupil is recommended to repeat the syllable *koo* four times rapidly, once long; following with *oo, oh, ah*. The effect, with a large class, would be highly pastoral and pleasing. Indeed, it is a comfort to know that this "will be published very shortly by Messrs. Chappell and Co., of 50, New Bond Street" (*vide* advertisement). The most original chapter of all is, however, that on "The Daily Life of the Voice-User." He or she is instructed as to residence, "ablutions," "face and neck powders" (see advertisement), dress, and especially as to a "special woven and shaped combination, reaching from neck to ankles and wrists." On turning with feverish haste once more to the advertisements, we find that this boon to human nature can be obtained of E. Ward and Co. of Ilkley, and that the cost is only 12*s*. 6*d*. On the other hand, while treating of diet, the authors, no doubt from a "combined view," say (p. 256), "We decline to give an opinion on cucumber."

The above extracts will show the general tone and style of the work. The writer of these lines wishes to speak with the greatest respect of Mr. Behnke's really valuable photographs, which he exhibited at the Royal Institution about a year ago. He cannot help regretting that that gentleman in bringing his new conception into the world should have called in the obstetrical aid of any surgeon, however "vocal." W. H. STONE

OUR BOOK SHELF

A Sequel to the First Six Books of the Elements of Euclid. By John Casey, LL.D., F.R.S. (Dublin: Hodges, 1884.)

WE have noticed (NATURE, vol. xxiv. p. 52, vol. xxvi. p. 219) two previous editions of this book, and are glad to find that our favourable opinion of it has been so convincingly indorsed by teachers and students in general. The novelty of this edition is a supplement of "Additional Propositions and Exercises" (pp. 159-174). This contains an elegant mode of obtaining the circle tangential to three given circles by the method of false positions, constructions for a quadrilateral, and a full account, for the first time in a text-book, of the Brocard, triplicate-ratio, and (what the author proposes to call) the cosine circles. Dr. Casey has collected together very many properties of these circles, and, as usual with him, has added several beautiful results of his own. He is not so thoroughly well up in the literature of the subject as he might be, but he has done excellent service in introducing the circles to the notice of English students. Again, Question 31, p. 174, to one unacquainted with geometrical results, would appear to make its *début* here, whereas it figures as a question in the "Reprint from the *Educational Times*" (vol. iii. p. 58),[1] and is discussed there in connection with an envelope which forms the subject of a paper by Steiner (see also pp. 97, &c., and vol. iv. p. 94).

Many of the trifling errors we previously pointed out have been corrected, but some are still left, as on p. 39, line 15, "*A B*" should be "*A C*"; p. 110, reference should be to the "*Reprints from the Educational Times*"; p. 74, line 8 up, should be "*B D*," not "*P D*"; Question 103, p. 157, is incorrectly printed; p. 172, the Brocard angle, in all the papers we have seen, is denoted by ω and not by α. We think a better place for the "Observation" on p. 172 would be after Question 3 on p. 171. The figure on p. 134 is inverted. In the "Index," Pascal's Theorem should be referred to p. 129 and not to p. 139. We only need say we hope that this edition may meet with as much acceptance as its predecessors: it deserves greater acceptance.

[1] It was proposed in the *Educational Times* for February 1865.

The Ores of Leadville, and their Mode of Occurrence, &c. By Louis D. Ricketts. 4to. (Princeton, New Jersey, 1883.)

THE author, in accordance with the requirements of the Ward Fellowship in Economic Geology in Princeton University, spent upwards of four months at Leadville in the study of the ores and their mode of occurrence, and more particularly in the Morning and Evening Star Mines. The result of his investigations are presented in a very useful memoir dealing with the minuter phenomena of the two mines investigated, which are admirably placed for this purpose, as, although small, they have yielded an enormous quantity of carbonate of lead associated with silver ore in the form of chloride and bromide, the whole deposit being probably a pseudomorph or substitution-product of a blue limestone of Carboniferous age, by infiltration of metallic minerals from an overlying sheet of gray porphyry. This class of substitution is not unknown in other parts of the world, the famous calamine deposit of Vielle Montagne being one of the most familiar examples, but nowhere else is it illustrated on the great scale observed around Leadville, which now produces nearly one-half of the total quantity of lead raised in the United States. The ore itself varies very considerably in character, consisting of mixtures in every conceivable proportion of hard granular and soft carbonate of lead, often exceedingly pure, with quartzose brown iron ore and silver chloride and chlorobromide, the latter sometimes in lumps of a few ounces or even a pound weight; more generally, however, it is diffused through the mass, which is enriched to from 50 to 100 ounces in the ton of ore. A point of great interest, we believe first noticed by the author, is the occurrence of beds of basic ferric sulphate underlying the lead carbonate, and also containing some silver as chloride and lead as sulphate. This the author considers to be due to the oxidation *in situ* of a belt of iron pyrites more or less mixed with galena, the change being so complete that no trace of pyrites is ever seen in it. In a second section the author gives much interesting detail as to the working of the mines and their produce, the whole forming a monograph of considerable value. H. B.

Elemente der Organographie, Systematik, und Biologie der Pflanzen. Von Dr. Julius Wiesner. (Wien: Alfred Hölder, 1884.)

THIS is the second volume of a more extensive work entitled "Elemente der wissenschaftlichen Botanik," the first volume of which dealt with the anatomy and physiology of plants. The first part of this the second volume is occupied with organography: the author recognises five fundamental types of vegetative organs, viz. "phyllom, caulom, rhizicom, trichom, thallom," and thus ignores the conclusion of Sachs, that stem, leaf, and root are not coordinate categories, but that the root should rather be coordinated with the shoot, a structure composed jointly of stem and leaf. Further, he cites the sporangia of Ferns as examples of trichomes (p. 5), and thus does not adopt the view of Goebel, that the sporangium is an independent organ, and is not referable to the categories of vegetative organs. These two points are sufficient to show that the book is not abreast of current morphological opinion.

The second part is devoted to the systematic study of plants. The arrangement adopted is that of Eichler's "Syllabus," in which the classification of Angiosperms is different from that in current use in England. This section appears to eonsist chiefly of an enumeration of facts, and the student is left to draw his own comparisons between the plants described.

Then follows a part on "Biology," a very readable treatise on the life of the individual, reproduction, and the origin of species. As an appendix a short history of the development of botany is given, and in a few pages of notes, references are given to the most important works on various branches of the subject. It is surprising under the head of classification of Phanerogams (p. 424) to find no mention of the "Genera Plantarum" of Bentham and Hooker, the most important publication of the sort in recent years. The book is illustrated by numerous woodcuts, many of which are taken from older books, for example Schleiden's "Grundzüge." Looking at the book as a whole, there is nothing sufficiently new either in the material or in the treatment to recommend it above others already before the public.

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.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On the Motion of Projectiles

I HAVE read with great interest Mr. Bashforth's article on a new method of estimating the steadiness of elongated shot when fired from large guns, and I have no doubt that we should have a much better knowledge of every new gun to be brought into service if we could try it, using the Bashforth chronograph, which is the most perfect for measuring the times occupied by a shot in passing over a succession of equal distances. That would give us at once the coefficient of resistance of the air to the projectiles used in that special gun, and then by very simple formulæ and tables the calculation of trajectories (which is one of the main points in artillery) would be a very easy task.

Instead, with the present system, viz. knowing only the muzzle velocity, we must rely for these calculations on the coefficients determined with only one sort of projectiles; and of course such coefficients must vary very much (more, perhaps, than is generally thought) with different projectiles, with different shapes of the head, and especially with the different methods of giving rotation.

Lately many improvements have been made in the form of the projectiles; many ogival-headed shots of two diameters have been introduced, and the use of breechloaders instead of muzzle loaders has allowed the use of better means of giving rotation.

Of course the present coefficients still hold good for comparatively short ranges, and for heavy projectiles, because then the loss of velocity is little on account of the small $\frac{d^2}{w}$. But when the $\frac{d^2}{w}$ is rather large, as in the case of small guns or rifles, then the coefficients K_v are less reliable.

I have had great experience in calculating with the Bashforth method, and I have been able to calculate trajectories for heavy guns, which were not far out from the actual practice; I had still better results using Prof. Niven's method and table; but when I had to calculate trajectories for small guns, both these methods failed to give me reliable results.

For instance, in calculating the trajectories for the Nordenfeldt one-inch gun, I had with Bashforth's method for an angle of elevation of 9° a range of 2282 yards, and for 12° of elevation a range of 2539 yards: instead by actual practice the elevations required were found to be—

For 2200 yards	... ...	7° 12′
,, 2400 ,,	... ...	8° 20′
,, 2600 ,,	... ...	9° 36′

The bullets have an ogival head struck with a radius of one diameter and a half, therefore they are not different in shape from the shots used by Mr. Bashforth in his experiments. Besides I divided the trajectory into many small arcs, and I was very careful in applying the correction for the different density of the air, viz. using always the formula $\frac{d^2}{w}\left(1 \pm \frac{\Delta}{534\cdot 22}\right)K_v$, instead of simply $\frac{d^2}{w}K_v$. I was even rather afraid of overdoing this correction, taking a lighter weight of the air than was necessary; and I was very much astonished when I saw that the trajectories calculated were much too short.

It seems to me also that the correction to be applied when the bullet rises to a great height, requires a little more consideration, and a thorough mathematical investigation.

I think that the problem of a body moving in a medium which becomes less and less resistant as the body advances through it is more complicated than we would think at first, and cannot be dealt with by only considering the density of the medium equal to the mean of the densities at the two terminal points.

E. RISTORI

Christian Conrad Sprengel

THE interest in my note on Sprengel (NATURE, vol. xxix. p. 29) may excuse some additional facts. In the Life of Dr. E. L. Heim (by G. W. Kessler, Leipzig, 1835, 8vo) the following is reprinted from Heim's diary, vol. ii. p. 72:—

"I read Rector Sprengel's work with indescribable satisfaction. Since the time when I read Hedwig's system of the fructification of the mosses, fourteen years ago, I never had such a great and thorough pleasure as to-day. I cannot admire enough the power of observation, the untiring assiduity, the acuteness, and the correct and clear exposition of the facts which he had observed. His work is a masterpiece, an original, which gives him honour and of which Germany can be proud."

Dr. Heim, who afterwards became a distinguished physician in Berlin, Prussia, was an enthusiastic mycologist, who had made the acquaintance of Sir J. Banks and Solander, had studied carefully Dillenius's Herbarium in Oxford, had later visited Gærtner and Koelreuter. He speaks rather enthusiastically about this naturalist, who showed and explained to him his experiments. Dr. Heim gave also the first instructions in botany to Alexander von Humboldt.

Mr. Kessler, the editor of Heim's Life, says (vol. i. p. 286):—"Heim found in Rector Sprengel, to whom he gave the first instructions in botany, a remarkable student. Sprengel repaid largely all pains which Heim had spent on him by the fruit of his careful studies."

The editor wrote this in 1835, and the fact that he selected out of the diary the above-quoted note proves well how much Sprengel's work was appreciated and admired even by non-scientists.

In Kœnigsberg, Prussia, Prof. C. F. Burdach, in his yearly lectures on physiology, taught and appreciated highly Sprengel's discoveries. In his large "Physiology," published in 1826 with the assistance of C. E. von Baer and H. Rathke, and in the second edition, 1835, with the same assistance, and, besides them, with E. Meyer and J. Valentin, and in a French translation of the same work, § 237 gives an account of Sprengel's discoveries. "If he should have gone a little too far in some cases it would be without importance; the same occurs with every scientist who makes a great discovery, and becomes with it enthusiastically excited." I know personally that Burdach's well-reputed assistants were thoroughly acquainted with Sprengel's observations.

Prof. H. Burmeister had studied in Greifswald and in Halle, and published his "Handbuch der Entomologie," 1832; an English translation by F. Shuckard. He speaks (vol. i. p. 303) about Sprengel's and Koelreuter's observations at some length, also as well known and of the highest importance. Prof. Burmeister will be indeed best able to state if he became acquainted with the facts in Prof. Hornschuck's lecture on the physiology of the plants, "naturæ mysterias nobis aperire expertus est" ("vita" in Prof. Burmeister's dissertation), or in Halle by Prof. Carl Sprengel, the nephew of Rector Sprengel, or somewhere else. I know personally that in Berlin, Link, Lichtenstein, Klug, Erichson were entirely acquainted with Sprengel's discoveries. Prof. Kunth was a very old friend of Heim (Life, ii. p. 9), and beyond doubt acquainted with the facts, though he has not brought it forward in his lectures after Dr. F. Müller's statement. I was assured by scientific friends that Treviranus in Bonn and Nees von Esenbeck in Breslau were well acquainted with Sprengel. I confess that I am entirely at a loss to understand how it happened that Sprengel was unknown to scientists in England, where Kirby and Spence's "Introduction," &c., had seven editions from 1815 to 1867, the last of 13,000 copies. There would be no difficulty to find in German libraries more publications to corroborate my views, but I believe those quoted are sufficient to prove what I intended to state in my former note. H. A. HAGEN

Cambridge, Mass., March 24

Salt-water Fish-Types in Fresh Water

MR. HARDMAN's observations on the occurrence of "sea-fish in fresh-water rivers" (NATURE, vol. xxix. pp. 452-53) are not by any means unique, as he has supposed. On the contrary, cases similar to those he has recorded are so frequent as to justify him in believing that "some caution must be observed in the classification of strata as fresh-water or marine on the evidence of fish alone." The incursion and confinement of the two types specially mentioned—the "sunfish" and "shark"—in fresh water have many parallels. For instance, in NATURE, vol. xiii. p. 107, Messrs. W. W. Wood and A. B. Meyer have recorded that "near Manila is the Lacuna de Baij, a large sheet of water" whose "water is quite fresh, and, after settling, perfectly potable," but in which live a sunfish (*Pristis perotelli*) and a small shark. Further, in Lake Nicaragua, whose mean height above mean tide in the Pacific and Atlantic Oceans is 107·63 feet, are likewise found a sunfish—apparently *Pristis antiquorum*—and a peculiar shark—*Eulamia* (or *Carcharias*) *nicaraguensis*. The last have been especially noticed in a "Synopsis of the Fishes of Lake Nicaragua, by Theodore Gill, M.D., and J. F. Bransford, M.D., U.S.N.," in 1877 (*Proc. Acad. Nat. Sci. Phila.*, pp. 175-91). Therein it is also urged that "these instances, supplemented as they are by many others, are sufficient to convey a caution against too extensive generalisation of the physiographical conditions hinted at by fossil remains of aquatic types." THEO. GILL

Washington, April 1

"The Axioms of Geometry"

MR. ROBT. B. HAYWARD has written to me that some of the statements in my article, "The Axioms of Geometry," in NATURE, March 13 (p. 453), are too sweeping, and that in particular Euclid I. 16 does not necessarily hold for the geometry of the eye-being, or, to use the more familiar language of spherical geometry, that this theorem does not hold unless the median line of the triangle on the side on which the exterior angle lies is less than a quadrant.

Mr. Hayward has also pointed out that the error lies in the assumption that a terminated straight line "may be produced to any length."

All this is clear enough, and I was conscious of it when I wrote the article. In fact I meant to add, but somehow omitted to do so, that every figure considered has to be limited to less than a hemisphere, or to less than half the space round the eye-being. If this is done, and if by the whole figure is understood the given figure together with any addition required for the proof, then my statements will hold, but with one exception. I was wrong in saying that Legendre's proof, given by Mr. Casey, can be treated in the same manner as Sir Wm. Hamilton's. For in this proof a series of triangles is constructed with sides which increase till they become infinite. The reasoning is therefore not applicable to the sphere. But neither is it to the plane. We have no right to reason about infinite figures as we do about finite ones. O. HENRICI

Wild Duck laying in Rook's Nest

A WEEK ago to-day six wild duck's eggs were taken out of a rook's nest about four miles from here. The rookery is situated on the banks of the River Test. The nest from which these eggs were taken (the bird flew off as the nest was approached) was in a horse-chestnut tree, and was about thirty feet from the ground; the tree was about twenty-five yards from the river, and was surrounded by others, mostly elm. An instance of so unusual a situation for wild duck's eggs might, I thought, interest some of your readers. JOHN H. WILLMORE

Queenwood College, near Stockbridge, Hants, April 3

[Our correspondent has sent us one of the eggs referred to, which we have submitted to a well-known oologist, who is of opinion that the egg is most likely a wild duck's.—ED.]

The Remarkable Sunsets

I LEARN from Mr. Frank Atwater, a teacher in the Native College here, that he observed the "glow" at 5 a.m. on September 5, when landing from the steamer at Maalaea, thirteen miles south-east of this. He had arrived in the islands only two days before, and marvelled much if such were the sunrises here. He is the only person I have met who observed it prior to the evening of that day. Mr. Atwater's date is verifiable by the regular movements of the steam-packet.

Lahaiua, Hawaiian Islands, March 14 S. E. BISHOP

Cats on the District Railway

WITH reference to Mr. Vicar's letter last week (p. 551) about the cats at Victoria Station, I beg to state that there are cats all over the District Railway both in and out of the tunnels, and many of them—familiarly called "Stumpy" by the men on the line—can testify by the shortness of their tails to the hairbreadth escapes they have had from passing trains. Those I have seen are mostly full-grown cats, and only once have I seen a kitten walking on the rails, and that was at night after the traffic had ceased. At one signal-box which is built on a platform over the line, and the only access to which is by a steep iron ladder, down which no cat could climb, there are two full-grown tabbies—toms I believe—and I have often seen them asleep behind the signal bells or even on the handrail of the platform, utterly callous to the trains rushing by underneath. As a rule the men are very kind to them, and give them milk, &c.

I would add that until quite recently there was a small fountain and circular basin near one of the pumping-engine houses wherein were two fish which had been there for about twelve years. One died last year, and now I see the basin has been converted into a flower-bed by the man in charge. E. DE M. MALAN

Victoria Station, District Railway, April 14

THE GEODETIC SURVEY OF THE UNITED STATES[1]

WE would congratulate Prof. J. E. Hilgard, the Superintendent of the Survey, on his first general Report on the work of his department, which gives an account of the Survey for the fiscal year ending June 1882. We are unable to gather why its issue has been deferred until now, but its arrival at the present time is not the less opportune, particularly as the programme of

[1] "Report of the Superintendent of the Survey." Washington, 1883. 556 pp. 4to.

the approaching International Geodetic Conference at Washington is beginning to claim decision.

The Report describes the nature and general procedure of the coast and topographical surveys, with a description of the instruments employed; full details of the observations and their methods of reduction being given.

Whilst the original leading aim of the Survey, the security of navigation, has been kept in view, other objects incidental to the work of trigonometrical survey, and of the highest scientific interest, have not been lost sight of.

Hydrographic surveys have been prosecuted in the waters and off the coasts of seventeen States and Territories, and topographic surveys for the exact definition and delineation of shore line have been carried on in eleven States and Territories. The triangulations for this work have been advanced in twenty-two States and Territories, and included the measurement of the base-line in California; and also, as is well known, the extension of the trans-continental triangulations urged by the late Prof. Peirce, for connecting the surveys of the Atlantic and Pacific coasts. In the interior States the work has included the continuation of the triangulations of Kentucky, Tennessee, and other States.

The incidental work has comprised the carrying of lines of precise "leveling" between points far distant (1125 miles); the exchange by telegraphic signal of the longitudes of important cities; the usual observations for latitude and azimuth, and of the magnetic elements; the determination of the force of gravity by pendulum experiment; and the study of ocean currents, particularly of the Gulf Stream.

For the year ending June 1884 the cost for carrying on the work of the U.S. Coast and Geodetic Survey, by which designation this department has been known since 1878, was estimated at $573,000, and it is gratifying to note that on the other side of the Atlantic the value of active scientific inquiry continues to be recognised by the State, provision having been made for further tidal, magnetic, gravity, and other scientific observations.

In a geodetic survey extending over an area so large as that of the United States the question of the size and figure of the earth becomes of great importance. Although, as Prof. Hilgard points out, different opinions are held as to the mode of prosecuting gravity experiments, all geodists agree that widely-distributed pendulum observations will give results valuable to geodesy and geology. It is undoubtedly desirable that opportunity should not be lost of combining the results of pendulum observations taken in different parts of the globe, and we trust that the valuable pendulum work done in India ("Great Trigonometrical Survey," vol. v.), and the discussion at the informal conference on gravity determinations between Col. J. Herschel, R.E., Prof. S. Newcomb, and the officers of the Survey Department, which was held at Washington in May 1882, may stimulate the recognition in this country of the necessity of further experiment and inquiry in this direction. Although the conclusions proposed by Prof. Newcomb, as amended and adopted by the conference, have been elsewhere discussed, it appears desirable at the present time again to invite attention to them. Generally they are as follows:—

1. The main object of pendulum research is the determination of the figure of the earth.

2. A complete geodetic survey should include determinations of the intensity of gravity.

3. A minute gravimetric survey of some limited region is at present of such interest as to justify its execution.

4. Extended gravimetric linear exploration is desirable.

5. Each series of such determinations should be made with the same apparatus.

6. Such determinations ought commonly to be accurate to the 1/200,000th part.

7. All pendulums should be compared at some central station.

8. Determinations of absolute gravity will probably prove useful in comparing the yard and the metre, and they should at any rate be made in order to test the constancy of gravity against the constancy of length of a metallic bar.

9. In the present state of our experience, unchanged pendulums are decidedly to be preferred for ordinary explorations.

In an appendix (No. 21) is given the reduction, with the employment of modern constants, made by the late Dr. C. R. Powalky at the charge of the Bache Fund of the National Academy of Sciences, of the places of 150 stars observed by La Caille at the Cape of Good Hope and at Paris, between 1749 and 1757. Since all these stars have been re-observed in recent years at Melbourne and at the Cape, the comparisons of La Caille's places with these determinations and with those of Dr. B. A. Gould at Cordoba became of scientific value.

An account is also given of the measurement of the primary base-line in Yolo county, Sacramento Valley, begun in 1879 with the new compensating base apparatus designed by Assistant C. A. Schott. The measurement was made under the directions of Assistant George Davidson, but the discussion of its results does not appear in the present Report

The measuring bar of the compensating apparatus is of a construction different from other compensating bars, but involves no new mechanical principle. It is composed of two metals, zinc and steel, so proportioned as to be compensatory for change of temperature, the expansion or contraction of a zinc bar five metres in length being counteracted by the expansion or contraction of the two steel bars between which it is placed.

The determination of the rate of expansion of the subsidiary steel and zinc bars by which the five-metre standard was verified was done by means of two micrometer microscropes securely fixed to stone piers placed a metre apart, the metre bar whose rate of expansion was to be determined being compared when at different temperatures with the distance between the two microscopes as determined at a constant temperature by reference to a second standard metre bar. The distance between the microscopes thus becomes a function of the temperature, and in this respect we cannot but think that the method attributed to General Wrede, by which the variable distance between the microscopes becomes unimportant, has a decided advantage.

The active investigations since 1871 as to the distribution of terrestrial magnetism in North America have beome generally known from the reports of Prof. Hilgard, as well as by the publication of Mr. Schott's paper on the magnetic variation of secular declination. Mr. Schott also now gives an important appendix to the Report on the distribution of the magnetic declination in the United States at the epoch January 1885, together with three isogonic charts in continuation of those issued by the Survey up to the year 1876. The results are also given of the magnetic observations made by Lieut. Very on the north-eastern coast of America, particularly at Labrador, in the remote settlement of Nain (lat. = 56° 33′ N., long. 61° 44′ W.).

In the exploration of the Gulf Stream, the facts brought out by the deep-sea soundings of Commander J. R. Bartlett during 1881, with Siemens's admirable electrical deep-sea thermometer, are also referred to; and the account of the deep-sea soundings taken off the Atlantic coast between 1879 and 1883 by Lieut. J. E. Pillsbury, in connection with the exploration of the Gulf Stream, and the discussion by Prof. Ferrel on the tides of the Pacific coast are now published. The inquiries of Dr. Thos. Craig as to fluid motion, particularly as to the motion of vessels and of bodies such as pendulums, when totally immersed in fluid, are also adverted to.

Twenty-five useful maps and charts are attached showing the general progress of the survey, particularly on the coasts of Florida, California, Oregon, and Carolina; together with illustrations of the apparatus used. As compared for instance with the precise drawings given by General Ibanez in his Reports in 1860 and 1865 on the Madrid base-line, there may perhaps be room for improvement in the finish of the illustrations given in this Report.

In the Report of the Superintendent for 1883 we shall look forward with interest to the results of the experimental researches on the force of gravity, by Assistant C. S. Peirce, who is now visiting Europe for the purpose of his inquiries.

In the success with which the Superintendent has been able to deal with the different branches of his department, much is due, as he indicates, to the forethought and systematic treatment of his eminent predecessors, particularly to Carlile P. Patterson, to whose memory a graceful tribute is rendered in the Report; as well as to the able assistance which the Government have placed at the Superintendent's disposal.

AGRICULTURE IN SUSSEX[1]

THIS Report bears evidence of a considerable amount of careful research bearing upon the agricultural practice of Sussex. The honorary secretary, Major Warden Sergison, must be congratulated upon his zealous administration of the finances, whereby an annual income of about 770*l.* has been secured for the three successive years of active operations. This Report deals with the results of the third year's work, which completed the period over which it was originally calculated that the work should be extended. We are therefore in a position to form some opinion as to the practical value of the results which have been gained. It appears from this Report that it is intended to extend this inquiry.

These experimental researches have been conducted by Mr. Thomas Jamieson, the Fordyce Lecturer on Agriculture in the University of Aberdeen, and it will be interesting to notice the improvements and economics which are claimed in his Report as resulting from this rather costly investigation. He says:—"The results are too numerous to give, . . ." but "an attempt will be made to give in a general way the lessons they seem to teach." He then proceeds to indicate these, placing them in the form of question and answer. We will take the first of these.

"*What food do plants need?* Prior to the experiments now recorded, the answer to this question would have been 'Nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, iron.' The results of the experiments warrant us in saying that the latter four substances may be disregarded by farmers. We thus realise the value of experiments. If the farmer of 100 acres will lay his manure bill before a chemist, and ask him to calculate how much he has paid for those useless—or hurtful—ingredients, he will recognise the direct benefit of such experiments."

Those who have watched the good work which Mr. Jamieson has done in connection with the Aberdeenshire Agricultural Association, and who have recognised the opposition with which he had to contend, cannot but regret the hasty conclusion at which he has arrived. It is a very bold assertion to make that sulphur, calcium, magnesium, and iron are not needed as plant-food. He cautions his friends "not to be led away by opposed statements, however plausible, if unaccompanied by proof." In this case Mr. Jamieson shall supply his own proof, for which purpose we refer to the Report of the Aberdeenshire Agricultural Association, 1875-76, p. 29. Here Mr. Jamieson reports a very valuable series of experiments which he made. White sand was supplied with all the ingredients found in turnips—except one—and turnip seeds were then sown. He says:—"Precisely the same sand, precisely the same seed, precisely the same watering, precisely the same ingredients added, except one—which was purposely omitted—*calcium*. In consequence of this omission, although all the other ingredients were present in abundance, the healthy seed produced healthy young plants, but speedily *the whole of them died.* Just as in an ordinary chemical experiment *the desired substance cannot be formed if one of the essential ingredients is absent.*" The lesson derived from this experiment is perfectly consistent with agricultural science, and it is a source of profound surprise to find that this substance—*calcium*—is one of the four bodies named in the Sussex Report as being unnecessary, and that it should be stated that "farmers will not hurt their crops by omitting these four elements." This is *a dangerous lesson* to deduce from this valuable series of experiments, and we regard it with the greater regret because the facts do not justify such a conclusion.

Other examples might be selected from this Report, which conflict with other experimental trials conducted with, at least, equal care, which also tend to show the necessity for taking more *practical* views of the results gained. The opinions expressed upon permanent pasture are also open to severe criticism. If the general series of Sussex experiments be placed in comparison with the investigations carried out for the Aberdeenshire Agricultural Association, they will be found devoid of those great national advantages which must long attach to the Scotch experiments. The value of the Aberdeen Association work has never been as fully appreciated as it deserves, and the agricultural public would have been highly gratified if the Sussex Association experiments had been equally definite and satisfactory.

[1] "The Annual Report of the Proceedings of the Sussex Association for the Improvement of Agriculture in Sussex. Season 1883."

SOCOTRA[1]

FOUR years have elapsed since an expedition was sent out from this country by the British Association and the Royal Society to explore the Island of Socotra. With the exception of diplomatic visits by the resident at Aden in the two or three preceding years, and of a short exploration in 1847 by the French naturalist Boivin, there is no record of any European having sojourned on the island since the date, forty years ago, of its abandonment by the Indian troops which had occupied it for this country during four years, and Wellsted's account of his survey of the island (in *Journ. Roy. Geog. Soc.* v. 1835) made in 1834, has been up till now the most recent and most satisfactory. It is remarkable that an island so long neglected and forgotten should be visited in two successive years by exploring expeditions; yet this has happened. In 1881 a party of German explorers followed the British Expedition. This German Expedition to Socotra formed part of a scheme of scientific exploration of many unknown or but little-known regions of the globe set on foot by Dr. Emil Riebeck, and for which his liberality provided the means, and the results of this portion of his undertaking, some account of which now lies before us, must be gratifying to him as they are valuable to and welcomed by science. Dr. Riebeck was accompanied to Socotra by the well-known traveller Dr. Schweinfurth and two other companions, Drs. Mantay and Rosset—a quartet of observers well qualified to take advantage of every opportunity of extending our knowledge of nature. Many

[1] "Ein Besuch auf Socotra mit der Riebeck'schen Expedition." Vortrag von Professor Dr. Schweinfurth. (Freiburg, 1884.)
"Allgemeine Betrachtungen über die Flora von Socotra," von G. Schweinfurth. Sep. Abd. aus *Engler's botanischen Jahrbüchern*, v. (1883).
"Land-Schnecken von Sokotra," von E. von Martens, aus *Nachrichtsbl. d. deutsch. Malakol. Gesellschaft*, No. 10 (1881).

difficulties and dangers beset their progress to the island, and their leave-taking appears to have been no less troubled; but eventually it has been their good fortune to bring to Europe a magnificent collection of specimens illustrative of its structure, its products, and the character of its inhabitants.

Most of the collections have now been worked out either in this country or on the Continent—Schweinfurth's large herbarium having been, with rare generosity, sent by him to this country to be examined along with that of the British Expedition—and the details regarding them are published in various periodicals. Herr von Martens' paper above mentioned is a supplement to the first part of Godwin-Austen's account (*Proc. Zool. Soc.* 1881, p. 251) of the shells brought home by the British Expedition, and deals with some new forms collected by the German explorers not mentioned in that account. It appeared, however, when the second part of Godwin-Austen's paper was in the press, and this overlapping of the papers has unfortunately led to some forms being described by both authors and under different specific names.

In the other pamphlets before us Schweinfurth gives us in his usual lucid and vigorous language a general *résumé* of results so far as they have been at present determined. It is satisfactory to find that his conclusions, drawn from considerations of the physical features and the fauna and flora, are almost entirely in consonance with those deduced by the British observers (see Bayley Balfour in *Rep. Brit. Ass.* 1881, and *Proc. Roy. Instit.* for April 1883). The antiquity of the island, the strong affinities of the animals and plants with those of the adjacent African and Arabian coasts, the presence in the flora of Mediterranean and general tropical types, as well as of forms related to those found on the highlands of Abyssinia, South Africa, and West Tropical Africa, are features insisted on by both. There is, however, a divergence of opinion regarding the Madagascar affinities. Godwin-Austen supposes these point to the conclusion that in Socotra and Madagascar we have remnants of an ancient and more advanced coast-line on the western side of the Indian Ocean, which was probably continuous through Arabia towards the north. Martens questions the identifications upon which this supposition rests, and does not agree with it, and Schweinfurth, though without advancing any cogent reasons, concurs with him.

The question, who are the Socotrans, and whence have they sprung? is one to which the German Expedition gave special attention, and Schweinfurth devotes a considerable portion of his address to its discussion. At the present time he estimates the population at ten to twelve thousand inhabitants. Of these about one-tenth are Arabs, colonists from the adjacent mainland, who live in the coast-villages, and are the merchants of the islands. Along with these are found many negroes, most of them runaway slaves. But the dwellers on the hills are the true Socotrans, and speak a language quite peculiar. Amongst them Schweinfurth recognises, as did Vicenzo in the seventeenth century, two races—a darker with curly hair, and a lighter one with straight hair. In addition he finds an apparently Semitic type, characterised by small head, with long nose and thick lips, straight hair, and lean limbs. The Socotran generally is of average height and size, with a quick, intelligent eye. The type of the true Socotran is quite different from that of the Somali, Galla, Abyssinian, South Arabian, and Coast Indian. From the little known of the Mahra and Qara tribes which inhabit the hill regions of middle South Arabia opposite, Schweinfurth is inclined to consider the Socotran resembles them most nearly. Many skulls were obtained from the grave caverns, and these are now in the hands of Prof. Welcker, whose report upon them may be looked forward to with interest.

From a study of the peculiar Socotran language the Germans anticipated much aid in elucidating the problem of the origin of the people. Unfortunately difficulties with interpreters prevented their achieving much success in this line. Schweinfurth notes, however, regarding the language two marked features. Firstly, its resemblance with the Mahra dialect, which is quite different from the old and the new Arabic, and is a peculiar element amongst the South Arabian dialects. This is opposed to the statement of Capt. Hunter, who says it in no way resembles Mahra. But Schweinfurth in support of his statement quotes the report of Wellsted, that the Mahras and Qaras could understand the Socotrans whilst coast Arabs could not do so; and further, a comparison of the vocabularies made by Wellsted and by his own expedition with the results of von Maltzhahn's studies on the Mahra dialect show many similarities between them. Secondly, it contains many foreign elements, and this is especially noticeable in the names of plants and animals, many of them having a thoroughly Greek sound.

Turning to history for a clue to the origin of the Socotrans of to-day, we find many references to their island in the older writers, and to these Schweinfurth refers. The author of the "Periplus" speaks of the people as a mixture of Arabs, Indians, and Greek merchants; and the presence of the Greeks is explained by subsequent writers by the story that Alexander the Great on the advice of Aristotle sent a colony of Greeks—some say Syrians—to cultivate the aloe. Cosmas relates that under the Ptolemies many colonists were settled on the island, and Jakut in the thirteenth century tells of the Greeks who had become Christians dying out and thus making room for an incursion of Mahra Arabs from the opposite coast. In these old narratives there is, as Schweinfurth points out, much that is contradictory and conflicting, and unfortunately there is at the present day but little internal evidence confirmatory of the existence in earlier times of a cultured race on the island. The visit of the Wahabees in 1800, as Wellsted says, may probably account for the disappearance of monuments and temples. Schweinfurth speaks of certain small heaps of ruins as perhaps representing old altars—but the only definite relic of this character now known is a series of hieroglyphics upon a wide limestone slab at Eriosch near Kadhab. These have attracted the attention of all who have visited the island in recent times, and Dr. Riebeck has paid especial attention to them. His interpretation has not yet been made public, but Schweinfurth states that in them some rows of Greek cipher are to be recognised. It may be hoped that their explanation may afford some clue which will help the solution of the interesting problem of the derivation of the Socotrans. The evidence existing at present is of so imperfect a character that it is impossible to determine with certainty their stock. Schweinfurth conjectures that in the Semitic element he observed may be traced a Greek type, and that the Mahra Arabs have most probably had a great share in forming the features of the present people. Future exploration must settle the question.

Altogether these papers by Schweinfurth are of the greatest interest, and his long experience amongst the native tribes of Africa gives to his observations regarding the people of Socotra great value. The material obtained by the two expeditions—British and German—has enabled us now to obtain a fair idea of the general character of the people, the natural history and physical features of Socotra; but the short time for work possible to the members of the expeditions—little more than six weeks in each case—naturally renders their results somewhat fragmentary. What has been done as yet is but preliminary, and from it we learn that there is still a vast field for future explorers—not only in Socotra itself but on the adjacent mainlands of Africa and Arabia. Until such further investigation takes place many most interesting problems—ethnological as well as concerning the distribution of plants and animals—must remain unsolved.

THE THREE HUNDREDTH ANNIVERSARY OF THE UNIVERSITY OF EDINBURGH

THIS week the University of Edinburgh is holding its Tercentenary Festival. An elaborate programme of festivities is being gone through by a collection of guests of literary, scientific, and social eminence such as rarely graces a British or even any foreign University seat. A mere recital of the list of those who are to be present to receive honorary degrees would be interesting, as showing the scope and catholicity of modern University culture. We see Hermite, Helmholtz, Pasteur, Haeckel, Virchow, Browning, Renan, Bishop Lightfoot, and Principals Tulloch and Rainy, capped by the same academic hand.

It may not be without interest to our readers to dwell for a moment on certain parts of the history of an organism whose appreciatory functions are so varied and at first sight even contradictory.

Three hundred years, though not an infant's age, is after all no great age for a University. Any uncertainty therefore that surrounds the early history of the University of Edinburgh is more the result of initial obscurity than the glamour of remote antiquity. She is, as some one has said, hopelessly modern. Nevertheless, her history is in some respects a very remarkable one. What has now developed into one of the largest of the Universities of Europe, numbering its students by thousands, began as a college for the "town's bairns," under the patronage of the Town Council, who in fact remained its rulers until 1859. There can be little doubt that the comparatively modern date of the foundation of the college, and the peculiar[1] nature of the governing body favoured its growth and development into what has claims to be the most liberally constituted of the Scottish Universities.

A glance at the chronology of science will show that the opening of the new Town's College in Edinburgh in 1583 falls at the time when the tide of progress in physical and mathematical science was just beginning to rise over Europe.

Napier of Merchiston was living hard by; Gilbert was probably collecting material for his great work on the magnet; and Galileo and Kepler were doing great things for physical science.

Nevertheless, the progress of the young institution was not at the outset very remarkable. This arose partly from the miserable poverty of its early endowment and of Scotland itself, partly from the plan of "regenting" on which it was organised, which compelled each of four regents to carry his students in four years through the whole course of the seven liberal arts of the mediæval curriculum. This plan, so fatal to special excellence in teaching or learning, continued until 1708, when it was finally abolished, and professors of the separate subjects established. During this first century, however, the patrons had already engrafted the germs of the modern University by appointing professors of separate subjects, which were sometimes outside the curriculum of the regents altogether, sometimes auxiliary to it. In this way arose some of the present chairs of the faculty of arts, and in this way originated many of the chairs that now form the separate faculties of theology, law, and medicine.

The powers of the Town Council left them absolutely unfettered in the founding of new chairs, and they proceeded in this work guided by their own views as to the necessities of the times, and aided by the best advice they could obtain inside, or more frequently outside, the University. They were not always quite judicious or wholly unbiased in their procedure, and many of their reforms were carried out in the face of bitter hostility from within the University. Yet it cannot be denied that, on the whole, their action as patrons and founders of chairs was for the good of the University. The sectarian feuds which occasioned the Disruption of the Established Church ultimately led, in 1859, to the severance of the close tie between the Town Council and the Town's College, long ere then grown into a full-blown University. There is no need here to dwell on the dark side of the picture of the management of the University by the Town Council. Their misdeeds are, we may hope, not likely to be imitated by modern patrons, and their enlightened policy in the foundation of chair after chair as the wants of the institution grew is, after all, the more important part of the story, and well worthy to be read in this day of infant Universities and of experiments on the large scale in the remodelling of older Universities of the kind.

As most of our readers probably know, the strength or weakness of a Scottish University depends wholly on the professoriate, with whom lie the whole of the teaching and disciplinary duties. Within certain limits set him by the Ordinances, and with some restrictions owing to the presence of colleagues in allied departments, a Scottish professor within his own class-room is absolutely free, and may develop into a great success, a mediocrity, or a great failure, according to circumstances; and with him rises or falls the department intrusted to his care. The system has its drawbacks sufficiently obvious; but it has this to say for itself, that it is an economical arrangement, and that it has produced a large body of citizens sufficiently well educated to take rather more than their own share of the higher employments in the British Empire. It will thus be seen that the interest of the educational history of a Scottish University centres mainly in the record of the occupants of its various chairs. We offer a few desultory remarks on this subject, chiefly from the scientific point of view, referring those who are interested in the matter generally to the recently published "Story of the University of Edinburgh," by Principal Sir Alexander Grant.

The earliest foundation of a special scientific chair was that of mathematics, to which the Town Council called James Gregory in 1674. This distinguished mathematician and physicist, the author of various theorems in pure mathematics and of several great ideas in optics (represented to the mind of the ordinary student by Gregory's "Series" and the Gregorian telescope), came of an Aberdeenshire family (related, by the way, to the notorious Rob Roy Macgregor), which, during the last three hundred years, has furnished something like a score of distinguished professors and men of science to the Scottish and English Universities. Gregory was not the first nominal Professor of Mathematics, but he was the first professor who had more than the name. After his brief but brilliant tenure, the office, with but little intermission, was filled by a line of distinguished followers, among whom we must content ourselves with naming David Gregory, who became Savilian Professor of Astronomy at Oxford, who was appointed on the urgent recommendation of Newton himself, who was in fact the friend and interpreter of Newton, and was by him reckoned worthy, along with Halley, to continue the great work of the co-ordination of celestial phenomena begun in the "Principia." He has the credit of introducing the Newtonian philosophy into the curriculum of Edinburgh thirty years before it obtained a similar place in the University of its author. Colin Maclaurin is the greatest perhaps of all the men of science that Edinburgh has produced; of his wide culture and extended activity we may give some idea when we say that he was a worthy successor to Newton in pure and applied mathematics, that he was a great teacher of mathematics and physics, a great popular lecturer in his day (one of the first of the scientific tribe of such, perhaps), that he was an authority on life assurance, on surveying, on geographical exploration, that he was an excellent classical

[1] Peculiar from a University point of view, for the older Universities as a rule were privileged corporations independent of, nay, often antagonistic to, the municipalities where they were situated.

scholar, a man of great social qualities, and lastly, that he tried to organise a defence of the town of Edinburgh against the Pretender in 1745, and caught thereby the malady that ended his life. Other occupants of the chair were Matthew Stewart, still remembered for his "Propositiones Geometricæ"; John Playfair, distinguished as a critic and historian of science, introducer of the Continental methods into the mathematical studies of Edinburgh; John Leslie, an excellent geometer, but now better remembered for his contributions to the science of heat; and William Wallace, inventor of the eidograph.

At first, natural philosophy, in so far as it was distinct from Aristotelian physics, seems to have been in the province of the Professor of Mathematics. It was so in Maclaurin's time, although a separate professorship for it had been founded in 1708. The first professor that need be mentioned here is John Robinson, whose articles in the third edition of the *Encyclopædia Britannica* are still worth consulting, and whose "Elements of Mechanical Philosophy" was for a time a standard work on the subject. The original close connection between mathematics and natural philosophy probably led to what at first sight seems a curious succession of professors. It more than once happened—notably in the cases of Playfair and Leslie—that the holder of the Chair of Mathematics was transferred to that of Natural Philosophy; in fact, it was in the latter subject that both these professors attained their greatest distinction, the former by his account of the Huttonian Theory of the Earth, the latter by his well-known researches on heat. But the greatest of all the past Professors of Natural Philosophy was undoubtedly James David Forbes; he, along with David Brewster, at first his patron, and for a long time his rival, are to be reckoned among the greatest ornaments of the University of Edinburgh during the generation that has passed away. Both were students of the University and both were candidates for the Natural Philosophy Chair; Brewster, failing probably for political reasons, was reserved for the higher honour of the principalship. The works of these two great men are so fresh in the recollection of our readers that no words need be wasted here in emphasising them. It is worthy of mention, however, that the late James Clerk Maxwell and Prof. Balfour Stewart, whose fame sheds undying lustre on their Scottish *alma mater*, were trained in practical physics under Forbes.

The Chair of Chemistry, founded in 1713, was at first essentially a medical chair; its first occupant, James Crawford, was a remarkable man in every way, a pupil of Boerhaave, and well versed in what little chemical knowledge then existed. It is noteworthy, as showing the small extent of medical and chemical knowledge at that time, that he was also Professor of Hebrew! His immediate successors call for no remark until we reach Cullen (1755), who, though better known as a great physician, was also distinguished as a great teacher of chemistry; he was, in fact, the first to establish that science as a study separate and distinct from medicine. His two immediate successors, Black and Hope, followed his lead, and were very successful teachers; in fact, in Hope's time the class reached the astonishing number of 500. Besides being a good teacher, Black was a man of genius. His results regarding carbonic acid, embodied in his graduation thesis "De humore acido a cibis orto, et magnesia alba," and his discovery of latent heat form cornerstones in the structure of modern chemical and physical science. Perhaps the greatest praise is that Lavoisier regarded him as his master. Hope will be remembered for his experiments on the maximum density point of water, and for his discovery of strontia as a separate alkaline earth. In 1844 the chair became a chair of pure chemistry. Among the past professors since then we may mention Sir Lyon Playfair, whose scientific reputation is now overshadowed by his fame as an educational organiser, and an able political champion of the interests of science.

The Chair of Natural History was a later foundation (1770?), and at first was a sinecure. Since the beginning of the century, however, it has not wanted for distinguished occupants. Jameson (1804) was an excellent mineralogist; he founded the splendid museum now absorbed in the Museum of Science and Art, and must have been a great teacher to judge by the number of distinguished pupils that he trained, among whom were Edward Forbes, John and Harry Goodsir, Macgillivray, Nicol, and Darwin. The first of these succeeded him, but was cut off after a brief but brilliant career too well known to need description. The last of the past occupants of this chair, Wyville Thomson, has done the University of Edinburgh enduring honour by connecting it with that most fascinating of all the walks of modern natural science—the exploration of the deep sea.

The history of the Chair of Astronomy has been little but a record of misfortune, as far as the University is concerned. The first professor, Robert Blair, was endowed with a fair salary, but no Observatory was given him, and he never lectured or took any part in the work of the University. He is remembered chiefly for his researches on achromatic telescopes, which he brought to great perfection by means of fluid lenses of his own invention. The second professor, Thomas Henderson, was invested with the dignity and duties of Astronomer Royal for Scotland, and was provided with the present Observatory on the Calton Hill. He devoted himself ardently to his duties as an observer, and will be remembered as the first to determine the parallax of a fixed star (α Centauri). He never lectured. Where the blame of the unsatisfactory position of the Astronomy Chair and of the Edinburgh Observatory rests, and how the matter is to be remedied, is one of the vexed questions to be settled by the coming University Commission for Scotland.

The Chair of Technology was inaugurated with great promise of success by George Wilson, whose brilliant lectures and important services in connection with what is now the Museum of Science and Art showed how important such a chair might under favourable circumstances become. The chair was, however, abolished in 1859, under circumstances that do not appear to reflect much credit either on those who then acted for the Senatus, or on the Government department which was concerned in the transaction. It may be hoped that, now the importance of technical education is being recognised, the mistake then committed will be remedied. This is all the more to be desired because Edinburgh already possesses the rudiments of a technical faculty in the Chairs of Engineering and Agriculture.

There remains but one more Chair of Natural Science to be mentioned, viz. Geology. It numbers but one past professor, Archibald Geikie, concerning whom we need only express the wish that his followers may be worthy of him.

Although the subject scarcely belongs to these pages, yet no notice of the scientific side of the University of Edinburgh would be complete without at least an allusion to the glories of its medical school, which have attracted the admiration, if not occasionally the envy, of similar institutions. It may seem curious, but it began by the institution of a botanical, or, as it was properly then called, a physic garden. The keeper of this garden (originally it is believed a member of the characteristically Scotch Guild of Gardeners), was after a time constituted (1676) the first Professor of Botany, and in fact the first medical professor.

If it were needful to insist farther upon the important place which the University of Edinburgh occupies among the educational bodies of Great Britain, we might point to the number of her students that now hold professorial chairs all over the United Kingdom, and indeed throughout the British Empire; and to the work which her *alumni* have done, and are doing, in science both pure and applied.

It might be profitable also to dwell on her defects, which she has in plenty, like other institutions guided by human brains, and endued with her own share of human inertia. But, as she has no want of candid critics, and is by and by to be put into the refining crucible, along with the other Scottish Universities, to emerge, let us hope, purified and strengthened, we may content ourselves with offering her, and asking of readers to join us therein, a hearty wish that she may prosper during the next hundred years as she has done during the present century.

G. CHRYSTAL

THE CONGO[1]

ALTHOUGH claiming to be little more than the record of a passing visit paid to the Lower Congo Basin towards the end of the year 1882, this is really a work of permanent interest to the naturalist and ethnologist. The author, a young and ardent student of biology in its widest sense, here conveys his impressions of

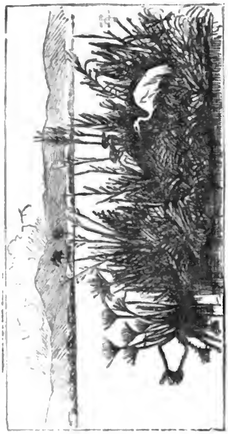


FIG. 1.—Floating Reed Island on Stanley Pool.

West African life and scenery in a series of graphic pictures, which owe much of their freshness and vigour to the circumstance that they are always drawn at first hand from nature, and are often an exact reproduction of jottings made with pen and brush in the midst of the scenes described. His skill as a draughtsman he turns to good account by illustrating the text with numerous drawings of plants, animals, and human types, many of which are absolute fac-similes executed by the Typographic Etching Company.

But Mr. Johnston does much more than merely describe in striking language the varied aspects of tropical nature revealed to his wondering gaze as he ascended from the low-lying marshy coastlands along the great artery from terrace to terrace to the grassy steppes and park-like uplands of the interior. Informed by the quickening influences of the new philosophy now accepted by all intelligent students of nature, he compares as he describes, carefully observes, and in apparently trifling incidents endlessly recurring throughout long ages he discovers the causes of mighty revolutions in the organic world. In Stanley Pool and elsewhere on the Congo he meets with numerous floating islands, tangled masses of aquatic vegetation, firmly matted together by their roots and fibres, and strong enough to bear the

FIG. 2.—*Lissochilus giganteus.*

weight of a man (see Fig. 1). These, like the huge snags and trunks of trees borne along by the swift current, are thickly peopled with all forms of animal and vegetable life, which are thus carried a long way from their original homes. Hence the inference that "on many rivers these floating trees must serve as a great means for the diffusion of species" (p. 283). So also in his recent work on the "Indians of British Guiana," Mr. Im Thurn notices the presence of turtles on the logs and stems swept down the rivers of that region.

[1] "The River Congo, from its Mouth to Bólóbó," by H. H. Johnston, F.Z.S. (Sampson Low, 1884.)

Another inference is that the Congo cannot possibly form a true parting-line or natural boundary in the distribution of the West African flora and fauna. "I have read in many works on Africa that the Congo was the southern boundary of the habitat of the gray parrot, the anthropoid apes, and the oil-palm (*Elaïs guineënsis*). Now the gray parrot reaches, perhaps, its great development in Malanje, a district of Angola nearly 300 miles south of the Congo, and, together with the oil palm, continues to be found as far as the tenth degree south of the equator, while the anthropoid apes can hardly be said to be limited southward in their distribution by the lower course of the Congo, for they do not reach even to its northern bank, or approach it nearer than Landana, 100 miles away. . . . There are, besides, many West African plants which stretch right away from the Gambia, across the Congo, into Angola on the south. In short, I have never seen any difference between the fauna and flora of the northern and southern banks of this great river; nor do I believe that it acts in any way as a limitation in the range of species" (p. 318).

On another point also our explorer differs from some distinguished botanists, who hold that tropical vegetation is inferior in brightness and fragrance to that of the temperate zone. "Although the Congo offers nothing, as we yet know, that is unique as genus or family, yet probably nowhere in Africa are there such magnificent displays of colour formed by the conspicuous flowering trees and plants. Here, at any rate, no one can maintain that the temperate zone can offer anything equal in the way of flower-shows. Many of the blossoms also exhale strong odours, sometimes very offensive, but also in many cases fragrant and delicious. Few perfumes are more pleasing than the clove like smell of the *Camoensia* or the balmy scent of the *Baphias*" (p. 324).

His botanical descriptions and sketches are generally admirable, as, for instance, of the *Lissochilus giganteus* (see Fig 2), "a splendid orchid that shoots up often to the height of six feet from the ground, bearing such a head of red-mauve, golden-centred blossoms as scarcely any flower in the world can equal for beauty and delicacy of form. These orchids, with their light-green, spear-like leaves, and their tall swaying flower-stalks, grow in groups of forty or fifty together, often reflected in the shallow pools of stagnant water round their bases, and filling up the foreground of the high purple-green forest with a blaze of tender peach-like colour, upon which no European could gaze unmoved'" (p. 35).

FIG. 3.—1, Mu-yansi; 2, Mu-téké; 3, Mu-shi-Kongo.

There is a deeply interesting chapter on the "People of the Congo," who, with the doubtful exception of some dwarfish or Bushman tribes, are all grouped in "that great Bantu family which, when seen in its purest exemplars, the Ova-héréro and Ova-mpo of the south-west, the tribes of the Zambesi, the people of the great lakes of Tanganyika and Nyassa, and the western shores of Victoria Nyanza, and finally of the Upper Congo, is so distinct, physically and linguistically, from the divers Negro, Negroid, and Hamitic populations to the north of it, and from the Hottentot-Bushman group to the south" (p. 396). Here we find the Bantus as a race distinguished by a good observer, not only from the Hottentots, Hamites, and Negroes proper, but even from the surrounding Negroid populations Further on the Bantus themselves are said to vary considerably in physical appearance, a statement fully borne out by the accompanying typical heads of a Mu-yansi, a Mu-téké, and a Mu-shi-Kongo (see Fig. 3). "The Congo tribes," we are told, "on nearing the coast, begin to lose their distinctive Bantu character, either through the degradation the coast climate seems to entail, or because on their migration westward from the north-east Bantu focus, they originally met and mixed with, in the low-lying coast-lands, an earlier Negro population. This latter supposition sometimes strikes me as being the true one, for the reason that, in such a littoral tribe as the Kabinda or Loango people, there are distinctly two types of race. One—the Bantu—a fine, tall, upright man, with delicately small hands, and well-shaped feet, a fine face, high thin nose, beard, moustache, and a plentiful crop of hair; the other an ill-shaped loosely-made figure, with splay feet, high calves, a retreating chin, blubber lips, no hair about the face, and the wool on his head close and crisply curled. The farther you go into the interior the finer the type becomes, and two points about them contrast very favourably with most of the coast races, namely, their lighter colour—generally a warm chocolate—and their freedom from that offensive smell which is supposed, wrongly, to characterise most Africans" (p. 397).

In this instructive passage all the facts are stated with tolerable accuracy. Yet the general inference cannot be accepted. There is, strictly speaking, no Bantu type at all, and the expression, correct in a linguistic sense, has no definite anthropological meaning. But for the fact that most of the peoples occupying the southern half of the continent speak dialects of a common mother-tongue, no ethnologist would ever have thought of grouping them together as forming a separate branch of mankind. Physically they must be regarded as distinctly Negroid, that is, an essentially mixed race presenting every possible shade of transition from the true Negro of Sudan and the West Coast to the true Hamite of the north-east coast. Between these two extremes they oscillate in endless variety, presenting nowhere any stable type distinct from either, and bound together only by the single element of their common Bantu speech. On the other hand, this Bantu speech itself is not Hamitic, but Negro, as clearly shown by the absence of grammatical gender. There appears to be also present a more or less distinct sub-stratum of Negro blood in all the Bantu-speaking tribes, from the Mpongwés of the Gaboon to the Ama-Khosas of the extreme south-east, and from the Wa-Swahili on the East to the Ba-Congo on the West Coast. Hence these peoples should apparently be regarded rather as Negroes affected by Hamitic than as Hamites affected by Negro elements. In other words they are Negroid rather than Hamitoid.

The spread of a single organic speech of an extremely delicate structure over such a vast area, unaided by the prestige of letters, or by far-reaching political influences, is certainly a surprising phenomenon. But it is not without its analogues in other quarters of the globe, where we find an equal and even wider diffusion, for instance, of the Malayo-Polynesian, Ural-Altaic, Aryan, Athabascan, and Guarani-Tupi forms of speech, also before the rise of literatures and great empires. And as no sound anthropologist regards the Aryan or the Malayo-Polynesian-speaking peoples as belonging to one physical type, neither can they regard the Bantu-speaking tribes as constituting a single ethnical group. All these terms, Aryan, Malayo-Polynesian, Bantu, are essentially linguistic, and as such have a definite meaning. Ethnologically they have little or no scientific value. It is noteworthy that, when not advocating theories, Mr. Johnston himself speaks of the Bantus of the Congo Basin as Negroes. Thus at p. 298, where he contrasts them unfavourably with the half-caste Wa-Swahili of Zanzibar, he writes:—"The mixture of Arab blood and Arab culture gives a stability and manliness to the Wa-Swahili which is lacking even in the finest race of pure Negro origin. The Congo peoples, for instance, are usually amiable and soft-mannered, but at heart they are seldom to be depended on. There is something so eminently childish in the Negro's character. . . . All these traits are found in the black races of Africa *that are of purely Negro or Bantu stock;* but in the Semiticised people of Zanzibar you find men of thought and reflection, whom you may use as counsellors and confidants; men who are really capable of zealous service, of disinterested affection, and to whom gratitude is a concept neither foreign to their intelligence nor their tongue." This is true and well put, and is the common experience of all travellers who have had dealings with the natives of South Central Africa. It shows at the same time that "even the finest" Bantu peoples must ultimately be affiliated to the Negro stock.

Besides the numerous illustrations, two useful maps and a copious index, this handsome volume is furnished with comparative linguistic tables of the chief Bantu languages current in the Congo basin, as well as full lists of the plants, birds, and mammals occurring in the same region.

A. H. KEANE

NOTES

EUROPEAN science has sustained a terrible loss during the past week. Monsieur Dumas, the venerable Perpetual Secretary of the French Academy of Sciences, died at Cannes on the 11th inst. at exactly the age of the century. Old as the great chemist was, his death will be felt as a real and serious loss to French science, for up to the last he took an active interest in all its doings. We gave in vol. xxi. so full a biography from the masterly pen of Prof. Hofmann of Berlin, that it is unnecessary to go over the ground again. We may, however, attempt in a future number to appreciate to some extent the position of Dumas in the chemistry of the past sixty years. The funeral took place at Mont Parnasse Cemetery on Tuesday, when MM. Bertrand, D'Haussonville, and others delivered addresses at the grave. The sitting of the French Academy of Sciences on Monday was postponed after the reading of an address by M. Rolland, the president, who praised M. Dumas for the talent and impartiality he exhibited as Perpetual Secretary of the Academy.

THE Museums of Economic Botany at Kew are second in importance to none in the world, and, except perhaps as to the size and splendour of the buildings, they are in every way worthy of a nation which has trade relations with every part of the globe. The foundation of these museums was laid by Sir W. J. Hooker in 1847, when he obtained leave to fit up an old fruit store with cases suitable for the exhibition of important vegetable products. Ten years later the house now known as Museum No. 1 was opened to the public, and in 1881 this was added to and the approaches greatly improved. It will be remembered that these buildings were not originally designed for museum purposes, and yet such is the arrangement of the cases and so well are the objects displayed and illuminated that we know of no museum built for the purpose that we would prefer to No. 1 Museum at Kew. The collections are contained in Museum No. 1, which is directly opposite the Palm House, on the other side of the Ornamental Water, in Museum No. 2, which is close to No. 1, at the northern end of the Herbaceous Garden, while Museum No. 3 occupies the old Orangery. At the north end of the Broad Walk the last Museum contains specimens of large timber, while the monocotyledons and flowerless plants are arranged in No. 2, and the dicotyledons in No. 1 Museum. An official guide to the contents of the latter Museum has just been published. As nearly every object exhibited is fully labelled, this guide-book does not enumerate a tithe of these, but a certain number of important objects are marked with a conspicuous number, and these numbers are referred to in the catalogue. In the 130 pages of this guide there is compressed a vast amount of information, a great deal of which is easily understood, even apart from the interesting collection on which it is founded; and if the student, as he walks through the Gardens, is struck at the beauty of the vegetable kingdom, he will, as he studies the products of that kingdom within these museum walls, be more struck at the extreme indebtedness of mankind to this kingdom for the necessaries and luxuries of life.

WE regret to learn that Sir Sidney Smith Saunders, C.M.G., for many years British Consul in various Mediterranean ports, and a distinguished entomologist, died suddenly on Tuesday evening (15th) at an advanced age. He was one of the original members of the Entomological Society of London, and was a vice-president of the Society at the time of his death. He devoted special attention to the singular bee-parasites known as *Stylopidæ*.

THE following are the arrangements for the lectures at the Royal Institution after Easter:—Dr. Klein, two lectures on the Anatomy of Nerve and Muscle, on Tuesdays, April 22 and 29; Prof. Gamgee, five lectures on the Physiology of Nerve and Muscle, on Tuesdays, May 6 to June 3; Prof. Dewar, seven lectures on Flame and Oxidation, on Thursdays, April 24 to June 5; Mr. Hodder M. Westropp, three lectures on Recent Discoveries in Roman Archæology, on Saturdays, April 26 to May 10; and Prof. T. G. Bonney, four lectures on the Bearing of Microscopical Research upon some Large Geological Problems, on Saturdays, May 17 to June 7. The following is a list of the Friday evening lectures:—April 25, the Art of Fiction, by Walter Besant; May 2, Krakatoa, by Prof. Judd; May 9, Mohammedan Mahdis, by Prof. Robertson Smith; May 16, the Dissolved Oxygen of Water, by Prof. W. Odling; May 23, Sidereal Astronomy, by Dr. David Gill; May 30, Sur les Couleurs (in French), by Prof. E. Mascart; June 6, Prof. Dewar.

BESIDES subjects of general anthropological interest, the following specially American topics, as to several of which Canada affords important evidence, are suggested for papers to be read in the Anthropological Section at the Montreal meeting of the British Association. The papers on each subject will, as far as possible, be grouped for reading on the same day, so as to insure a general discussion. (1) The native races of America: their physical characters and origin; (2) Civilisation of America before the time of Columbus, with particular reference to earlier intercourse with the Old World; (3) Archæology of North America, ancient mounds and earth-works, cliff-dwellings and village-houses, stone architecture of Mexico and Central America, &c.; (4) Native languages of America; (5) European colonisation and its effects on the native tribes of America. It is requested that all papers may be sent to the office of the Association, 22, Albemarle Street, London, W., on or before July 1.

THE International Ornithological Congress at Vienna was brought to a conclusion on Friday last by an appropriate speech from its patron, the Crown Prince Rudolph, who, among other things, warmly thanked the scientific men from abroad for their appearance in Vienna. The next Congress will not take place till three years hence, and will be held in Switzerland. The Crown Prince has accepted the honorary office of Patron of the Permanent International Committee for the Establishment of Ornithological Observatories, or stations for the observation of the habits of birds, especially those of the migratory species. Prof. Blasius, the president of the third section, to whose sphere the subject belongs, explained the nature, object, and importance of such ornithological stations of observation. M. Rodde proposed that the meteorological stations should be used as ornithological ones. Dr. Schier of Prague afterwards gave an account of his efforts to secure a regular system of observation. He had received from some hundreds of correspondents many valuable notices in regard to the line of passage of migratory birds.

THE Academy of the Lincei have elected Prof. Francesco Brioschi, a senator, to fill their presidential chair recently left vacant by the death of Signor Quintino Sella, electing at the same time Commendatore Fiorelli, who so long directed the excavations at Pompeii, to fill the office of vice-president. The new president, Signor Brioschi, is a distinguished mathematician.

AN interesting little volume appears this week in Edinburgh containing an annotated list of the illustrious dead who have been in any way connected with Edinburgh University. The names are classified according to the departments with which they are connected, "Zoologists and Botanists," for example, beginning with Erasmus Darwin and ending with Charles Darwin. The brief notes attached to the names have, we believe, been compiled by various specialists.

THE Anthropological Institute will hold its first meeting in its new premises, No. 3, Hanover Square, on the 22nd instant.

THE next Ordinary General Meeting of the Institution of Mechanical Engineers will be held on Thursday, May 1, and Friday, May 2, at 15, Great George Street, Westminster. The Chair will be taken by the President, Mr. I. Lowthian Bell, F.R.S., at half-past seven p.m. on each evening. The following papers will be read and discussed as far as time will admit:—On Thursday, May 1, on the consumption of fuel in locomotives, by M. Georges Marié, of Paris; on portable railways, by M. Paul Decauville, of Petit-Bourg, Paris; on the Moscrop engine recorder, and the Knowles supplementary governor, by Mr. Michael Longridge, of Manchester. On Friday, May 2, description of the automatic and exhaust-steam injector, by Mr. A. Slater Savill, of Manchester; description of the apparatus used for testing current-meters, at the Admiralty Works at Torquay for experimenting on models of ships, by Mr Robert Gordon, of Burmah; description of the Francke "Tina" or vat process for the amalgamation of silver ores, by Mr. Edgar P. Rathbone, of London.

THE Report of the U.S. Solar Eclipse Expedition, *Science* states, has just been ordered to be printed by Congress. Among its contents are:—Meteorology of Caroline Island, by Mr Winslow Upton; Botany of Caroline Island, collections by Dr. W. S. Dixon, U.S.N., and identifications by Prof. W. Trelease; Notes on the zoology of Caroline Island, by Dr. W. S. Dixon, U.S.N.; Memorandum on the butterflies, &c., of Caroline Island, collections by Dr. J. Palisa, identifications by Messrs. Herman Strecker and Arthur G. Butler; Chemical constituents of the sea-water of the lagoon of Caroline Island, determined by Messrs. Stillwell and Gladding; Observations of twenty-three new double stars, by Prof. E. S. Holden and Prof. C. S. Hastings; Plans for work on the day of the eclipse, by Prof. E. S. Holden.

FROM *Science* we learn that at the request of the Navy Department, the Fish Commission steamer *Albatross*, Capt. Tanner commanding, was fitted out during the winter for the purpose of carrying on a series of deep-sea soundings and dredgings in the Caribbean Sea, a region very little known in respect to its depths. The vessel left Washington on January 1, and reached St. Thomas on the 17th, and, after coaling, proceeded on her voyage, making the following ports:—Curaçoa, Trinidad, the Island of Oruba, Alta Vela, Jacmel, Gonaives, Santiago de Cuba, Navassa, and Kingston (Jamaica), where she arrived March 1. She left Kingston March 11, and arrived at Aspinwall, *viâ* Savanilla, March 25. On her return from Aspinwall she will proceed *viâ* Cape San Antonio to Key West, expecting to arrive at the Washington navy-yard about the middle of May. The expedition has been a great success in all respects, numerous satisfactory series of soundings and temperatures having been taken, and large numbers of marine animals obtained. In the collections incidentally obtained during the stay of the steamer at Trinidad were two specimens of the guacharo bird, *Steatornis caripensis*, which is such a rarity in museums, and two of the great fishing-bat.

ON Easter Monday the Essex Field Club held a meeting at Saffron Walden, about sixty members and visitors being present. Alighting at Audley End Station, the party drove to Lord Braybrooke's mansion, where they had an opportunity of inspecting the fine collection of birds and prehistoric and Roman antiquities contained in the museum. The Club was then conducted to a neighbouring hill, known as Ring Hill, where an ancient circular entrenchment is to be seen, and from there proceeded to a wood known as Peverels, where the true oxlip (*Primula elatior*) grows in profusion, the ground being in parts carpeted with the flowers of this interesting species. After luncheon a visit was paid to Mr. Joshua Clarke, F.L.S., at his residence, Fairycroft, and the visitors viewed the magnificent collection of humming-birds and birds of Paradise formed by this gentleman. The Club next assembled in the grounds of Mrs. Gibson, and inspected the site of the ancient Saxon cemetery and the collection of skulls and relics found therein during the excavations undertaken by the late Mr. G. S. Gibson, a full description of which has been published in a recent number of the *Transactions of the Essex Archæological Society*. The splendid library of scientific and other works belonging to the late Mr. Gibson having been hastily viewed, and the party having partaken of the hospitality offered by Mrs. Gibson, they were next conducted to the Saffron Walden Museum, where the various collections were greatly admired, and the curator, Mr. Maynard, much complimented upon the ability and zeal which he had displayed in their organisation and arrangement. In the ruins of the ancient castle adjoining the Museum Mr. Maynard read a paper on the history of these remains, and the party then proceeded to view the church, under the guidance of the Rev. Mr. Stevens. After tea an ordinary meeting of the Club was held, the president, Prof. Boulger, being in the chair. A paper, on the cultivation of the saffron in connection with the old town of Saffron Walden, was read by Mr. Joseph Clarke. With the object of promoting the extension of natural history science throughout the county, the Club proposes to establish local centres in the chief towns of Essex, and arrangements will shortly be made to commence operations at Saffron Walden, where so much interest was shown in the visit of the Club.

ON Saturday next, April 19, at three o'clock, a meeting of the Essex Field Club will be held at the British Museum of Natural History, South Kensington, under the direction of Dr. Henry Woodward, F.R.S. Dr. Woodward will deliver an address in the lecture-room on "Wingless Birds," and afterwards give a demonstration of the species, extinct and recent, in the geological and zoological galleries.

THE Council of the Linnean Society of New South Wales have been presented by a member of the Society with 100*l*., accompanied with a request that it should be offered as a prize for an essay on "The Life History of the Bacillus of Typhoid Fever." The Council has assented to the proposal, and advertisements to that effect will be immediately inserted in the most prominent scientific publications throughout the world. The essay will be received by the Society not later than December 31, 1884. The intention and wishes of the donor of the prize will be best given in his own words. "The questions chiefly to be solved in the investigation of the life history of the *Bacillus* of typhoid fever, are—1. What are the specific characters of the organism, as distinguished from other *Bacteria?* 2. What are the changes, if any, which the organism undergoes in the human body? 3. What are its modes of development and reproduction in the human body? 4. What changes or metamorphoses, if any, does the organism undergo after ejection from the human body, or in any other condition of its existence? 5. What fluids or other substances seem best adapted for the growth and multiplication of the organism? 6. Can the organism live or be cultivated in pure or distilled water? 7. What are its limits of endurance of heat, cold, dryness, or humidity? As far as these points are concerned the author should confine himself entirely to facts which come under his own observation, and those should be given in detail, with a full explanation of the method of investigation. But in dealing with the results obtained by these investigations, and the consideration of the means whereby a knowledge of the life history of this most dangerous organism may help towards its eradication, the theories and observations of others may appropriately be referred to, but in every such case the authority must be correctly cited. The chief points to be ascertained in this branch of the subject are—1. How, and under what conditions, does the organism get access to the human body? 2. How can its growth be impeded, or its vitality destroyed in the human body without serious injury to the individual affected? 3. How can it be eradicated or rendered innocuous in wells, water-holes, drains, &c."

AMONG the superabundant "Universities" of the United States Harvard is unquestionably taking its place as a national institution on a par with British establishments which hold a similar designation. The last quarterly *Bulletin* of its proceedings is before us, which has to acknowledge during that short time nine legacies or donations in money, varying from 200 to 100,000 dollars, and amounting to 168,000 dollars. One of these is 10,000 dollars subscribed for the purchase of meteorites, and another is 2000 dollars from the Massachusetts Society for Promoting Agriculture, to assist in the establishment of a veterinary hospital, to which institution also a collection of pathological models is presented. Other donations are, a new building for the law schools, two portraits of eminent divines, and the anatomical collection of a doctor who had previously founded a museum there. The *Bulletin* is edited by the well-known Harvard librarian, Mr. Justin Winsor, and a very carefully printed catalogue of the chief accessions to the University library in English, French, German, Italian, Spanish, Danish, Russian, Polish, and Hindustani, forms the bulk of it. Many of these additions are treasures which few libraries can acquire possession of, a few only of which have been printed, chiefly for private circulation, others, nevertheless, being both important and familiar books published a year or two ago. The books are divided into ten subjects, and it shows how different technical experience sometimes is from theoretical ideas, when so experienced a librarian finds it convenient to class together "History and Geography," while "Antiquities" are under a separate heading. We doubt, however, whether Izaak Walton or any one else would have looked for "The American Angler's Guide; or the Complete Fisher's Manual for the United States," under the head of "Law and Sociology," even if "Caxton's Game and Play of the Chesse" may in some sense belong to the latter. The advantages possessed by the librarian of such an institution as this are being fully utilised by Mr. Justin Winsor who is issuing in each number of the *Bulletin* most carefully written results of his researches into the bibliography of various subjects—in this January number, of "Ptolemy's Geography" and "The Kohl Collection of Early Maps," specially noting the gradual and irregular spread of the knowledge of America.

A STALACTITE cavern was recently discovered by accident near Cerdon in the Ain Department (France). It is situated near the old high road connecting Lyons with Geneva. Some country people who ventured into it state that it extends about 300 metres underground, and that its height varies considerably. Lyons and Geneva naturalists are now making a more minute investigation of the cave.

A STRONG shock of earthquake was felt at Urbino at a few minutes before 8 a.m. on the 9th inst. Its duration was five seconds. A shock was also felt at Belpasso, near Catania, at 10 a.m. on the 10th. It occasioned no damage.

OWING to the frequent earthquakes that have recently occurred in Slavonia, Prof. Pillar has been sent to observe these occurrences by the Hungarian Government, and will shortly present a detailed report to the Government on the subject.

ACCORDING to Herr Jæger of Rinde, on the Sogne Fjord, who, since 1858, has noted the number of earthquake shocks that have been felt in the district, there have been appreciable shocks from that period till 1879. Since the latter year no shock has been felt. It is worthy of record that on two occasions, viz. in 1860 and 1865, the shocks were perceived on the south side of the fjord, the districts on the northern coast being wholly undisturbed.

THE last number of the *Transactions of the Seismological Society of Japan* (Yokohama, 1884) contains various papers on seismology. The first is by Prof. Milne, on earth pulsations; the next is by Mr. Alexander, on the interpretation of a diagram described by a particular form of earthquake instrument. The object of the writer is to calculate not only the maximum velocity, but also the maximum rate at which the velocity changes, "which is a measure of the effect which an earthquake exerts in overturning and fracturing bodies placed on the earth's surface." Prof. Ewing describes the construction of a pendulum which shall be without a tendency to swing when the point from which it is suspended suffers displacement. Mr. Gergens gives a note on ripple-like marks found on the surface of an iron casting supposed to have been shaken while solidifying, which marks are picturesquely described as "a note in a congealed earthquake." The remainder of the volume is occupied by suggestions for new types of seismographs, a list of earthquakes in Tokio, and a report on systematic earthquake observations.

A CORRESPONDENT in *Naturen* has drawn attention to the great differences of climate observable last winter between Christiania and Stavanger. While in the former place there was a depth of from ten to twelve inches of ice during the month of January, vegetation had never been wholly arrested in the latter region at the same period. The grass plots in the various gardens at and near Stavanger were as green as in summer: daisies, snowdrops, pansies, violets, and primroses had their blossoms well set; peonies had appeared above the ground, and many roses had thrown out vigorous shoots. The thermometer fell only once in January to freezing point.

MM. MIGNON AND TOUARD, who established the refrigerating service at the Paris morgue, have made experiments with their system on hams infected by trichinæ, and are stated to have proved that these are rendered wholly innocuous by exposure during an hour to a cold of -20° C. It will be proposed for the protection of consumers from trichinosis to render exposure obligatory in the case of importations from America or Germany.

THE great work of lighting the Paris Opera by incandescent light has already begun. The whole house will require 6000 lamps; at present 400 lamps are used.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus* ♀) from Java, presented by Dr. Benthall; a Weeper Capuchin (*Cebus capucinus* ♀) from Brazil, presented by Miss Vincent; a Short-eared Owl (*Asio brachyotus*), British, presented by Mr. Oscar Burrows; a Smooth Snake (*Coronella lævis*), a Common Viper (*Vipera berus*), a Common Snake (*Tropidonotus natrix*), a Slow-worm (*Anguis fragilis*) from Hampshire, presented by Mr. W. H. B. Pain; an Alligator (*Alligator mississippiensis*) from the Mississippi; a Horrid Rattlesnake (*Crotalus horridus*) from Florida, presented by Mr. A. Begg; a Philantomba Antelope (*Cephalophus maxwelli*) from South Africa, deposited; a Moose (*Alces machlis*) from North America, two Mute Swans (*Cygnus olor*), European, a Common Viper (*Vipera berus*), British, purchased; six Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

GEOGRAPHICAL NOTES

WE much regret to learn of the death, at Loanda, on March 17, of Dr. Paul Pogge, the successful African explorer. Dr. Pogge, since 1880, was the companion of Lieut. Wissmann in the exploration of the region inland from the Portuguese possessions, and around the kingdom of Muatà Janvo. He accompanied Wissmann as far as Nyangwé in the journey of the latter across Africa, and in May 1882 set out to return to the station at Mukenge. Doubtless the hardships to which he has been subject, combined with fever, have told on Dr. Pogge's health. In 1874 he was a member of the German African Expedition which was sent out to explore the same region, and with only native companions succeeded in penetrating as far as the capital of Muatà Janvo.

THE announcement that Mr. Stanley intends to proceed from the Middle Congo north-east to the Mombuttu country, partly, no doubt, to settle the question of the course of the Aruwimi, the great north-east tributary of the Congo, renders Dr. Junker's discoveries in the Wellé region of special interest. In the map sent home and published in the new number of *Petermann's Mittheilungen* we find in the northern part the Wellé, after receiving the Gádda, proceeding west-north-west, and on the north it is joined by the Mbrúöle, and not much further westwards by the Gúrba—both considerable rivers rising in the southern A'-Sandeh kingdom. After taking up the waters of the Gúrba, the Wellé curves sharply round, at first southwards, making many windings in its course, and describing a large semicircle round the land of A-Madi, a semicircle variegated by a series of islands. Later on it resumes its west and west-north-west direction. With the exception of the two larger tributaries from the north just mentioned, the Wellé along the whole extent of the sketch receives no considerable waters either from north or south. As far as the southern territory is concerned, this fact is explained by the circumstance that the most important tributary of the Wellé-Makua, the Bomokándi or Májo (Nemajo of Schweinfurth) flows in an extremely long course from east to west and north-west, approximately parallel to the Wellé Hut, an interval of hardly two days' journey. Further to the west, however, it discharges into the Wellé River. The Bomokándi, showing almost half the breadth of the Wellé, rises far in the east, and may also have its source in the mountainous country bordering the Albert Nyanza in the west. In consequence of this approach to each other of the two streams, no other tributaries are developed in the long tongue-shaped peninsula formed by the junction of the Wellé and Bomokándi. Except innumerable little rivulets, few rivers of any size run either northwards to the Wellé or southwards to the Bomokándi from the plateau of this peninsula. It is otherwise, however, with the rivers discharging into the Bomokándi from the south. The watershed whence flow its southern tributaries lying considerably further to the south, there is ample scope here for the formation of larger accessory streams. Proceeding from west to east, we come upon three rivers of almost equal rank with the Mbrúöle and the Gúrba—the Makongo, Pokko, and Telli. A river no longer paying tribute to the Bomokándi, but discharging further to the west directly into the Wellé, is, according to information, the Mbe'lima, the source of which is not far from that of the Makongo to the east. With these partly indirect tributaries to the Wellé through the medium of the Bomokándi and the direct tributary, the Mbe'lima, the river-system of the Wellé to the south comes to an end. Further south, and flowing from east to west, is the Náwa, belonging, according to information received, to a more southern river-system, forming indeed a northern tributary to the Népoko. Dr. Junker made his way south to the Népoko, four days' journey from the Bomokándi, and reached it in the middle of its course, where it holds the same longitude with the Bomokándi. He evidently travelled a long way from the region in which lie the sources of the Népoko, the Bomokándi, and the Kibuli, that is, the Kibbi (Wellé)—rivers which collectively descend from the mountain and table-lands west of Albert Nyanza; the water-parting must be sought in a line running approximately from south-south-west to north-north-east. That the Népoko, from the point at which he met it, and where probably it describes a northern curve, bends in its further course in an approximately south-west direction, may be inferred from the fact that though indeed known in the western territories, it is yet transferred far to the south beyond the Náwa, which rises in the west, not far from his line of route to the Népoko. In the region between Bomokándi and Népoko traversed by Dr. Junker, the watershed of the two river-systems is hardly perceptible, yet the country of the Népoko tributaries from the north is highly characteristic. Instead of the high trees which everywhere else clothe the banks of the streams, you here meet broad, flat, treeless swamps. A floating vegetation, very like the Ssett in the Nile, forms a bridge by which to cross these swamps, though it is unavailable for riding and for beasts of burden. Dr. Junker closes his remarks on the hydrography of this region with the observation that he feels entitled to identify this Népoko, which does not belong to the Wellé system, with the Aruwimi of Stanley. Proof that the Wellé is the upper course of the Shari he hopes to be able to adduce later on.

IN *Petermann's Mittheilungen*, 1884, Heft iii., is a map of the Amambara Creek of the lower Niger region, which we owe to the indefatigable African explorer Eduard Robert Flegel. Just as by way of preparation for his Adamawa expedition he executed maps of the route from Eggan to the Akoko Mountains, and of the Niger tract, till then unknown, from Bussa up the river as far as Gomba, and finally explored the route from Bidda by way of Keffi Abd-es-Senga to Loko on the Benué; so now as preparatory to his third African exploration he has executed a map of the Amambara which discharges into the lower course of the Niger. While Flegel was waiting at Lagos for a remittance from Germany to enable him to prosecute his travels, the representative of the Marseilles "Compagnie du Sénégal et de la Côte occidentale d'Afrique," J. Zweifel, the well-known discoverer of the sources of the Niger, undertook in July 1883, for trading purposes, an expedition up the Amambara, on the banks of which are planted a series of old commercial establishments, but which, nevertheless, had never yet been mapped out. To this expedition Flegel at once gladly joined himself, and hence the map in question. This must be reckoned as another valuable contribution towards clearing up the geography of the Lower Niger, so complicated by tributaries, arms, deltas, creeks, &c. In an article in the *Mittheilungen* commenting on the map of the Amambara Creek, an interesting sketch is given of the progress of geographical knowledge of the Niger for the last 300 years, or rather of the misconception and vacancy that prevailed up till quite recently regarding that region, our knowledge of which is still so very defective. Since the discovery of the rich produce in palm-oil yielded by the banks of the Niger and Lower Benuë, trade has rapidly developed there, and is now so lively that Flegel, in 1883, counted as many as twenty-three large ships, mostly steamers, constantly plying on their waters, besides a series of flat barges.

WE find in the last issue of the Caucasian *Izvestia* the following new information on the Merv oasis, due to M. Alikhanoff:—Its surface is about 2150 square miles, which area could be increased by irrigation, the whole of the oasis having its origin due to the irrigation of the sands by canals drawn from the Murgab. This river, being dug at Kaushut-khan-bend, two canals, subdivided into numerous *aryks* (smaller canals), issue from it, taking in nearly all the water of the river which does not flow beneath the dam. Notwithstanding the southern position of the oasis, it has a cold winter, and there falls every year some snow, sometimes two feet deep; it soon disappears, however, as the temperature rises rapidly, and reaches occasionally 30° Celsius in February. During the summer, strong hot winds, which bring masses of hot sand, blow, mostly from the south-west. Still the climate is healthy enough, and healthier than that of Akhaltekke; but the mortality is very great, owing to the poverty of the inhabitants and the dirtiness of their habits: the *kara-masta*, or black disease, a kind of pestilence, and the *merghi*, a kind of cholera, are endemic. The population is estimated at 32,700 *kibitkas*, which M. Alikhanoff considers to represent no less than 194,000 or 200,000 inhabitants. This population is, however, too numerous for the oasis, the average area of irrigated land being only six acres per inhabitant. M. Alkihanoff considers the Mervis as the least attractive of the Turcomans, and discovers in them only one good feature—their hospitality.

AT the annual meeting of the Bremen Geographical Society it was stated that a young German naturalist intends to start on an exploring expedition to Ovambo-land and further into the interior of Equatorial Africa, accompanied by Dr. Hoepfner. A member of the Society has presented him with good astronomical instruments, and the traveller will report to the Society from time to time, and his cartographic results will belong to the Society. The Society is also preparing a geographical and natural history expedition to the Bonin Islands, lying south of and belonging to Japan. Dr. Gottsche of Kiel, an eminent geologist, who is now in Japan, will be the leader of this expedition.

THE Russian Imperial Geographical Society has received the following telegram from Col. Prjevalsky, who is for the fourth time attempting to penetrate into Thibet:—"Alashan, January 8.—We have traversed the desert of Gobi without mishap. In the northern part the cold exceeded the freezing point of mercury. We are all well, and start to-morrow for Koukou-nor. It is said that hitherto the Thibetans pray heaven to shower down stones on our heads."

THE Melbourne *Age* has despatched to New Guinea a second exploring party, the members of which include a naturalist and an artist.

ONE result of Mr. Colquhoun's recent journeys in Indo-China has been the appointment of an English official to reside at Cheng-mai, or Zimmé, on the borders of the Shan States, and an officer of our consular service in Siam has been selected for that purpose, and is now at the post. This town, it may be recollected, forms the centre of the railway communication which Mr. Colquhoun proposes between British Burmah and South-Western China, and it can be reached either from Rangoon or from Bangkok. Mr. Bock travelled from the latter town up the Meinam. With the example of the exploration of the English consuls who have resided at Chung-king on the Yangtsze before him, it is to be hoped that the consul at Zimmé will be able to add largely to our knowledge of the regions, especially of the Shan States, lying between China and Siam. His appointment is certainly another step in the prolonged efforts to obtain a trade route into South-Western China, and he will serve, on the south of the frontier line, the same purpose as the officer at Chung-king on the north.

VOLCANIC ASHES AND COSMIC DUST[1]

IN the session of 1876, Mr. John Murray communicated to this Society a paper on the distribution of volcanic debris over the floor of the ocean,[2] and in it announced the discovery of cosmic dust in deep-sea deposits. It was shown that at points where neither the action of waves, rivers, or currents can transport the debris of continents, volcanic materials play the most important *rôle* in the formation of the mineral constituents of the deep-sea deposits. It was pointed out that pumice, on account of its structure, was able to float to great distances, but in time became waterlogged and sank to the bottom, there to decompose. On the other hand, incoherent volcanic matters, ejected in the form of lapilli, sand, and ashes, into the higher regions of the atmosphere, may, *cæteris paribus*, be conveyed, in consequence of their small dimensions and structure, to greater distances than other mineral particles derived from the continents. The possibility was also admitted that submarine volcanic eruptions might also contribute to the accumulation of those silicates and pyrogeneous minerals and rocks whose microscopic characters and distribution at the bottom of the sea we shall presently point out.

During the past few years we have added greatly to the observations which were the subject of Mr. Murray's communication. The present paper has been suggested by the striking analogy which exists between the volcanic products we have found in all deep-sea sediments, and the ashes and incoherent products of a recent celebrated eruption,—that of Krakatoa. The remarkable meteorological phenomena we have recently witnessed have been attributed by some to the presence in the atmosphere of mineral particles derived from this volcanic eruption, and by others to that of cosmic dust. It is said that in several places in America, and even in Europe, matters have been collected which must be regarded as the ashes from Krakatoa, which have been suspended for several months in the upper currents of the atmosphere. The importance of this matter has been recognised by the Royal Society of London, which has appointed a committee of its members to collect all the documents and observations relative to the distribution of these ashes. The present state of the question induces us to make known some results of the detailed researches which we have undertaken upon similar subjects. We desire to make known, to those who wish to study atmospheric dust, the distinctive microscopic characters by the aid of which we have been able to establish the volcanic or cosmic nature of certain particles found in deep-sea deposits, and to show at the same time the enormous area of the ocean over which we have been able to detect their distribution.

We believe that no better example could be found in support

[1] "On the Microscopic Characters of Volcanic Ashes and Cosmic Dust, and their Distribution in the Deep-sea Deposits." A paper read before the Royal Society of Edinburgh by Mr. John Murray and M. A. Renard.

[2] *Proc. Roy. Soc. Edin.*, 1876-77.

of our interpretations than the microscopic study of the ashes from Krakatoa, whose mineralogical and chemical composition M. Renard[1] was the first to make known, and whose observations on this subject have been amply confirmed by the later researches of other mineralogists. On the other hand, the conditions under which floating pumice was found after that eruption agree perfectly with the interpretation given eight years ago by Mr. Murray relative to the mode of transport of these vitreous matters and of the accumulation of their triturated debris on the bottom of the ocean. We shall also see how the sorting which takes place in the transport of the ashes of a volcano has its analogy in what we find in the deep-sea deposits.

In the first part of this communication we shall give the mineralogical description of the fragmentary products of Krakatoa, and consider generally the observations relative to these ashes. We shall also give the diagnostic characters of this volcanic dust, and of all similar particles which we find in deep-sea deposits. In the second part we will treat of the cosmic matters found in the abysmal regions of the ocean, to which Mr. Murray was the first to draw attention, and discuss their origin and distribution.

First Part

It is unnecessary to refer to the abundance of floating pumice, to its various degrees of alteration, to its conveyance by means of rivers, waves, and currents, and to its universal presence in deep-sea deposits, which have been pointed out in some detail in Mr. Murray's paper above referred to; but we will briefly recapitulate the characters of these volcanic matters, in accordance with the examination we have made of a large number of soundings and dredgings. We need not describe in detail the special characters of the lapilli which have been brought up in the dredge and sounding-rod from great depths. These fragments of more or less scoriaceous rocks belong to the same lithological varieties as those derived from terrestrial volcanoes. They consist of fragments of trachyte of various dimensions, of basalt, and, above all, of augite-andesite; the most remarkable, beyond all question, being lapilli of sideromelan, which are often entirely transformed into palagonite, and pass into the clay which is found so widely distributed, especially in the Pacific.

We do not propose here to take up in detail the wide distribution of the materials ejected from Krakatoa; we are engaged in collecting these, and will place the observations on maps along with those of Mr. Buchan on the upper currents of the atmosphere, which will be published in the *Challenger* Reports.

Before, however, passing to the description of the ashes themselves, we will briefly refer to some points touched upon by Mr. Murray in his paper. It is there pointed out that, in regions far removed from coasts, rounded fragments of pumice were collected on the surface of the sea by means of the tow-net, and that, at certain points on the bottom of the ocean, the greater part of the deposit is composed of vitreous splinters derived from the trituration of pumice-stones. The description of the phenomena connected with the Krakatoa eruption gives us a complete explanation of these observations. The specimens of pumice from Krakatoa, which have been collected floating on the sea and which we have examined, are in like manner rounded. The angular surfaces are all worn away just as in pebbles; the only asperities to be observed consist of crystals and fragments of crystals, which project beyond the general surface of the vitreous matter, which last, on account of its structure, presents less resistance to wear and tear than the minerals which are embedded in it.

We may recall the fact that the Bay of Lampong, in the Straits of Sunda, was blocked by the vast accumulation of pumice, formed in a few hours by the eruption of Krakatoa, which completely filled the bay. This floating bar of pumice-stones was about 30 km. long, 1 km. broad, and 3 m. to 4 m. in depth, 2 m. or 3 m. of which were below the surface of the water, and 1 m. above. These numbers give about 150 millions of cubic metres of ejected matter. This moving elastic wall rose and fell with the waves and tide,[2] and was carried by currents thousands of miles from the point of eruption over the surface of the ocean. The rounded form of blocks of pumice met with everywhere floating on the surface of the sea, as well as of those samples which, after having floated some time, became waterlogged and sank to the bottom, may be perfectly explained if we remember the friability of this rock, and, at the same time, the agitation to which it is submitted by the waves, through which the pieces are continually being knocked against each other. We understand also how this wear and tear gives rise to an immense quantity of pulverulent pumice fragments, which contribute in a great measure to the formation of oceanic deposits. As a matter of fact, rounded fragments of pumice have been met with floating on the surface of every ocean, and during the last few years many samples have been sent to us by captains of ships and missionaries. As has been already pointed out, they are universally distributed in oceanic deposits, although frequently highly altered.

If it be easy to pronounce upon the volcanic nature of these larger fragments, it becomes, on the other hand, exceedingly difficult when we have to deal with particles reduced to powder, and when recourse must be had to the microscope. Let us see what are the microscopic characters by which we recognise the particles of this dust.

We may here point out that it is not so much the presence of volcanic minerals which enables us in a marine sediment, as well as in an atmospheric dust like the ashes of Krakatoa, to recognise that the small fragments have an eruptive origin, as the microscopic structure of the small vitreous particles. It is well known that minerals reduced to small dimensions and irregularly fractured, as in the case of volcanic ashes, often lose their distinctive characters. Their size does not allow us to judge of their optical properties; their form, irregular and fragmentary, renders it difficult to determine the characteristic extinction of the species; the phenomena of coloration, of pleochroism, and the tint peculiar to the mineral, all lose so much of their intensity that they no longer serve for the identification of isolated minerals like those of the volcanic ashes which we have to study. As a result of our observations, we believe that in most cases where a mineral, under the conditions we have just described, reaches dimensions less than 0·05 mm., its determination with certainty is no longer possible, and consequently its origin can no longer be established; whilst a vitreous fragment, like those of volcanic ashes or triturated pumice, continues to be discernible when its dimensions are less than 0·005 mm. A reason for showing that the absence or rarity of crystals, or of fragments of volcanic crystals, ought not to be taken as a proof that a sedimentary matter, either from the atmosphere or from the deep sea, is not of volcanic origin, is the sorting process to which these matters are subjected in the air and in the water, a phenomenon to which we shall presently recur.

The most reliable distinctive character is always found in the structure of the small vitreous particles which are derived from the trituration of pumice or have an analogous origin, inasmuch as they have been ejected from the volcano in the state of ash. The structure peculiar to these materials is seen in their fracture, which leaves its impress upon the smallest fragments of debris, in which the microscope can decipher no characteristic properties except such as have relation to form. In order to assure ourselves that these characters of pumice remain constant to the extreme limits of pulverisation, such as are employed in the preparation of silicates for chemical analysis, we pounded in an agate mortar several varieties of pumice, and the powder thus produced clearly showed itself to be composed of particles in which were recognisable, with little trouble, the characters of the pumice-like material which is constantly met with in the sediments, and of which the ashes of Krakatoa give us beautiful examples. The diagnostic character to which we here make allusion rests on the distinctive peculiarities of incoherent volcanic products. What distinguishes them from lavas is not merely the extraordinary abundance of vitreous matters, but also the prodigious number of gas-bubbles which are inclosed by the pumice and vitreous volcanic sands and ashes. These bubbles are due to the expansion of the gases dissolved in the magma which also determine the eruption. If we admit, as everything seems to show, that these incoherent volcanic matters are the products of the pulverisation of a fluid magma, we can understand that these particles, on cooling rapidly, will remain in the vitreous state, and, on the other hand, that the dissolved gases, yielding to the expansion, will form numerous pores which will become elongated owing to the mode of projection. It is the existence of these bubbles, or of such a filamentous structure, which points out to us the vitreous volcanic materials in spite of the great fineness of subdivision. It is also this structure which allows these bodies to be carried to such great distances from the scene of eruption.

The examination of the Krakatoa ashes, and of the dust resulting from the pulverisation of the pumice of that volcano,

[1] "Les cendres volcaniques de l'éruption du Krakatau" (*Bull. Acad. Roy. de Belgique*, sér. 3, t. vi. No. 11, Séance du Nov. 3, 1883).

[2] *Comptes rendus de l'Académie des Sciences*, November 19, 1883, p. 1101.

shows markedly the peculiarity due to the bullous structure. If this gray-green pulverulent matter be placed under the microscope, it is seen to be composed of almost impalpable grains, with a mean diameter of 0·1 mm., which are almost exclusively colourless or brownish vitreous particles permeated by bubbles. The bubbles are rarely globular, but often elongated, as we have just pointed out, and they give a drawn-out appearance to the fragments. As often happens, several bubbles are elongated parallel to each other, and in this case the pore becomes a simple streak; the fragment then assumes a fibrous texture, which may cause it to resemble at first sight a striated felspar or an organic remnant; but an examination of the outline will never allow of this confusion. If we examine the terminal contours and lines of these bubble-containing fragments, we never find that they are straight lines, but that they show a ragged appearance, all the sinuosities being curvilinear. This mode of fracture is in correspondence with the vacuolated structure, and, just as in the porous pumice, the vitreous volcanic ashes are permeated by vacuoles; besides, everything goes to show that the fragmentary condition and the fresh fractures are due to a tension phenomenon which affects these vitreous matters in a manner analogous o what is observed in the "Rupert's drops."

FIG. 1.—Vitreous particles of the ashes of Krakatoa, which fell at Batavia, August 27, 1883 ($\frac{1}{1}\frac{1}{0}$).

We have pointed out that brown vitreous fragments are rare in the ashes of Krakatoa. These, however, contain skeletons of magnetic iron, and are devitrified by microliths.[1] It is scarcely necessary to add that the particles, whose form we have indicated, are isotropic. If under crossed nicols we sometimes see the field illuminated, this is due to crystals in the vitreous matter, or to phenomena of tension, which are sometimes observed in the neighbourhood of the bubbles.

These details on the micro-structure of the vitreous particles from Krakatoa can be applied with most perfect exactitude to the volcanic dusts, which we have determined as such, in the deep-sea deposits. In virtue of their bullous structure, their dimensions, and their mode of projection, they are capable of being widely transported from the point of eruption by aërial currents. It must be admitted, however, that in the deep-sea sediments a very large part of these vitreous splinters has not been derived from the pulverised ejections from a volcano, but from the trituration of floating pumice, of which we have given above a striking example. It will be understood that it is scarcely possible to trace the difference between volcanic ashes, properly so called, and the products resulting from the pulverisation of floating pumice which we have just indicated. As in the incoherent products of Krakatoa, so we find spread out on the bottom of the sea many more vitreous particles, similar to those we have just described, than of true volcanic minerals. This is easily explained, however, when we remember how the distribution of volcanic dust takes place.

Let us now point out the minerals which can be determined with certainty in the ashes of this great eruption; and we may at once remark that they are the same which we have almost always found associated in the deposits with the splinters of glass. In general all the crystals are fractured, except those which are still embedded in a vitreous layer; this vitreous coating is often crackled and bullous. In the ashes of Krakatoa, however, we have not remarked the globules of glass which are often described as glued to the minerals of volcanic ashes, nor have we seen the drawn-out vitreous filaments resembling Peles hair. The minerals of the Krakatoa ashes which are susceptible of a rigorous determination belong to plagioclase, augite, rhombic pyroxene, and magnetite.[1] We shall presently see the peculiarity which distinguishes each of these species in the ashes.

Among the most frequent minerals, but poorly represented in comparison with the vitreous matter, plagioclase felspar comes first. This mineral has about the same dimensions as the vitreous fragments, and, with the exception of the crystals, entirely inclosed in the pumice matter, is in the form of debris. Sometimes twins on the albite plan can be distinguished, and the results of analysis clearly indicate that it is triclinic felspar which should almost exclusively be found in this ash. But the most interesting crystals of plagioclase, and the most characteristic of this ash, although represented very rarely, are in the form of rhombic tables, extremely thin, and covered with a fine lacework of vitreous matter. We know that the crystals described by Penck[2] in a great number of lapilli and of volcanic ashes, upon the nature of which doubts have been expressed, belong incontestably to the plagiocalases, and represent an isomorphic mixture analogous to that of bytownite. It is to Mr. Max Schuster[3] that we owe this specific determination. Having found in numerous sediments of the Pacific these same crystals in the form of rhombic tables, and possessing preparations which would be of great interest to him in his remarkable optical studies on the felspars, we submitted them to this ingenious mineralogist in order to confirm our determination. We believe it will be interesting to give a *résumé* here of the results of the observations of Mr. Schuster, which are perfectly applicable to the characteristic crystals of felspar from Krakatoa, as well as to those which we have discovered in a great number of deep-sea soundings.

This plagioclase occurs for the most part in flat tabular crystals with the clinopinacoid especially developed. Individuals of the columnar type, elongated in the direction of the edge P/M, are rare. These tabular crystals consist essentially of a combination of the clinopinacoid with P and *x*, more rarely with P, *u*, and *y*, and occasionally *x* and *y* appear together. In the first case the crystals have the form of a rhomb, in the second case they are elongated through the predominance of either *x* or P. The dimensions of those crystals which were examined and measured lie between the line 0·61 mm. broad and 1 mm. long as maximum, and 0·015 mm. broad and 0·042 mm. long as minimum. The extinction of the plagioclase is negative. Its value was found to vary between 22° and 32° on the clinopinacoid, and between 8° and 16° on the basal plane. The average values of many measurements made on good crystals are as follows:—24° 12′, 25° 6′, and 29° 6′ on the clinopincaoid, 10° 42′ on the one side, and 10° 18′ on the other side of the twinning line, as this is shown on the basal plane. Polysynthetic individuals, made up of repeated twins on the albite plan, were very rarely observed. The felspar in its optical properties is thus seen to lie between labradorite and bytownite. The twin growths are particularly frequent and interesting on account of the structure of the individuals. In addition to th se of the albite type, others were observed in which the edges P/M and P/K could be definitely determined as the axes of twinning, whilst P and K formed the twinning planes. The plane of composition was principally either P or M when penetration twins were not observed.

These fragments and crystals of plagioclase contain inclusions of vitreous matter, and sometimes grains of magnetite. Perhaps a small number of felspathic grains may belong to sanidine, the presence of which is insinuated by the percentage of potass indicated by the analysis which follow (K_2O = 0·97 per cent.).

We have said that the pyroxenic minerals of the ash are augite and a rhombic pyroxene; we distinguish them by the microscope sometimes in the form of fragments—and this is usually the case—sometimes in the form of crystals, which we can isolate from the volcanic glass covering them by treating them with hydrofluoric acid. In the crystals of augite we distinguish the faces of

[1] Just as we can divide pumice microscopically according as it is acid or basic, so the products of its trituration may be recognised under the microscope, inasmuch as the former often give colourless and more elongated particles, while the fragments of basic pumice have a more pronounced tint and more rounded pores.

[1] Lately the works on these same ashes have made known as accidental elements pyrites, apatite, and perhaps biotite (?). It is to be remarked, however, that these minerals must be extremely rare in comparison with the vitreous matters and mineral species above-mentioned.

[2] Penck, "Studien über lockere vulkanische Auswurflinge," *Zeitschr. d. deutsch. geol Gesellsch.*, 1878.

[3] Schuster, "Bemerkungen zu E. Mallard's Abbandlung sur l'isomorphisme des feldspaths tricliniques, &c.," *Min. petr. Mitth.*, v. 1882, p. 134.

a prism, of the brachypinacoid, and indications of the faces of a pyramid. This augite is pleochroic and has a greenish tint, and extinguishes in certain cases obliquely to the prismatic edges. It is this character which often permits it to be distinguished from rhombic pyroxene with which the augite is associated. The crystals of hypersthene are transparent, of a deep brown colour, strongly dichroic, with green and brown tints. They are in rectangular prisms terminated by a pyramid, and extinguish between crossed nicols parallel to their longitudinal edges. Magnetic iron, which is rather abundant in the ashes, is recognised in the form of grains and octahedrons. We have not been able to detect with certainty either hornblende or olivine. The largest grains of this ash are true microscopic lapilli, where we distinguish in a vitreous mass microlithic crystals of felspar, of magnetite, and more rarely of pyroxene. Finally, we observe with the microscope particles of an organic origin, which are easily recognisable by their fibrous and reticulated structure. These impurities may have been transported by winds, or may have come from the ground where the ashes were collected.

In spite of all the uncertainties which the exact diagnoses of volcanic dust present, we can consider them often, from the point of view of their mineralogical composition, as analogous with the augite-andesites. We know, besides, that it is to these rocks that the lavas of the volcano of Krakatoa should be referred.

The ashes which fell at Batavia on August 27, 1883, and samples of which were sent to Holland by M. Wolf, resident on that island, have been analysed with the following results :—

I. 1·119 grm. of substance dried at 110° C., and fused with carbonate of soda and potash, gave 0·7799 grm. of silica, 0·1754 grm. of alumina, 0·0911 grm. of peroxide of iron, 0·0401 grm. of lime, 0·398 grm. of pyrophosphate of magnesia, answering to 0·01434 grm. of magnesia. A recent determination of titanic acid has given 0·62 per cent. TiO_2.

II. 1·222 grm. of substance dried at 110° C. gave 0·0335 grm. of loss on ignition (water, organic substances, chloride of sodium); the same substance treated with hydrofluoric and sulphuric acids gave 0·1161 grm. of chloride of sodium and potassium, and 0·0118 grm. of chloroplatinate of potassium, answering to 0·0118 grm. of potash and to 0·0188 grm. of chloride of potassium; by difference = 0·0973 grm. of chloride of sodium, answering to 0·05163 of soda.

III. 1·7287 grm. of substance dried at 110° C. was treated in a closed tube with hydrofluoric and sulphuric acid. The oxidation required 2·3 cc. of permanganate of potash (1 cc. = 0·0212 grm. FeO), answering to 0·047876 grm. of peroxide of iron.

	I.	II.	III.	
SiO_2	65·04	—	—	65·04
Al_2O_3	14·63	—	—	14·63
Fe_2O_3	4·47	—	—	4·47
FeO	—	—	2·82	2·82
MnO	traces	—	—	traces
MgO	1·20	—	—	1·20
CaO	3·34	—	—	3·34
K_2O	—	0·97	—	0·97
Na_2O	—	4·23	—	4·23
Loss	—	2·74	—	2·74
				99·44

It will be understood that it is barely possible to submit this analysis to discussion. The abundance of vitreous particles in the ashes renders illusory the calculation of the values obtained, and the distribution of the substances among the different species of constituent minerals. This vitreous matter can indeed contain an indeterminate quantity of the different bases. On the other hand, the difficulties of the calculation are all the greater, as the constituent minerals of the ashes may contain, as isomorphs, the bases which the analysis suggests. It is none the less true, however, that the percentage composition expressed by the analysis supports the preceding mineralogical determinations, without permitting the species to be precisely determined. It agrees with the interpretation that the magma from which the ashes were formed belongs to the augite-andesites.

The vitreous and mineral fragments we have just described rom the Krakatoa eruption being identical with those which we encounter in deep-sea sediments, we may conclude that both have a similar origin. In certain cases, however, we have in place of augite a predominance of hornblende, and sometimes black mica is abundant. Again, we find more or less fragmentary crystals of peridote, of magnetite, of sanidine, and, more rarely, of leucite and of hauÿne. We can easily understand this variation in composition, following the nature of the magma from which the ashes collected in different regions of the sea were derived. But in all cases it is the predominance of vitreous particles, with their special structure, which indicates most clearly the volcanic nature of the inorganic constituents of a sediment.

If now we consider the conditions which govern the distribution of ashes in the atmosphere or at the bottom of the sea, we shall be able to show how it is that there is generally a predominance of vitreous particles in these ashes. In the first place, these are vitreous matters rather than minerals, properly so called, from the moment of ejection from the crater. Moreover we should, in a general way, not expect to find that incoherent eruptive matters, which are spread out at a distance from the volcano, present a perfectly identical composition with those other loose products, such as lapilli, volcanic bombs, and scoriæ, which are projected only a short distance from the focus of eruption. Even where there exists a perfect chemical and mineralogical identity, in the crater itself, between the lavas and the pulverulent materials of the same eruption (the supposition being that the ashes arise simply from the trituration of the lavas), we can easily understand that these latter, being carried far and wide by the winds, must undergo a true sorting in their passage through the atmosphere, according to the specific gravity of the amorphous elements or crystalline constituents. It results from this that, according to the points where they are collected, volcanic ashes may, although belonging to the same eruption, present differences not only with respect to the size of the grains, but also with respect to the minerals.

In this mode of transport it is evident that the vitreous particles, other things being equal, will be transported farthest from the centre. In the first place, they are more abundant than the other particles, and again they possess in their chemical nature and in their structure conditions which permit the aerial currents to take them up and carry them to great distances; they consist of a silicate in which the heavy bases are poorly represented as compared with the other constituent elements; they are filled with gaseous bubbles which lower their specific gravity, and at the same time are capable of being broken up into the minutest particles. The minerals with which they are associated at the moment of ejection from the crater are not, like them, filled with gaseous bubbles; they do not break up so easily into impalpable powder, for they are not porous, and are not in the same state of tension as the rapidly-cooled vitreous dust. Finally, many of these species are precisely those whose specific gravity is very high, on account of the bases entering into their composition. These minerals will not then be carried so far from the centre of eruption, and in all cases the vitreous particles are the essential ones in the atmospheric dusts derived from volcanic ashes.

We have a beautiful illustration of this in the ashes of Krakatoa. In proportion as the ashes are collected at a greater distance from a volcano, so are they less rich in minerals, and the quantity of vitreous matter predominates. According to a verbal communication from Prof. Judd, the ashes collected at Japan contain only a relatively small proportion of pyroxene and magnetite.

If we wish to assure ourselves of the nature of an atmospheric dust, and, as has lately been frequently attempted in Europe, to show that the dust is really from the Krakatoa eruption, it is important above all to seek for the presence of vitreous fragments. The characters which we have indicated permit any one to recognise them easily under the microscope. We would remark, however, that the presence of crystals, either of hypersthene, of augite, or of particles of magnetite in an atmospheric dust collected in Europe, does not prove in a certain manner that the dust belongs to the ashes from Krakatoa; for, besides the difficulties of an exact mineralogical determination of the fragmentary elements, it is difficult to understand how these heavy minerals should have been carried by the aërial currents, while the vitreous dust is absent. As we have just shown, it is the contrary which should have taken place.

It results as a corollary from these considerations that the chemical composition of an ash may vary according to the point at which it has been collected, and it tends also, other things being equal, to become more acid the further it is removed from the centre of eruption. If we admit, for example, that the magma which gave birth to the ashes of Krakatoa is an augite-andesite, as everything seems to indicate, the percentage of silica (65 per cent.) which our analysis shows appears too high, but if we remember, what we have just said, that the ashes become deprived, during their passage through the atmosphere, of the heavier and more basic elements, it will be understood that the vitreous and felspathic materials, which have a lower specific gravity, and are at the same time more acid, will accumulate at points farthest from the volcano. It will be sufficient to have directed the attention to this fact to show how the percentage of silica in the ashes from the same eruption may vary according as they are collected at a variable distance from the crater.

The predominance of vitreous splinters in deep-sea sediments far removed from coasts is even more pronounced than in volcanic ashes collected on land. This arises, as we indicated at the commencement, from the large quantity of pumice carried or projected into the ocean, whose trituration, which takes place so easily, gives origin to vitreous fragments difficult to distinguish from those projected from a volcano in the form of impalpable dust. In addition, we may state that, in the distribution of volcanic materials on the bottom of the sea, the ashes are subjected to a mode of sorting having some analogy to that which takes place during transport through the atmosphere. When these ashes fall into the sea a separation takes place in the water; the heaviest particles reach the bottom first, and then the lighter and smaller ones, descending more slowly, are deposited upon the larger and heavier fragments and crystals from the same eruption. We have a fine example of this stratification of submarine tufa in the centre of the South Pacific, lat. 22° 21′ S., long. 150° 17′ W. This specimen is entirely covered with peroxide of manganese, and at the base of the fragment we see the large crystals of hornblende and particles of magnetite. This lower layer is covered by a deposit in which these minerals and coarser grains are observed to pass gradually into a layer composed of small crystals of felspar, debris of pumice, and more or less fine material.

We do not propose to occupy ourselves here with the mode of formation of volcanic ashes, and with those of Krakatoa in particular. It will suffice to indicate that in the dust of a volcano we find all the characters supporting the interpretation which regards volcanic ashes as formed by the pulverisation of an igneous fluid mass in which float crystals already formed, and from which, when projected by gases, the pulverised vitreous particles undergo a rapid cooling and decrepitation during their passage through the atmosphere. It is not only the microscopic examination of these volcanic matters that leads us to this conclusion, but the prodigious quantity of ashes formed during the eruption of this volcano, which do not agree with the interpretation that regards these ashes as the result of a pulverisation of a rock already solidified in the crater. Indeed one cannot understand how in two or three days the immense quantity of ashes ejected from Krakatoa could be formed by this process, as, for instance, on August 26, 1883, and in the May eruption, which was the prelude to that catastrophe.

Second Part

The recent brilliant sunsets have been attributed to the presence in the atmosphere of minute particles of an extra-terrestrial origin, as well as to volcanic dust. This induces us to conclude this brief abstract of our observations by a description of the cosmic particles which we have found, along with volcanic ashes and pumice, in those regions of the deep sea far from land, where the sediment accumulates with extreme slowness. In another memoir [1] we have pointed out the distribution of these particles on the floor of the ocean, and indicated the conclusions which we believe are justified by their relative abundance in the red clay areas of the Central Pacific.

It is known that the atmosphere holds in suspension an immense number of microscopic particles which are of organic and inorganic origin, and are either dust taken up by aërial currents from the ground, or are extra-terrestrial bodies. A large number of scientific men, headed by Ehrenberg, Daubrée, Reichenbach, Nordenskjöld, and Tissandier, have studied this interesting problem, and have brought forward many facts in support of the cosmic origin of some of the metallic particles found in atmospheric precipitations. It is certain that serious objections may be raised against the origin of a large number of so-called cosmic dusts.

In a great many cases it can be shown that these dusts are composed of the same minerals as the terrestrial rocks which are to be met with at short distances from the spot where the dust has been collected, and we can attribute a cosmic origin only to the metallic iron in these dusts. It is somewhat astonishing, however, that no trace is ever found in these dusts of meteoric silicates, although in a great many meteorites it might be said that the iron is only accidentally present, while the silicates predominate. On the other hand, having regard to the mineralogical composition of meteorites, it appears strange that the so-called cosmic dusts should present characters so variable, from the point of view of their mineralogical composition, in the different regions where they have been collected. It might also be objected that even the iron, nickel, and cobalt would come from volcanic rocks in decomposition in which these bodies are sometimes present, and this objection would seem quite natural, especially in our particular case, when we remember the numerous volcanic fragments in decomposition on the bottom of the sea. Again, according to numerous researches, native iron is found, although rarely, in various rocks and sedimentary layers of the globe. A reduction of the oxide of iron into metal might also be admitted under the influence of organic substances. It might still further be objected in opposition to the cosmic origin of the fine particles of native iron that they might be carried by aërial currents from our furnaces, locomotives, the ashes of our grates, and in the case of the ocean, from steamers. All our materials of combustion furnish considerable quantities of iron dust, and it would not be astonishing to find that this, after having been transported by the winds, should again fall on the surface of the earth at great distances from its source.

Such are the objections which present themselves when it is proposed to pronounce upon the origin of particles which we are inclined to regard as cosmic, and of which we propose here to give a short description. We shall see that many of these doubts are at once removed by a statement of the circumstances under which cosmic spherules are found in deep-sea deposits, and it will be found also that all the objections are disposed of when we show the association of metallic spherules with the most characteristic bodies of undoubted meteorites.

In the first place, the considerable distance from land at which we find cosmic particles in greatest abundance in deep-sea deposits, eliminates at once objections which might be raised with respect to metallic particles found in the neighbourhood of inhabited countries. On the other hand, the form and character of the spherules of extra-terrestrial origin are essentially different from those collected near manufacturing centres. These magnetic spherules have never elongated necks or a cracked surface like those derived from furnaces with which we have carefully compared them. Neither are the magnetic spherules with a metallic centre comparable either in their form or structure to those particles of native iron which have been described in the eruptive rocks, especially in the basaltic rocks of the north of Ireland, of Iceland, &c.

Having referred to the objections, let us now see on what we must rely in support of the hypothesis that many of the magnetic particles from the bottom of the sea which are specially abundant in those regions where the rate of accumulation of the deposit is exceedingly slow are of cosmic origin. If we plunge a magnet into an oceanic deposit, specially a red clay from the central parts of the Pacific, we extract particles, some of which are magnetite from volcanic rocks, and to which vitreous matters are often attached; others again are quite isolated, and differ in most of their properties from the former. The latter are generally round, measuring hardly 0·2 mm., generally they are smaller, their surface is quite covered with a brilliant black coating having all the properties of magnetic oxide of iron; often there may be noticed upon them cup-like depressions clearly marked. If we break down these spherules in an agate mortar, the brilliant black coating easily falls away and reveals white or gray metallic malleable nuclei, which may be beaten out by the pestle into thin lamellæ. This metallic centre, when treated with an acidulated solution of sulphate of copper, immediately assumes a coppery coat, thus showing that it consists of native iron. But there are some malleable metallic nuclei extracted from the spherules which do not give this reaction, they do not take the copper coating. Chemical reaction shows that they contain cobalt and nickel; very probably they constitute an alloy of iron and these two metals, such as is often found in meteorites, and whose presence in large quantities hinders the production of the coppery coating on the iron. G. Rose has shown that this coating of black oxide of iron is found on the periphery of meteorites of native iron, and its presence is readily understood when we admit their cosmic origin. Indeed these meteoric

[1] *Proc. Roy. Soc. Edin*

particles of native iron, in their transit through the air, must undergo combustion, and, like small portions of iron from a smith's anvil, be transformed either entirely or at the surface only into magnetic oxide, and in this latter case the nucleus is protected from further oxidation by the coating which thus covers it.

One may suppose that meteorites in their passage through the atmosphere break into numerous fragments, that incandescent particles of iron are thrown off all round them, and that these eventually fall to the surface of the globe as almost impalpable dust, in the form of magnetic oxide of iron more or less completely fused. The luminous trains of falling stars are probably due to the combustion of these innumerable particles, resembling

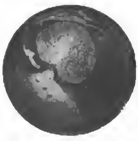


FIG. 2. FIG. 3.

FIG. 2.—Black spherule with metallic nucleus (60 : 1). This spherule, covered with a coating of black shining magnetite, represents the most frequent shape. The depression here shown is often found at the surface of these spherules. From 2375 fathoms South Pacific.

FIG. 3.—Black spherule with metallic nucleus (60 : 1). The black external coating of magnetic oxide has been broken away to show the metallic centre, represented by the clear part at the centre. From 3150 fathoms Atlantic.

the sparks which fly from a ribbon of iron burnt in oxygen, or the particles of the same metal thrown off when striking a flint. It is easy to show that these particles in burning take a spherical form, and are surrounded by a layer of black magnetic oxide.

Among the magnetic grains found in the same conditions as these we have just described are other spherules, which we refer to the *chondres*, so that if the interpretation of a cosmic origin for the magnetic spherules with a metallic centre was not established in a manner absolutely beyond question, it almost becomes so when we take into account their association with the silicate spherules, of which we have now to speak. It will be seen by the microscopic details that these spherules have quite the constitution and structure of *chondres* so frequent in meteorites of the most ordinary type, and on the other hand they have never been found, as far as we know, in rocks of a terrestrial origin; in short, the presence of these spherules in the deep-sea deposits, and their association with the metallic spherules, is a matter of prime importance. Let us see how we distinguish these silicate spherules, and the points upon which we rely in attributing to them a cosmic origin.

Among the fragments attracted by the magnet in deep-sea deposits we distinguish granules slightly larger than the spherules with the shining black coating above described. These are yellowish-brown, with a bronze-like lustre, and under the microscope it is noticed that the surface, instead of being quite smooth, is grooved by thin lamellæ. In size they never exceed a millimetre, generally they are about 0·5 mm. in diameter; they are never perfect spheres, as in the case of the black spherules with a metallic centre; and sometimes a depression more or less marked is to be observed in the periphery. When examined by the microscope we observe that the lamellæ which compose them are applied the one against the other, and have a radial eccentric disposition. It is the leafy radial structure (*radialblättrig*), like that of the *chondres* of bronzite, which predominates in our preparations. We have observed much less rarely the serial structure of the *chondres* with olivine, and indeed there is some doubt about the indications of this last type of structure. Fig. 4 shows the characters and texture of one of these spherules magnified 25 diameters. On account of their small dimensions, as well as of their friability due to their lamellar structure, it is difficult to polish one of these spherules, and we have been obliged to study them with reflected light, or to limit our observations to the study of the broken fragments.

These spherules break up following the lamellæ, which latter are seen to be extremely fine and perfectly transparent. In rotating between crossed nicols they have the extinctions of the rhombic system, and in making use of the condenser it is seen that they have one optic axis. It is observed also that when several of these lamellæ are attached, they extinguish exactly at the same time, so that everything induces us to believe that they form a single individual.

In studying these transparent and very thin fragments with the aid of a high magnifying power, it is observed that they are dotted with brown-black inclusions, disposed with a certain symmetry, and showing somewhat regular contours; we refer these inclusions to magnetic iron, and their presence explains how these spherules of bronzite are extracted by the magnet. We would observe, however, that they are not so strongly magnetic as those with a metallic nucleus.

We designate them under the name of bronzite rather than of enstatite, because of the somewhat deep tint which they present: they are insoluble in hydrochloric acid. Owing to the small quantity of substance at our disposal, we were obliged to limit ourselves to a qualitative analysis. We have found in them silica, magnesia, and iron.

We have limited our remarks at this time to these succinct details, but we believe that we have said enough to show that these spherules in their essential characters are related to the *chondres* of meteorites, and have the same mode of formation. In conclusion, we may state that when the coating of manganese depositions, which surround sharks' teeth, ear-bones of Cetaceans and other nuclei, is broken off and pounded in a mortar to

FIG. 4.—Spherule of bronzite (25 : 1) from 3500 fathoms in the Central South Pacific, showing many of the peculiarities belonging to *chondres* of bronzite or enstatite.

fine dust, and the magnetic particles then extracted by means of a magnet, we find these latter to be composed of silicate spherules, spherules with a metallic centre, and magnetic iron, in all respects similar to those found in the deposits in which the nodules were embedded.

We have recently examined the dust collected by melting the snow at the Observatory on Ben Nevis, in order to see whether, in that elevated and isolated region, we should be able to find volcanic ashes or cosmic spherules analogous to those we have described. This atmospheric dust, which we have examined microscopically, has not shown any particles which could with certainty be regarded as identical with those substances which are the subject of this paper. Particles of coal, fragments of ashes, and grains of quartz predominated. Besides these, there were fragments of calcite, augite, mica, and grains of rock of all forms and of variable dimensions. These were associated with fibres of cotton, of vegetables, splinters of limonite and of tin—in short, everything indicating a terrestrial origin.

In order to give an idea of the facility with which the wind may carry these matters even to the summit of the mountain, we may add that Mr. Omond has sent to us fragments of crystalline rocks, some having a diameter of two centimetres, which, he states, were collected on the surface of the snow at the summit after the storm of January 26, 1884.

Arrangements are being made to collect the dust at the top of Ben Nevis during calms with great care.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

COLLEGE OF AGRICULTURE, DOWNTON, SALISBURY.—At the close of the winter session on Wednesday, 16th inst., the certificate of membership and the certificate of proficiency in practical agriculture were granted to Mr. R. A. Benson, F.H.A.S., 11, Caledonia Place, Clifton; Mr. W. de Hoghton Birch, 1, Bathwick Street, Bath; and Mr. C. W. Lincoln Hardy, F.H.A.S., Gittisham, Honiton, Devon; and the certificate of proficiency alone to Mr. B. S. Dunning, 2, Warwick Square, S.W.

THE authorities of University College, Liverpool, have asked that that institution be incorporated with Victoria University.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, April 3.—Sir J. Lubbock, Bart., president, in the chair.—Mr. W. Broekbank exhibited a series of double daffodils, wild forms of *Narcissus pseudo Narcissus*, which were gathered in a Welsh meadow from among many of both the single and double forms occurring there in every stage of growth. Sections invariably revealed stamens and pistils, and in two of the most double forms ovaries filled with seeds were present. With this evidence he therefore contended against the current notion of cultivation and root-growths having produced a heterogeneous multiplication of the perianth segments, split-up crown, and conversion of stamens into petal-growths, his belief being that the plants in question were propagated in the ordinary seed-bearing manner.—Mr. R. M. Middleton showed a jackdaw with albinism of the wing feathers, causing considerable resemblance in the bird to a magpie.—Prof. P. M. Duncan gave a revision of the families and genera of the Sclerodermic Zoantharia, the Rugosa excepted. Since MM. Milne-Edwards and Haimes' work, 1857-60, no systematic revision of the Madreporaria has appeared, while since then a great number of new genera have been founded; hence the necessity for a revision has arisen, and more especially in consequence of the morphological researches of Dana, Agassiz, Verrill, and Moseley. Prof. Duncan explained that the old sections of the Zoantharia required modification and addition. In his present revision the sections Aporosa and Perforata remain shorn of some genera, the old family Fungidæ becomes a section with three families, two of which are transitional between the sections just mentioned. The section Tabulata disappears, some genera being placed in the Aporosa, and the others are relegated to the Hydrozoa according to Moseley. The Tubulosa cease to be Madreporarian. Hence the sections treated are Madreporia-Aporosa, M.-Fungida, and M.-Perforata. The nature of the hard and soft parts of these forms is considered in relation to classification, and an appeal is made to naturalists to agree to the abolition of many genera, the author having sacrificed many of his own founding. The criticism of 467 genera permits 336 to remain good, and as a moderate number (36) of sub-genera are allowed to continue, the diminution is altogether about 100. The genera are grouped in alliances, the numbers in families being unequal. Simplicity is aimed at, and old artificial divisions dispensed with. There is a great destruction of genera amongst the simple forms of Aporosa, and a most important addition to the Fungida. The genera *Siderastræa* and *Thamnastræ* are types of the family Plesiofungidæ, as are *Microsolenia* and *Cyclolites* of the family Plesioporitidæ. The families Fungidæ and Lophoseridæ add many genera to the great section Fungida. There is not much alteration in respect of the Madreporaria-Perforata, but the sub-family Eusamminæ are promoted to a family position as the Eusammidæ.—Mr. Chas. F. White thereafter read a note on some pollen from funereal garlands found in an Egyptian tomb *circa* B.C. 1000. It appears that from among the dried flowers of *Papaver Rhœas* the pollen obtained freely absorbed water, became swollen, and in other respects the grains were barely able to be differentiated by the microscope from the pollen grains of the recent poppy.—A paper was read by Mr. F. J. Briant, on the anatomy and functions of the tongue of the honey bee. Authorities, it seems, are yet divided in opinion as to how the organ in question acts. Kirby and Spence, Newport and Huxley, aver the bee laps its food; while Hermann Müller and others attribute a full share to the terminal whorl of hairs to which the honey adheres, and therefrom is withdrawn. Mr. Briant, on the other hand, from experiment and study of the structures, is inclined to the view that the honey is drawn into the mouth through the inside of the tongue by means of a complicated pumping action of the organ, aided by the closely contiguous parts.

Chemical Society, April 3.—Dr. W. H. Perkin, president, in the chair.—The following papers were read:—On the influence of certain phosphates upon vinous fermentation, by A. G. Salamon and W. de Vere Mathew. It has been suggested that the addition of phosphates to beerworts stimulates the growth of the yeast-plant and increases the rapidity of attenuation of the wort. The authors find that ordinary English wort contains an excess of phosphoric acid over that which is proved by their experiments to be most favourable to fermentation; hence it follows that the addition of phosphates to wort is not advisable.—On the occurrence of rhabdophane in the United States, by W. N. Hartley. The author shows that a new mineral, scovillite, described by Brush and Penfield in the *Amer. Journ. Sci.*, xxv. 459, is but a variety of rhabdophane. In a subsequent number of the journal, March 1884, the identity of the two minerals is recognised by the above authors.

Geological Society, April 2.—Prof. T. G. Bonney, F.R.S., president, in the chair.—Frank Gotto and George Varty Smith were elected Fellows, and Dr. E. Mojsisovics von Mojsvár, of Vienna, a Foreign Correspondent of the Society.—The following communications were read:—The rocks of Guernsey, by the Rev. E. Hill, M.A.; with an appendix on the microscopic structure of some of the rocks, by Prof. T. G. Bonney, F.R.S. The southern part of the island is a high plateau consisting entirely of gneiss. This is very coarse, and the bedding is seldom well marked. The bedding, when visible, coincides with the foliation, and the author hopes that hereafter an order of succession may be established. At Rocquaine Castle occur a few slaty beds intercalated in the gneiss, the origin of which is somewhat difficult to understand. The northern part, low ground with hummocks, consists principally of a group of crystalline or subcrystalline rocks, in constitution diorites or syenites. They are described by Ansted as sedimentary rocks metamorphosed into syenites; but they show no bedding either in the many quarries, or, in general, in the shore outcrops, nor do their varieties occur in any manner indicating an order of succession. They appear at Castle Cornet to meet the gneiss intrusively, and their microscopic structure is igneous. A remarkable appearance of bedded structure at Fort Doyle is the only strong argument for a metamorphic origin, and this may be explained as a caught-up mass in conjunction with crushing-planes. The author therefore regards them as igneous. An oval area between St. Sampson's and St. Peter's Port is occupied by hornblendic rocks, locally called "birdseye," which may be described as hornblende-gabbros. These also have been called metamorphic. They too, at Hogue-à-la-Perre and another point, present appearances of bedding; but on the same general grounds as for the preceding group these also are regarded as igneous. Two granitic masses are described: the coarse pink granite of Cobo, on the west coast, and the finer-grained gray granite weathering pink of Lancresse, on the north. Each is seen to intrude: the Cobo granite into gneiss at Hommet Barracks, the Lancresse granite into diorite at Fort Le Marchant. Besides these are some smaller masses. Dykes are remarkably abundant and various. Granites and elvans are plentiful everywhere; felsites very rare. The majority of the dykes are diorites, varying in coarseness and often of enormous size; there is also mica-trap. In some of these dykes a cleavage has been developed, so that some resemble slates. Infiltration-veins are abundant. In relative age the gneiss appears to be the oldest rock, the hornblende-gabbro to be next, then comes the diorite group, while the granites are newer still. Of the dykes the newest are the compactest diorites. As to the absolute geological age of the rocks no satisfactory evidence at present is known; it will have to be sought for in the other islands and in France.—On a new specimen of *Megalichthys* from the Yorkshire coalfield, by Prof. L. C. Miall.—Studies on some Japanese rocks, by Dr. Bundjiro Kotô. Communicated by Frank Rutley. The author has studied series of Japanese rocks from the collection of the Tokio University and the Geological Survey of Japan. The microscopical investigation was carried on at the Mineralogical Institute at Leipzig, under the direction of Prof. Zirkel, and the chemical analyses were made in the laboratory of Prof. Knop. The most abundant rocks are the pyroxene-andesites, which are not of a glassy texture, but for the most part holocrystalline. The most abundant mineral in these rocks is a plagioclose felspar with twinned and zonal structure, which is proved, by its extinction-angles and by the chemical analysis of its isolated fragments, to be labradorite. Sanadine is present in small quantities. The augites of these rocks present many peculiarities; they are all decidedly pleochroic; and they exhibit the oblique extinction in basal sections first pointed out by Mr. Whitman Cross, and which is characteristic of triclinic and not of monoclinic crystals. A careful examination of the question has led the author to conclude that the mineral which has lately been regarded as a rhombic pyroxene (probably hypersthene) is really only ordinary augite cut parallel to the optic axis. He does not regard the property of pleochroism as distinctive of hypersthene, while the absence of a brachypinacoidal cleavage and the presence of 10 per cent. of lime in the mineral forbids our referring it to that species. The other abundant minerals in these augite-andesites are magnetite, which is always present, and quartz, which occurs in some of them, both as a primary and a secondary constituent. Hornblende is very rare in these rocks, and when present the peripheral portions of the crystals are seen to be converted into augite, probably by the action of the caustic magma upon them. Enstatite is rare in these rocks, but apatite is always found in them, while tridymite occurs not unfrequently. The author described a number of structural variations in the augite-andesite from different localities. Among the most interesting is a variety containing as much as 69 per cent. of silica. Among the less abundant rocks are the enstatite-andesite, the quartz-augite-andesite, and the hornblende-andesites. The plagioclase-basalts of Japan can only be distinguished from the augite-andesites by the presence in them of olivine. Magma-basalts are rare, most of the varieties being of the dolerite type; but under the name of "basalt-lavas" the author describes varieties with a glassy base. In an appendix some account is given of a number of pre-Tertiary rocks, including granite, one variety of which contains the new mineral, reinite, of Fritsch (the tetragonal form of the ferrous-tungstate), quartz-mica-diorite, diorite-porphyry, and diabase.

Victoria Institute, April 7.—A paper was read by the Rev. J. M. Mello, F.G.S., on the prehistoric flint implements at Speinnes, implements used by man before the mammoth and rhinoceros had disappeared in Europe. The author described the works at Speinnes, and afterwards said there was one question, namely, were these early men of Europe always in the condition in which they appear to have been living, or were they offshoots of the parent stems of humanity, and had their ancestors no higher civilisation?

EDINBURGH

Mathematical Society, April 10.—Mr. Thomas Muir, F.R.S.E., president, in the chair.—Dr. Alexander Macfarlane, F.R.S.E., submitted a note on simple, combination, and cumulative voting, after which Mr. A. J. G. Barclay read a paper on the teaching of geometry.—Mr. Muir gave an explanation of an algebraical theorem communicated by Prof. Tait to the January meeting of the Society.

MANCHESTER

Literary and Philosophical Society, February 5.—Charles Bailey, F.L.S., in the chair.—On the introduction of coffee into Arabia, by C. Schorlemmer, F.R.S.

February 19.—H. E. Roscoe, Ph.D., LL.D., F.R.S., &c., president, in the chair.—Notice of the geology of the Haddon district, eight miles south-west of Ballarat, Victoria, by F. M. Krausé, Professor of Geology in the School of Mines, Ballarat. Communicated by the President.

PARIS

Academy of Sciences, April 7.—M. Rolland in the chair.—An exact or highly approximate calculation of the thrust of sandy masses against their retaining walls, by M. de Saint-Venant.—On the specific heats of water and of carbonic acid at very high temperatures, by MM. Berthelot and Vieille.—Note on Brioschi's theorem respecting symmetrical functions, by M. Sylvester.—Documents relating to the liquid air condensers for several years employed in the piercing of the Mount Cenis Tunnel, by M. A. de Caligny.—Tabulated results of the various circumstances attending electric discharges during the thunderstorms that occurred in France during the second half of the year 1883, communicated by the Minister of the Posts and Telegraphs.—Telegraphic determinations of the differences of longitude in South America, by M. de Bernardières.—Charts of the atmospheric movements passing over Europe in the various *régimes*; remarks on their application to the prediction of storms, by M. A. Poincaré.—Note on the influence of luni-solar attraction on the action of pendulums, by M. A. Gaillot.—On the solar spots observed in Rome during the first three months of the year 1884, by M. P. Tacchini.—Note on the halos of diffused light observed round the sun on March 31 at Auteuil, by M. Ch. Moussette.—On the aspect presented by the Pons-Brooks comet on January 13, 1884, by M. L. Cruls.—Note on an error committed in determining the exact moment of the chief eruption at Krakatoa last year, by M. A. A. Buijskes. This disturbance, generally stated to have occurred a few minutes before noon on August 27, really took place exactly at eight o'clock in the morning of that day. Hence the calculations of the velocities of marine and atmospheric currents based on the former date must be rectified accordingly.—On the principle of the prism of greatest thrust laid down by Coulomb in the theory of the equilibrium of sandy masses, by M. J. Boussinesq.—On the quaternary quadratic formulas, and on the corresponding hyperabelian groups, by M. E. Picard.—On the theory of quaternions in connection with Prof. Sylvester's recent solution of equations in which all the given quaternions are found on the same side as the quaternion sought for, by M. Ed. Weyr.—Note on the application of Faraday's law to the study of the conductivity of saline solutions, by M. E. Bouty.—Note on the verification of the law of transverse vibrations in elastic rods, by M. E. Mercadier.—Fresh experiments in the liquefaction of hydrogen; solidification and critical point of pressure for nitrogen, by M. K. Olszewski.—On the chief circumstances attending the transformation of superheated octahedral sulphur into prismatic sulphur, by M. D. Gernez.—Quantitative analysis of the phosphoric acid found in arable lands and in rocks, by M. Ad. Carnot.—On the artificial production of fayalite, by M. Alex Gorgeu. The author's experiments show that the protochloride of iron, fused with silica, produces fayalite under conditions in which the chloride of manganese yields tephroite. It appears incapable of producing a bisilicate corresponding to rhodonite, and yields chlorosilicate of iron with difficulty. Highly crystallised magnetite and hausmannite may be obtained under analogous conditions by the fusion of their respective chlorides in contact with the air.—Claim of priority of discovery in connection with recent communications on the vitality of virus and of the yeast of beer; letter addressed to the President by M. Melsens.—Researches on the incubation of hens' eggs in confined air, and on the part played by ventilation in the development of the embryo, by M. C. Dareste.—On the variations of electric excitability and of the period of latent excitement in the brain, by M. H. C. de Varigny.—Note on a Siberian pseudo-meteorite, by M. Stan. Meunier.

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THURSDAY, APRIL 24, 1884

THE EDINBURGH UNIVERSITY FESTIVAL

THE brilliant celebration of its three hundredth anniversary by the University of Edinburgh last week suggests some reflections on the connection between University progress and the growth of Science. One of the most remarkable features in these festive proceedings has been the preponderance given to the recognition of the claims of scientific research to University distinction. A hundred years ago and less, had such a gathering been thought of, the great men who would have been invited to receive the highest academic honours would have been learned scholars, eminent professors of the mediæval branches of education, with perhaps a few distinguished medical men and doubtless a good many candidates whose only claim would have been the possession of a hereditary title of nobility. But now a new host of competitors has arisen, and upon them have the laurels of the University been mainly bestowed. Physicists, chemists, physiologists, botanists, geologists, and other representatives of modern science have almost elbowed the older philosophies out of the field. In the pæan sung at every meeting of the festival the brilliance of scientific discovery, the prowess of scientific discoverers, and the glory shed on the University by its connection with both have been the chief themes.

This great change in the objects of University recognition has been silently in progress for several generations. But it has never been so openly and strikingly proclaimed as during these recent meetings at Edinburgh. It is not that any formal alteration has there been made in the curriculum of study. On the contrary, the same subjects are still required for degrees in Arts as were demanded centuries ago. Outside the conservative government of the University there has, however, been a steady growth of modern ideas, modern life, and modern science. To he Medical School, in the first place, must the credit be ssigned of fostering this wider culture. Its professors ave thrown open their old monopoly of teaching, and ork harmoniously with their competitors outside the alls of the University. They have cast aside the ancient nefficient system of mere prelections, and have introduced ractical teaching into every branch of their science. To ass from the state of things in the youth of these eachers to what they have now made it is to cross a gulf uch as might be thought to mark an interval of some enturies. Everywhere we see practical scientific reearch taking the place of musty lecture-notes and dry nproductive text-books. Not only have the professors imed at being successful teachers, but many of them ave themselves led the way in original discovery. They ave likewise kept themselves and their students abreast f the progress of research all over the world. Hence the ames of Continental men of science have become houseold words among the rising generation. We can readily nderstand and sympathise with the uncontrollable outurst of enthusiasm with which the students greeted the ctual appearance among them of a Pasteur, a Helmholtz, d a Virchow.

Silently and unconsciously perhaps the Universities are passing from the exclusive domination of the older learning. At Edinburgh the emancipation is far advanced, but has yet to take shape in a definite rearrangement of the curriculum of study. No thoughtful scientific man would advocate a merely scientific education. The foundations of every man's culture should be laid broad and deep in those humanising departments of thought which the experience of centuries has proved to be admirably fitted for the mental and moral discipline of youth. But the day is not far distant when it will be acknowledged that modern science must be admitted to a place with ancient philosophy and literature in the scheme of a liberal education, when in all our Universities provision will be made for practical instruction in scientific methods, and when at least as much encouragement will be given by fellowships and scholarships to the prosecution of original scientific research as has hitherto been awarded to classical study or learned indolence.

To those who hopefully look forward to the widening and broadening of University culture the Edinburgh festival is full of encouragement. Such a gathering of representative intellect has probably never before been assembled. Delegates from the oldest and youngest Universities of the world, from scientific societies and other learned bodies, brought their congratulations to their northern sister. But they felicitated her not so much because she had been a successful educational centre for three hundred years, as because she had held up the torch of scientific discovery, because her professors and graduates had widened the boundaries of knowledge and deciphered new pages in the great book of Nature. If such has been the result of the trammelled past with all its hampering traditions and vested interests, its obstructions and jealousies, what may we not anticipate for the liberated future! After the lapse of another century, what new conquests will there not be to chronicle, what new realms of discovery to celebrate! In this ever-advancing progress, the University of Edinburgh, which has done so much in bygone years, will doubtless more than hold her own. No centre of education and research has greater advantages in its favour. The comparatively small size of the city, the proximity of its lecture-rooms, laboratories and libraries to each other; its vicinity to the sea on the one hand and to a varied and picturesque country on the other, combine to offer exceptional advantages to the student. Not the least of its attractions is its own unchanging beauty, which never ceases to appeal to the eye and to stimulate the imagination. Long may Edinburgh remain a beacon of light in educational advancement, in the cultivation of scientific methods, and in the march of scientific discovery.

PRJEVALSKY'S TRAVELS IN CENTRAL ASIA

Third Journey in Central Asia. From Zaisan through Khami to Thibet and the Sources of the Yellow River. By N. M. Prjevalsky. Russian. (St. Petersburg, 1883.)

THIS large work is the complete account of the third journey of Col. Prjevalsky to Thibet, notices of the progress of which from time to time appeared in our pages during the year 1880. The first journey, it will be remembered, was performed during the years 1870-73, when this distinguished traveller reached as far as the Lama monastery of Cheibsen near Lake Koko-Nor, and to Tsaidam, but was forced to abandon his intention of going to Lhassa, and so retraced his steps to Alashan. From thence he went to Pekin, and returned to Siberia across the Desert of Gobi. The second journey was undertaken from Kuldja to the Lake Lob Nor across the Tian-shan Mountains. On the third journey Col. Prjevalsky started from Zaisan, passing through Barkul Khami, Sa-tzhei, and Tsaidam, where he reached the country he had explored on his first journey. He now proceeded to carry out his former intention of going to Lhassa, and he struggled over the great plateau of Tan-la till he reached the town of Boomtza. At Nap-chu, in the neighbourhood of this town, he was informed that he would be allowed to proceed no further in the direction of the capital of the Dalai Lama. He was then a little more than 160 miles from Lhassa. Negotiations were useless: he was not allowed to proceed. Contenting himself with taking a portrait of the messengers from the Dalai Lama, he turned northwards and retraced the long and wearisome march across the Tan-la plateau. The winter of 1879-80 was occupied with this march and with the observations upon the manners and customs of the people, as well as investigations into the flora and fauna of the district he was passing through. Prjevalsky possesses in an eminent degree the buoyant spirit of the traveller which enables him to observe calmly and critically the surroundings in which he finds himself, even though he is overcome with hardship or pressed by the weight of disappointment. Returning to Tsaidam, he set out on his way to Lake Koko-Nor, where he had been in the year 1873. He remained in this neighbourhood for some time, and he followed the course of the Hoang-ho for about 150 miles. This part of his journey took him over new ground, and his explorations of these upper waters of the Yellow River or Hoang-ho are of the utmost value. He followed the course of the river as far as Gui-dui, which forms an oasis amidst great arid mountain-chains. It was so difficult to advance and forage was so scarce that Prjevalsky turned back from the Hoang-ho and directed his steps towards Lake Koko-Nor. The rain, which had stopped for a time, recommenced, and was often accompanied with severe cold, which added materially to the discomforts of the journey. The monastery of Cheibsen was revisited after the lapse of about seven years, and there Prjevalsky was well received by the priests, whose acquaintance he had made on his former visit. The journey was continued through Nan-shan and Alashan amidst the wildest mountain scenery, till a descent was made upon the great Desert of Gobi. The change was great from the high mountains of Pan-cu to the waterless expanse of the desert, but Prjevalsky was always ready with his note-book as well as with his gun; and the result is that this volume contains a mass of information for the ethnologist as well as for the naturalist. The return was made in safety through the desert to Urga and Kiakhta. This is a brief outline of the journey recorded in these pages, and the only regret one has is that so few amongst us can read the language in which it is written. It is to be hoped that the volume will ere long be translated into our own language.

The simplicity of the style, the novelty of the subject, the interest of the narrative, and the personality of the writer, who has reached such a high position amongst adventurous travellers, combine to make this a most invaluable acquisition for the library of the naturalist as well as of the geographer. Very many new species have been obtained of both plants and animals, and one of the most important of the discoveries recorded is that of a new species of horse. Polyakoff has proposed to call this new species (of which a specimen is to be found in the museum of the Academy of Sciences in St. Petersburg) after the discoverer—*Equus Prjevalskii*. But the new species of plants and animals are so numerous that it has been proposed to apply a special name to the flora and fauna of the district, which are found to differ considerably from those of Western China.

OUR BOOK SHELF

Deutsche Kolonien. Ein Beitrag zur Besser Kenntniss des Lebens und Wirkens unserer Landleute in allen Erdteiler. Von Karl Emil Jung. (Leipzig: Freytag, 1884.)

DR. JUNG is well known as an accomplished writer, both on the scientific and economical aspects of the Australian colonies, in which he spent some years. His present *brochure* is one of much interest, though its immediate subject is beyond our scope. It is a curious fact that though the Germans have no colonies, they are probably, next to the English, the greatest colonisers of any European nation. Even according to the census returns, the German population of the United States is very great, and as Dr. Jung shows, it is much greater than it seems, for many of the earlier colonists have Anglicised their names, and been absorbed in the general population. To the culture of the States, and indeed to the intellectual side of all the colonies in which they have settled, the Germans have largely contributed. Dr. Jung gives interesting details of German migrations into England, Russia, Australia, South Africa, as well as the States, and from the ethnological standpoint his little work deserves the attention of the scientific student.

Catalogue de la Bibliothèque Japonaise de Nordenskjöld. Coordonné, revu, annoté, et publié par Léon de Rosny. (Paris, 1883.)

THIS collection of Japanese works in all departments of literature, which appears to have been collected by Baron Nordenskjöld while in Japan, has been presented by him to the Bibliothèque Royale at Stockholm. The editor, the veteran Japanese scholar, M. de Rosny of Paris, has not been satisfied with a bald catalogue, but has in many instances added descriptive and analytic notes of the contents, the character of the work, and its place in Japanese literature; and although the collection can hardly equal in extent and value those of several European libraries, we are not aware that such an excellent catalogue exists in any European language. The whole contains about 1000 works in over 5000 volumes, and is divided and subdivided by M. de Rosny with much nicety. The scientific works are not very numerous. On the exact sciences (arithmetic, geometry, algebra, astronomy, &c.) there are only 104 volumes, and on the natural sciences 445. But most of these are dated prior to the opening of the country to foreigners, and to the student who could examine them they would present an interesting picture of the state of scientific knowledge at various periods.

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.

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Dust of Krakatoa

IN the interesting paper by Mr. John Murray and the Abbé Renard, which appears in your last number (p. 585), there is an erroneous reference which it may be well to correct without delay. I am made responsible for a verbal statement concerning Krakatoa dust which fell in Japan. In your issue of the 3rd inst. (p. 525) a letter from myself will be found, stating, on the authority of Prof. John Milne of Tokio, that, contrary to the original statements made on the subject, no dust of Krakatoa is known to have fallen in Japan. My friend M. Renard must have misunderstood the communication which I made to him, which was to the following effect:—I have had the opportunity of examining a great number of specimens of the dust of Krakatoa which fell at different distances from the volcano, ranging from 50 to nearly 1000 miles. The dust collected at the greatest distance from Krakatoa, with which I am acquainted, is that which fell on board the *Arabella* in lat. 5° 37′ S. and lat. 88° 58′ E., Java Head bearing E. ½ S. about 970 miles. It is certainly true that the dust which has fallen at the greater distances from the volcano contains less magnetite, augite, and hypersthene than that descending nearer to the source of eruption; and the obvious explanation of this is found in the greater density and compactness of the particles of those minerals as compared with the associated glassy fragments. At the same time it must be remembered that this is not the *only* explanation of the high silica-percentage in these ashes. The prevailing rock in the islands and on the shores of the Sunda Strait appears to be a hypersthene-augite-andesite, containing an unusually large proportion of brown, glassy base. This base contains a far higher proportion of silica than the included minerals; and hence, as shown by Verbeek and Fennema, these rocks have a percentage of silica ranging up to, and even exceeding, 70 per cent. The same is true of the pumices formed from the glassy andesite rocks, including that of Krakatoa itself. JOHN W. JUDD

Hurstleigh, Kew

ON January 13 I collected a sample of snow from an open field, and examined under the microscope the residue left by its evaporation. This residue showed a number of objects which are not usually found in atmospheric dust. Great precautions were taken to prevent the entrance of dust during evaporation, the vessel being kept covered with filter-paper. Crystals of common salt were very abundant. There were numbers of other large prismatic crystals, colourless, insoluble in water, and doubly refracting. But the most characteristic objects were minute granules, transparent, colourless, and scattered in thousands all over the field of the microscope. These were insoluble in water. Many black particles were visible and some of these were attracted by the magnet. In fact, when the magnet was swept slowly over the residue, its poles became covered with fine black crystalline particles, evidently magnetic oxide of iron. However, there are large iron-works in this vicinity, which *may* account for the presence of the magnetic dust. To determine this and other interesting points, it is my intention to examine the snow and rainfall regularly during the next twelve months at least.

A specimen of snow, freshly fallen on March 10 showed none of the prismatic crystals referred to above. With a high power very small crystals of similar shape and properties were observed. The small granules were, however, to be seen along with crystals of common salt and ammonic nitrate. No magnetic dust was found in this specimen.

These results are, in my opinion, in favour of the dust theory of the remarkable sunset phenomena of the past winter.

W. L. GOODWIN

Queen's University, Kingston, Canada, March 31

P.S.—Snow fell to-day (April 1), and a sample was examined for dust. The insoluble prisms have completely disappeared, and the minute dust is present in much smaller proportion.

W. L. G.

"Earthquakes and Buildings"

PROF. JOHN MILNE, of Tokio, refers in an article under this heading (NATURE, vol. xxix. p. 290) to *buildings in Caracas, which are low, slightly pyramidal, have flat roofs, and are bound along their faces with iron*. Being for more than twenty years a resident of this city, I hope I may be credited with knowing something of its architecture, and as such I must say that certainly the houses are generally one-story buildings, but all the remainder of the foregoing description is quite erroneous. However, I do not wish to make Mr. Milne answerable for its inaccuracies, as it appears to be taken from a ridiculous article published by one Horace D. Warner in the *Atlantic Monthly*, March 1883. This article is a most audacious fiction from beginning to end, and in none of the statements it pretends to give with graphic seriousness is there any shadow of truth, as I have pointed out in the *American Journal of Science*, July 1883, with respect to the principal assertion of an earthquake said to have been witnessed by the author on September 7, 1882, in Caracas.

House-building in our good city is of the most ordinary type, and certainly not what it ought to be in a place which already once was ruined by an earthquake (1812): the walls are built of brick and mortar; the roofs are very seldom flat, but have a very slight inclination, say 15 to 20 degrees. They are, however, made too heavy by a thick stratum of loamy mud, spread over the closely-joined laths (generally the stems of the arborescent grass, *Arundo saccharoides*), on which the tiles are set in alternately convex and concave rows.

The earthquake of Cua (NATURE, vol. xviii. p. 130) is an instance of the remarkable influence of the soil on the intensity of destruction: all the houses built on the rocky hill in the middle of the town were ruined, whilst those on the surrounding alluvial plain suffered scarcely any damage. The same happened in 1812 in Caracas: the northern part of the city, where the stratum of detritus is less deep, was almost completely laid waste; but the southern part, built on a far deeper deposit of loose matter, experienced comparatively small destruction. A. ERNST

Caracas, March 16

On the Transmission of Organic Germs through Cosmical Space by Meteoric Stones

IN his *addendum* to his well-known lecture on "The Origin of the Planetary System" Prof. Helmholtz uses the following remarkable sentence, to which so far as I am aware, attention has not hitherto been directed:—

"But even those germs which were collected on the surface when they reached the highest and most attenuated layer of the atmosphere would long before have been blown away by the powerful draught of air, before the stone reached the denser parts of the gaseous mass, where the compression would be sufficient to produce an appreciable heat."

Helmholtz is contending in favour of the possible transmission of germs from one heavenly body to another, and his point here is that the germs, owing to their being small and light, will be more rapidly retarded (blown back) on reaching the first traces of our atmosphere than the stones on which they reside, and will thus escape the great rise in temperature to which the stones are subject in consequence of friction and air compression.

Now when a germ just leaves its meteorite its velocity is equal to that of the meteorite. If m be the mass of the germ, $\frac{mv^2}{2J}$ will be the heat developed in destroying its velocity. Were all this heat to go to raise the temperature of the germ, the rise in temperature would be $t = \frac{v^2}{2Js}$, s being the thermal capacity of the germ. This shows that the rise in temperature is independent of the mass of the body brought to comparative rest by the atmosphere. In reality, since the germ experiences a greater retarding acceleration than the stone, its temperature must rise much more rapidly and consequently higher than that of the stone. Further, the terminal velocity of the germ will be less than that of the stone, which will conduce to further raise the temperature of the former. Of course neither the stone nor the germ will get all the heat generated, but this cannot materially affect the question. J. H. STEWART

Physical Laboratory, Royal College of Science for Ireland

Instinct of Magpies

I HAVE read in NATURE (p. 428) your correspondent's letter relative to the instinct shown by magpies in Scotland as to the time for commencing their nest-building, which goes so far as to assume that this particularly cunning bird is capable of fixing a certain day in March (the Sunday after the 16th as I remember) as the invariable time to start the nest. And the writer observes that it would be well to ascertain if difference of latitude made any difference in the magpies' calculation. Now I live in the south-east of Ireland, a good many degrees south of your correspondent's Scotch magpies' locality, and it so happens that I have for the last twenty years observed the nest-building of magpies, who have enjoyed undisturbed possession, and who invariably build in the trees close to my house. It is curious that this colony (if a single pair may so be called) never increases—four young "mags" are brought out every year—but though I have observed congregations of ten or fourteen at times, the breeding birds never exceed two. The young birds never, like rooks, join a colony near their paternal nests, but are shipped off to new localities. I could mention many traits of my magpies' instinct—"their tricks and their manners"—but will confine myself to the nest-building. They never repair or reoccupy an old nest. A new one is constructed every year, and always, each year, in a different tree. Their nest-building is a serious labour, and takes a long time. So they begin early in *February*, selecting the sites often with much deliberation. The work is entered on very early in the morning, and the "mags" seldom work in the daytime. About the end of March this domed nest with its two openings is finished, and the laying of eggs commenced. I am quite certain that the middle of March is not the time of beginning the nest, and this is important, as the claim set up for the magpies instinctive knowledge of dates therefore falls to the ground. I do not conceive it possible to prove that in this particular magpies have a more highly developed instinct than most other birds; all have their normal time of nesting, although there may be cases of abnormally late or early building; but as to the magpies or any other bird being able to fix dates exactly to the day, it is unproved and incredible.

Inisnag, Stonyford, Co. Kilkenny JAMES GRAVES

Cats at Victoria Station

THAT the cats should repose comfortably amidst all the noise and vibration of a busy railway is not, after all, to be much wondered at. Animals much more defenceless and timid have found out that they need not be afraid of either the vibration or the trains, although they do not seem to have discovered that if they get in the way of the trains they are either maimed or killed. For instance, along the London and North-Western Railway between Manchester and Liverpool, which carries an enormously heavy traffic, rabbits burrow almost immediately beneath the ballast forming the permanent way, and I have often seen them sitting nearer to the train than most human beings would like to stand. It is strange, however, that along this line of railway, which is one of the oldest in England, neither the rabbits nor the grouse and partridges have learnt that, though the train is not to be dreaded as a man is dreaded, it is usually fatal to those who are struck by it. All these creatures, as well as hares, pheasants, &c., are constantly being run over by passing trains. A hen grouse or partridge will frequently take her brood on to the railway, no doubt for the purpose of dusting themselves, and meet with this fate. The survivors, however, do not seem to take warning by the occurrence. The same may be said of the telegraph-wires, against which the birds are constantly flying. The number killed in this way is considerable. This is the more remarkable because along this line wild animals have had such a lengthened experience of rail and wire that one would suppose it might have taught them wisdom.

ROOKE PENNINGTON

Wild Duck laying in Rook's Nest

WITH reference to Mr. Willmore's note in NATURE (p. 573), I have met with several instances in Lincolnshire of wild ducks nesting at a considerable height above the ground—once in an oak in a plantation in the old nest of a carrion crow—in ivy on a ruined wall, and on the top of a straw stack; once also on the roof of an old bean stack in the marches. I have known a wild duck nest on the ground amongst brambles and rough grass in the centre of a plantation a mile or more from pond or running stream. JOHN CORDEAUX

Junior Athenæum Club, April 21

Science and the Public Service

THE public are greatly indebted to your correspondent for drawing attention in NATURE of March 27 (p. 511) to the astounding proposal of the War Office to adopt the scheme of examination described by Lord Morley in the House of Lords on March 27—a scheme so absolutely retrogressive, and opposed to the recommendations of the Public School Commission of 1862 and of the Commission on Scientific Instruction in 1872 (composed of many eminent men and presided over by the Duke of Devonshire), and to the rapidly strengthening opinion in favour of education in science. The Government must be asked to withdraw the scheme. S.

Whittington, Chesterfield, April 16

THE HONG KONG OBSERVATORY

1. IT was found to be impossible to select a suitable site for the new Observatory near the city of Victoria, as the mountains shut off from view a large section of the southern sky, extending up to 25° of altitude. It is for the same reason impossible to determine the direction and velocity of the wind accurately near the town. Besides it is likely that the ferruginous rocks would deviate the plumb-line, not to mention the magnetic needles.

2. The Observatory was therefore built on the peninsula of Kaulung opposite. It stands on the top of Mount Elgin, a small hill built up of decomposed granite, rising abruptly on all sides from the surrounding level ground, and culminating in two humps distant over 300 feet from each other. The top of one of these is flat, and forms, roughly speaking, a circle of about 200 feet in diameter, and 110 feet above mean sea-level. Here the main building is situated, about 75 feet south-west of which the stands for the meteorological instruments, including the self-recording rain-gauge, are placed. It commands an unobstructed view of the sky, the tops of the hills rising only about seven degrees above the horizon. The magnetic hut is erected on the other prominence, the top of which was levelled, and forms a rectangle 36 feet by 30 feet.

3. The situation of the Observatory is rather secluded. It is surrounded by villas and summer residences; and the picturesque town rising opposite on the side of the steep mountain at a distance of a couple of miles, and the harbour, filled with the most bewildering mixture of men-of-war and merchant ships belonging to nearly all nationalities, and literally swarming with boats and sampans, make up a charming view from the verandas of the Observatory, which, on the other hand, forms a prominent object as seen from the town and harbour.

4. I was appointed to take charge of the Observatory on March 2 last year, and when I arrived in the colony on July 28, the foundations of the building had been already laid. It was then erected under my superintendence, and I was allowed to arrange every detail to suit the requirements. By January 1 the main building was so far finished that I could take up my residence there, and start tri-diurnal meteorological observations, and issue a daily weather report, containing also information concerning the direction and force of wind indicated by the gradients, based on telegrams received from the Treaty Ports, Manilla, and Nagasaki. I receive a telegram from Wladivostock in addition. The observations are made at 10 a.m. and at 4 p.m. on the previous day.

5. The main building of the Observatory is a rectangular block, 83 feet long and 45 feet wide (not including the transit-room), the architecture of which does credit to the Surveyor-General's department. The upper floor is devoted entirely to my quarters. The ground floor com-

prises four rooms, each 20 feet long, 16 feet wide, and 14 feet high. In the entrance hall is placed the telegraphic apparatus; to the right is my private office, where the library is placed, contained in glazed teak-wood book-cases, to protect the books from insects in the summer. I have already received extensive donations from scientific institutions in all parts of the world. The room next to this contains the clocks, which are fixed to brick piers neatly covered with teak wood. The piers, which rest on cement concrete, are carried down 6 feet below the ground in holes lined with bricks. Behind this is a small room in which the galvanic batteries are placed.

6. The mean-time clock, which is to discharge the time-ball automatically, is furnished with a magnetic apparatus for setting to correct time without touching any part of the clock. The time-ball will be dropped at Tsim-sh'at-sui Point, opposite the harbour, about a mile from the Observatory. It is 6 feet in diameter. Opposite the mean-time clock is the sidereal standard clock, which is of the most finished construction. It communicates by wire with a sympathetic dial placed in the transit-room. The face of the latter is black, and the hands and the figures are white, which I found very convenient at Markree Observatory, but unfortunately, Messrs. Dent and Co., who made all the horological apparatus, have omitted a second every minute. For marking a chronograph such an arrangement is most desirable, but it is rather awkward in observing with eye and ear. The clock-room contains the relays, and also one sidereal and two mean time chronometers.

7. The transit instrument, by Troughton and Simms, is placed in a wing room painted dark gray, 14 feet square and 14 feet high, next the clock-room. The meridian opening is 1 foot wide. The transit instrument has also a delicate level for observing zenith distances according to Talcott's method. The pivots are made of chilled bell-metal, a material which, I believe, was introduced to astronomical instrument-makers by Brinkley of Dublin, whose instruments remain serviceable up to this day, while the pivots of transit instruments of much later date are corroded, being made of steel—a material that should not be used except where unavoidably necessary. An adjustable meridian mark is placed on a pier 66 feet north of the transit instrument. It is observed through a lens of that focal length, which is fixed in the meridian opening of the transit-room.

8. To the left of the entrance hall is the general office and computing room, next to which is the room where the barometers, as well as the self-recording thermograph and barograph, are placed. Behind this is a small room that serves as a photographic laboratory. Every part of these two rooms, including ceilings, floors, and furniture is painted dark red, and there are only a few panes of glass in the windows, which are glazed with double red glass. The thermograph is supported by massive blocks of wood fixed on solid masonry, but the barograph is placed on a stand merely screwed to the floor. The screw that holds the self registering thermograph is made of zinc.

9. Over the upper story of the building a turret rises 8 feet above the flat roof. This holds the self-recording parts of the anemometer, which is erected on top of it. The cups are 45 feet above the ground. The roof forms a convenient platform for making observations. The sunshine-recorder is placed in a groove in the coping-stone on the parapet, 34 feet above the ground. Lightning conductors are placed on the two chimneys. They rise a few feet higher than the anemometer.

10. A one-storied block of outbuildings, containing servants' quarters and store-rooms, communicates with the main building by a covered passage.

11. The magnetic hut is 17 feet long, 13 feet broad, and the roof rises 11 feet high. It is made of wood, painted pure white outside and inside. Bamboo chips instead of nails were used in its construction, as well as in that of the furniture. It has double doors, louvered and glazed, to the north and south, and two windows on either side, as well as two windows in the roof, which is convenient for reading the verniers. On top of massive teak-wood blocks sunk 3½ feet in the ground and rising 4 feet above the floor are placed the dip-circle and the unifilar magnetometer. All the instruments were brought out safely, except the dipping needles, which appear not to have been sufficiently cleaned before packing. The hut is very comfortable, and forms therefore, in my opinion, a contrast to other structures used for making magnetic observations, in arranging which the importance of attending to the comfort of the observer in the hut is but too often lost sight of. The deviation is only 47 minutes easterly. The dip is 32 degrees (north end dipping). A broad road leads from the main building to the magnetic hut. This road is broken in the middle by a depression, across which a bridge will shortly be built.

12. Beside this road, at a distance of about 75 feet from the main building, it is intended to build a small house for the assistants, and near this has been selected the site for the refractor of 6 inches aperture, the loan of which I was promised by the Astronomer-Royal. That will complete the outfit.

W. DOBERCK
Government Astronomer

Hong Kong Observatory, March 11

THE CEDAR FOREST OF CYPRUS

IN 1879 Sir Joseph Hooker communicated to the Linnean Society[1] the unexpected discovery of a form of the cedar of Lebanon (*Cedrus libani* var. *brevifolia*, Hook. f.) by Sir Samuel Baker in Cyprus.

The following extract from a letter lately received by the Director of the Royal Gardens, Kew, from Sir Robert Biddulph, K.C.M.G., C.B., the High Commissioner, gives a more detailed account of the forest, and will no doubt be interesting to many readers of NATURE :—

"*Cyprus, March* 25

"With regard to the cedars, I went last summer all through the thickest part of the forests, including the cedar forest, and I am able to give you some of the particulars you ask for, having noted them at the time. The cedar forest occupies a ridge on the principal watershed of the southern range, and about fifteen miles west of Mount Troodos. The length of the forest is about three miles, its breadth very much less. A few outlying cedar-trees were visible on neighbouring hills, but on the ridge they were quite thick, and probably many thousands in number. I took the height above the sea by an aneroid barometer, and found it to be 4300 feet. The trees are very handsome and in good condition, but comparatively young. The smallest seemed to be from ten to fifteen years old; the largest, I am told by the principal forest officer, are probably not over sixty or seventy years. The worst feature is that there were *no* seedlings or young trees under ten years; and indeed this is the same with regard to the pine forests. It would seem as if the great influx of goats has been comparatively recent. I made a tour through the heart of the forest last August. I started from a point on the west coast, and from thence ascended to the main watershed, and kept along the top till I reached Mount Troodos, taking three days to do it. The country through which we passed on the first day was perfectly uninhabited, and a mass of hills and forest, chiefly *Pinus maritima* [*P. halepensis*] and the Ilex. The trees were in very great number, but there was a scarcity of young trees, and most of the old ones had been tapped for resin. On the second day we passed through the cedar forest, and the same sort of country as before, the *Pinus Laricio* beginning at an altitude of 4000

[1] *Journ. Linn. Soc. Bot.* xvii pp. 517-19.

feet. We got as far as the monastery of Kikko that day, and the next day I continued along the watershed to the camp at Troodos. Our road as far as Kikko was a mere track on the side of the hill, in some parts rather dangerous, and we had to lead our ponies on foot, in many parts very steep. The difficulty on the road is the want of water at that elevation. We halted the first night at a beautiful spring, but we had to carry with us food for man and beast for the whole party, muleteers, &c. The scenery was wild and romantic. This spot is the centre of the '*moufflon*' ground; three of them were at the spring when we approached it. It gave me a clearer idea of the forests of Cyprus than I ever had before.

"We have had a great deal of rain this winter, and the country is clothed with vegetation."

MINERAL RESOURCES OF THE UNITED STATES[1]

THIS volume, published by the United States Geological Survey, is the first statistical report upon the condition of the mining industries of the United States, and contains much valuable information concerning the great and ever-increasing production of metals, especially in the States west of the Missouri and the Rocky Mountains.

In addition to the columns of figures of weights and values constituting the statistical matter proper, the author, or rather his coadjutors, for the volume is the work of many contributors, have furnished notices and descriptions of processes, especially in the metallurgical section; and a review of the course of the markets for the preceding eight years (to 1875) is given for each important metal. By a curious provision in the Act of Congress providing for the publication of these statistics, the field is restricted to mineral products other than gold and silver, but, in order to present as complete a view of the total output as possible, the best available figures of the production of precious metals are given in a concise form. This, though valuable, is rather disappointing, as we miss the interesting accessory descriptions which are given in other parts of the volume. How important the production of these metals has been during the last quarter of a century is seen in the statement that the aggregate yield up to the middle of last year has been 2707 tons of gold and 15,680 tons of silver, and of these enormous quantities less than 1 per cent. of the gold, and none of the silver was raised before 1858 At the present time the annual production varies from 12 to 16 millions sterling coinage value, divided about equally between gold and silver, the latter being usually a little in excess.

The coal raised in the different States is a little over 87 million tons, of which 29,120,000 tons were anthracite and the remainder bituminous coal and lignite of all kinds, and some anthracite mined "outside" of Pennsylvania, the recorded value being 29,326,000*l.* The above totals represent 1·8 ton per head per annum of the population, which is, however, somewhat less than the consumption, in addition to enormous quantities of wood and charcoal. Among the most interesting recent developments are the Tertiary and Cretaceous coal-basins which extend along the base of the Rocky Mountains and are also seen at different points on the Pacific Coast, the total area of these being reported as greater than those of the Carboniferous formations proper in the Eastern States. These areas are, however, marked as doubtful by the author. At Crested Butte and Irwin, in the very heart of the Rocky Mountains, both anthracite and good coking coals are found in these newer formations, the quality of the latter especially being comparable with the coal of Connellsville or the best coking coal in Pennsylvania.

[1] "Mineral Resources of the United States." By Albert Williams, jun. 8vo. (Washington, 1883.)

The iron industry of the United States is now of first-rate importance, and the subject is well treated in a paper contributed by Mr. J. M. Swank, the well-known secretary of the American Iron and Steel Association. The iron ore raised is in round numbers 9 million tons, and the pig iron made from it 4,623,000 tons. The value of the latter is given at 21,267,000*l.*, which is only a few pounds less than that of the gold, silver, copper, and lead taken together. The largest production of iron ore is in the district producing the richest quality, namely Lake Superior, whose yield of 2,948,000 tons is comparable with those of the other great hematite districts of the world, Furness, Whitehaven, and Bilbao.

The United States are now among the largest producers of copper, and here we are met by the peculiarity of the unequal distribution of the producing centres. Thus, of a total product of 40,903 tons, 25,439 tons were from a single district, namely, Lake Superior, and of this again the larger proportion, 14,309 tons, was from a single mine, the "phenomenal" Hecla and Calumet of Houghton, Michigan. The Lake copper is entirely produced from the native metal, and is of the highest degree of purity. Latterly, however, a competitor of some importance has arisen in the south, in the barren desert country of Arizona, where masses of carbonates and oxides have been discovered in considerable quantity under conditions resembling some of the famous mines of South Australia. The handling of these ores is not, however, easy. The smelting must be done on the spot, and when the furnaces are at a distance from railways, the coke used may cost from 10*l.* to 15*l.* per ton. The most remarkable mine in this district, the Copper Queen, has already paid 200,000*l.* in profits, and produces copper at a cost of 4½*d.* to 5*d.* per pound.

Lead is another metal in which the United States have taken a prominent position during the last few years, the product being now 132,890 tons, while in 1870 it was only 17,830 tons. This great increase is due to the development of several important groups of mines in the Western States, but more particularly in Utah, Nevada, and Colorado, the latter State alone producing 58,642 tons, or nearly half the total production of the country; while in 1873 the State was credited with only 56 tons. The enormous increase is due to the development of the carbonate deposits of Leadville, in the Rocky Mountains, where ores containing only 10 to 20 per cent. of lead are smelted in enormous quantities to obtain the silver and gold contained, which are relatively high in proportion; the pig lead or "base bullion" produced being sent eastward by railway to the refineries at Omaha, Chicago, St. Louis, Pittsburg, and even New York. The information given in the volume concerning this important branch of industry is so full that it will be a welcome one to the library of every metallurgist.

Another important and almost specially American mineral industry is that of petroleum, the production being restricted to the States of Pennsylvania, New York, California, West Virginia, Ohio, and Kentucky, the last four being, however, insignificant as compared with the first three. Here again there is a considerable disparity, the States of Pennsylvania and New York yielding 61,[illegible] barrels daily, while in California the annual total is only 70,000 barrels. The barrel contains 42 gallons U.S. measure, which is the same as the old English wine gallon of 231 cubic inches. The consuming power of the world seems in this article to have been passed by the supply, the average price of 41*s.* 2*d.* per barrel in 1[illegible] having fallen to 3*s.* 4*d.* in 1883. Notwithstanding the great fall in price the total produce of the year is valued at £4,740,000, or about one-half more than that of the copper.

The minor metallic and other minerals are of less [illegible]portance, but their statistics are set forth in considerable detail in other parts of the volume, which we hope to s[illegible] reprinted, if not annually, at least at short intervals of years, as furnishing one of the most valuable contributions to economic geology. H. B.

THE LATE DR. ENGELMANN

SO many years have elapsed since Dr. Engelmann, whose death was recently announced in your columns, wrote his academic dissertation "De Antholysi Prodromus, 1832," that it is no matter for surprise if many among the younger generation of botanists have forgotten this little treatise, or have failed to associate its author with the historian of American conifers and other selected orders. This is the less surprising as, although in Dr. Engelmann's systematic memoirs there are frequent traces of his early morphological studies and of the interest he felt in them, he, so far as I know, wrote no treatise specially devoted to teratology other than the one already mentioned. A few words on this little book may therefore not be unacceptable to those who honour Engelmann's memory. It would be an interesting and not an unprofitable task to trace out the connection between teratology and the modern views of evolution, which is much closer than is generally imagined, albeit the ideas of natural selection and survival of the fittest find no place in the older teratological literature. For such a task I have neither the requisite ability nor the necessary leisure. My object in alluding to the matter is to call to mind the light in which Engelmann considered the subject, influenced as he was by the writings of his great fellow-countryman Goethe, whose views, originally published in 1790, were by no means universally accepted, even in 1832. Schimper and Alexander Braun were among those who appreciated the value of Goethe's heory, and those two learned men and acute morphoogists were Engelmann's teachers, and as we learn from iimself, exerted great sway over him.

It is curious to contrast the modest pamphlet "De Antholysi Prodromus," written in Latin, which I at least lo not find very easy to construe, with the more elaborate 'Élémens de Tératologie Végétale" of Moquin-Tandon, ublished nearly ten years later (1841). Moquin's work s written in a style which even a foreigner can read with leasure. Its method, too, is clear and symmetrical, ut when we compare the two works from a philosophical oint of view, and consider that the one was a mere colge essay, while the other was the work of a professed otanist, we must admit that Engelmann's treatise, so far s it goes, affords evidence of deeper insight into the nature nd causes of the deviations from the ordinary conformaon of plants than does that of Moquin. A few illustraons will suffice to make this clear. Speaking of proressive development, or as he calls it "*evolutionis rogressus*," Engelmann says that while it is only bscurely indicated in celestial bodies, and with difficulty udied in animals, "*clarissime apparet in plantis*." lant-history is for Engelmann the narrative of the proess of evolution—"*evolutio progrediens*"—and variaons from the ordinary course are to be accounted for, *ex nimio motu, et ex nimio impeditione*," or, as we ould now say, from excess or from arrest of development.

The main end of a plant is to produce seed, and e morphology of the plant appears to have been nsidered by Engelmann as the result of a compromise tween this tendency (*nisus*) and the progressive deveopment of each individual part. The morphological unit him, as for Goethe, from whom he derived the notion, is the leaf—"*unitas autem in foliis posita est*"—and the riations from the leaf-type were, as we have seen, attrited to arrest of development, to reversion (*regressus*), to progression. But these changes were looked upon n chiefly in relation to the greater or less development and specialisation of individual parts with little or no reference to their possible genealogical significance as elements in a general pedigree of plants, or at any rate as suggestive of such elements. Hereditary influence, however, was not wholly overlooked; on the contrary, Engelmann speaks of it as "*magni momenti*," and goes on to show how woody plants frequently show, year after year, the same malformations, how perennial plants less frequently do so, and how such repetition is much less frequently observable in annuals and plants propagated wholly by seed. Only "*antholyses epiphyticæ hereditariæ esse possunt*" (§ 69), says our author, by which he means that partial changes are not perpetuated by descent, but only those in which "*omnes plurimive flores morbosi sunt*." It is not necessary to stop to consider what amount of truth there is in this assertion, but it is interesting to see the use then made of the word "epiphyte." Engelmann, influenced by his medical studies, spoke of "local," "epiphytical," "sporadic," "enchoric," and "enchronic" affections; enchoric changes being limited to certain localities, enchronic alterations occurring at definite times. These terms have not been generally adopted, while the signification now attached to the word "epiphyte" is widely different from that which Engelmann intended. He, at least, had not the right of priority in this matter, for Bischoff, in his "Botanische Terminologie" (1830), speaks of epiphytes as external parasites (citing as examples *Cuscuta* and *Viscum*), in contradistinction to entophytes. It would seem from this that in matters of terminology custom overrides priority. But this by the way. Our present concern is with the fact that certain changes, or certain degrees of change, are more likely to be perpetuated than others. Similarly we find Engelmann calling attention to certain "critical" regions of the plant,—spots, that is, more subject than others to teratological change,—the apex of the stem in definite inflorescences for instance (§ 67), a point subsequently dwelt on by Darwin at some length, though he does not seem to have been aware of what Engelmann had previously written on the subject.

Lastly, reference may be made to the assertion made by Engelmann that plants of a high state of relative structural perfection "*structurâ magis evolutâ et typo magis composito*," are specially liable to retrograde metamorphis. This is a statement that from the nature of things seems so reasonable that it is generally accepted without question. Nevertheless, it is one which requires qualification and further investigation. To take one case which occurs at the moment. Let any observer call to mind the number of instances in which he has seen the carpels the subjects of retrograde metamorphosis, and he will probably find that such changes are far more common in cases where the carpels are free and superior, than in those in which they are in union one with another and with the thalamus, as in the so-called inferior ovaries, which are considered to represent a higher type of structure than do the free carpels.

But the object of this note is not to discuss any particular view that Engelmann may have held, but merely to call attention to his claims as a morphologist, claims which are overlooked by reason of his greater—numerically greater—claims as a systematist.

MAXWELL T. MASTERS

SIWALIK CARNIVORA [1]

BY the publication of the present memoir on the Siwalik and Narbada Carnivora, Mr. Lydekker completes the second volume of the series of the "Palæontologia Indica" devoted to the Indian Tertiary and Post-Tertiary

[1] "Palæontologia Indica," Series x. Indian Tertiary and Post-Tertiary Vertebrata, Vol. ii. Part 6. Siwalik and Narbada Carnivora. By R. Lydekker, B.A., F.G.S., F.Z.S. Published by order of His Excellency the Governor-General of India in Council. (Calcutta, 1884.)

Vertebrat·. Both these volumes, it may be remarked, treat of mammalian forms, and, with the exception of a memoir on *Rhinoceros deccanensis*, by Mr. R. B. Foote, are from the pen of Mr. Lydekker. Each volume contains about 300 pages and forty-five plates.

No traces of mammals have yet, it would appear, been detected below the Eocene in India, and even in this formation only some very fragmentary bones have been obtained from the Punjab. From the Miocene the remains of a rhinoceros have been found. In the Pliocene mammalian remains begin to be pretty numerous. Thirty-three species of Carnivora from Siwalik are described in the present memoir; they belong to the following families: Mustelidæ, Ursidæ, Viverridæ, Hyænidæ, Felidæ, and Hyænodontidæ. Of the first of these families, two species of the genus Mellivora are described; one of these, *M. sivalensis*, was first noticed in the supplemental plates of the "Fauna Antiqua Sivalensis," and the original is in the British Museum. A second skull and the ramus of a mandible are in the Science and Art Museum, Dublin. The annexed woodcut shows the right side (Fig. 1, *a*) of the palate of this latter. The original describers of these

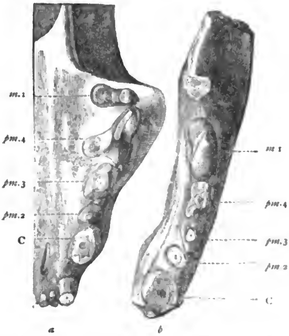


FIG. 1.—*Mellivora sivalensis* (F. and C.). The right half of the palate (*a*) and the left ramus of the mandible (*b*). Natural size.

specimens, Colonels Sir W. Baker and Sir H. Durand, remark on their close affinity to the recent *Mellivora indica*, and Mr. Lydekker says that in most respects the forms of the recent and fossil jaws are exceedingly alike. In the fossils the *pm*.2 and *pm*.3 are slightly larger in the upper jaw than in the recent form, and the true molar (*m*.1) of the former differs from that of the latter by being much less expanded at its inner extremity. In the mandible (Fig. 1, *b*) there is not much difference between the fossil and recent forms. The difference, however, between the extinct and recent Indian ratel may be summed up as being about the same in degree as between the recent Indian and African forms, leaving it probable that India may have been the original home of the genus. A second species is described as new, *M. punjabiensis*. A new genus (Mellivorodon) is formed for a form intermediate in size between the ratel and the glutton, while the form and relative proportions of its teeth indicate that it was more nearly allied to the former than to the latter. Two species of Lutra, *L. palæindica*, F. and C., and *L. ivalensis*, F. and C., are described from the region of he typical Siwalik Hills in the neighbourhood of the Ganges and Jumna Valleys, and one, *L. bathygnathus*, Lyd., from the Siwaliks of the Punjab; this last is of extreme interest, as, while presenting no sort of affinity to any of the existing Indian species, it is most closely allied to the recent South African otter (*L. lalandi*), and thus affords another well-marked example of the intimate connection of the Tertiary mammalian fauna of India with the present African fauna.

The evidence of the close relationship of the bears and the dogs appears to Mr. Lydekker too strong to refer them, at all events for palæontological purposes, to separate families. We therefore have the Ursidæ comprehending the two modern families Ursidæ and Canidæ, these being formed into groups as Ursinæ and Caninæ. The author does not, however, attempt to form a definition of the family as thus extended, nor is he even quite certain as to the limits of the sub-groups. Of the species described, one, *U. namadicus*, F. and C., is from the Pleistocene Narbada beds; the other, *U. theobaldi*, Lyd., was obtained by Mr. Theobald from the Siwaliks of the Kangra district. It would seem to be nearly related to the recent *U. labiatus*, which itself seems to stand quite isolated from all the other recent bears, its strangely

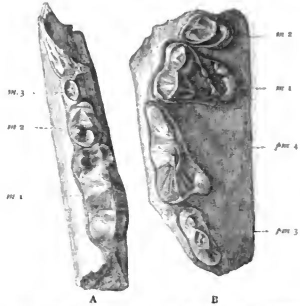
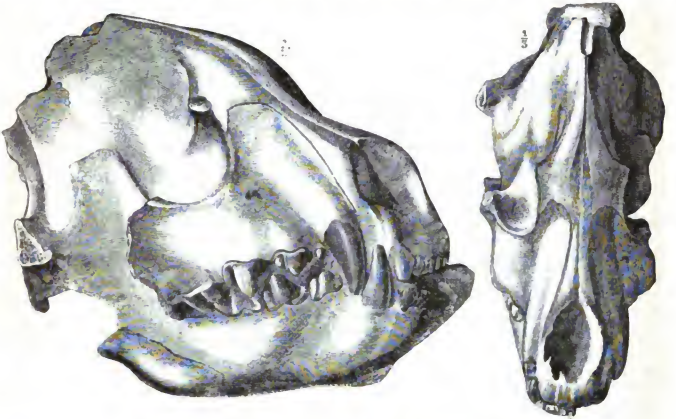


FIG. 2.—*Canis cautleyi* (Bose). Part of the left ramus of the mandible (A) and the left side of the palate (B).

modified molar dentition being the result of the nature o its food. Three species of Hyænarctos are mentioned: *H sivalensis*, F. and C., *H. punjabiensis*, Lyd., and *H. pal indicus*, Lyd. The line of descent of the genus is though to be from the bears, through Dinocyon, to the true dogs *Amphicyon palæindicus*, Lyd., is redescribed and re figured; it approaches *A. intermedius*, Myr., describe from the Miocene of Bohemia on the eastern side c Europe. Of the genus Canis the following are de scribed:—*C. curvipalatus*, Bose, and *C. cautleyi*, Bose The occurrence of this latter species in the Siwaliks is co "of extreme importance in regard to the Pliocene age c at least a large portion of those deposits, for in th Tertiaries of Europe, with which the Siwaliks are i many respects closely allied, true wolves are unknow before the Pliocene." Among the Siwalik fossils in th Science and Art Museum, Dublin, there is an associate portion of the skull and two fragments of the mandible c this wolf, portions of which are represented in the wood cut (Fig. 2). In A are shown *m*.1 and *m*.2 in a very pe fect and almost unworn condition, and also the broke fang of *m*.3. In B the left side of the palate shows th canine and the earlier premolars.

Of the Viverridæ we find the following:—*Viverra bakeri*, Bose, and *V. durandi*, Lyd. Of the Hyænidæ four species of Hyæna are described, based on specimens in the collections of the British, Indian, and Dublin Museums, and there are not wanting evidences of a fifth form. It is remarkable to find so many species of hyæna existing contemporaneously in India; but, when the large number of Proboscidia and other ungulate forms that existed at the same time is recalled to memory, to find the genera of Carnivora equally strongly represented in species is perhaps only what might have been expected. The earliest notice of the remains of Hyæna from the Siwaliks appeared in 1835 in the *Journal of the Asiatic Society of Bengal*, where Sir W. L. Baker described a specimen as "the most perfect fossil we have yet been so fortunate as to meet with." This specimen is figured in the annexed woodcut (Fig. 3), and is at present in the Dublin Museum. The species has been described by Mr. Bose as *H. felina*. Its affinities are towards the recent *H. crocata* of South Africa, a species common in Europe during the Pleistocene period; and this fact points, Mr. Lydekker thinks, to the conclusion that Asia rather than Africa may be regarded as the cradle of the race of hyænas. *H. colvini*, Lyd., *H. macrostoma*, Lyd., the latter a species that seems to constitute an important link between the more typical members of the genus and the viverroid and canoid Carnivora. *H. sivalensis*, Bose, is redescribed and figured. A new genus, Lepthyæna, is made for a species previously recorded as *Ictitherium sivalense*.

The Siwalik Felidæ embrace *Æluropsis annectans*, Lyd., a new genus and species of which but little is known; *Ælurogale sivalensis*, Lyd., for a carnivore intermediate in size between the Thibetan lynx and the leopard. Six species of Felis are either described or indicated; of those described are *F. cristata*, F. and C., *F. brachygnathus*, Lyd., and *F. subhimalayana*, Bronn. Of the genus Machærodus two species are included in the list of Siwalik forms. *M. sivalensis*, F. and C.: a



A B

FIG. 3.—*Hyæna felina* (Bose) A, oblique view of right side of cranium; B, front view.

nearly complete left ramus of the mandible of this species is in the Dublin Museum, and is represented in Fig. 4; posteriorly it is complete, with the exception of the coronoid process, while anteriorly it is broken through the symphysis; it shows part of the alveolus of the canine and the greater portion of the descending expansion. The three cheek teeth are preserved, but in a more or less broken condition; a large part of the outer surfaces of *pm*.4 and *m*.1 have been chipped away. These teeth agree with the type specimen in the British Museum, with the exception that *pm*.3, though still small, is inserted by two distinct fangs. The last family, that of Hyænodontidæ, is one considered by Prof. Huxley as occupying a position connecting the Carnivora with the Insectivora. Only one species belonging to the genus Hyænodon has been found. This genus has hitherto only been recorded from Europe and North America. The species *H. indicus*, Lyd., is represented by teeth from the Siwaliks of Kúshalghar and the Punjab.

Perhaps the most striking feature in this list of extinct forms is the fact that by the side of ratels, bears, jackals, and civets, some hardly to be distinguished from living species, there are to be found essentially primitive forms,

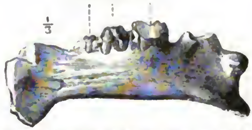


FIG. 4.—*Machærodus sivalensis* (F. & C.). Outer view of left ramus of mandible of a male.

proving the survival in India of old types long after they had disappeared from other parts of the world. Equally noteworthy is the apparently contemporaneous existence of specialised and generalised forms of the same genus; this is well seen in the hyæna. It will also be seen that the Siwalik carnivorous fauna fill up many gaps in the chains of relationship, such as that between the bears and dogs, the viverroids and hyænas, and these latter and the cats.

The rock series in which these fossils occur is therefore one of very great interest. From the Brahmaputra to the Jhelum, for a distance of 1500 miles along the base of the Himalayas, there extends with varying width a succession of ridges or ranges which are known as the sub-Himalayan hills. Physically and constitutionally they are readily distinguished from the ranges belonging to the mass of the Himalayas proper. The rocks forming them are all of Tertiary age, and they are divisible into an upper (the Siwalik) and a lower (the Sirmur) series; these again are further divisible respectively into upper, middle, and lower groups. This is the principal and classic area of these rocks, but they occur also in Burmah, Perim Island, and in Sind.

With the Sirmur series, which in part consists of marine (Nummulitic) strata, we have no special concern at present. It is from the rocks of the Siwalik series alone that the vast harvest of remains of fossil vertebrates has been collected in the sub-Himalayan region during the past fifty years. The fossil-bearing beds are principally conglomerates of undoubtedly fresh-water origin, indeed, owing to their local development at the gorges of the existing great rivers, where they emerge from the Himalayas, it is clear that they were deposited at a time when, so far, the configuration had been established; but, as the very highest beds exhibit signs of intense disturbance and crushing, it is no less apparent that, although the main drainage lines have not altered, there has been much movement and upheaval, which, however, appears to have been effected, not by sudden, but rather by slow and gradual action.

After much discussion as to the correlation of these fossiliferous conglomerates with the established order of sequence in Europe, it would appear to have been finally adopted that, in spite of a certain Miocene facies in the fauna, the general characteristics are such as to indicate a Pliocene age. Fossil-bearing beds of Post-Pliocene age occur, it may be here remarked, in other parts of India.

Numerous and varied as the fossils from these rocks are which are now preserved in the museums of Calcutta, London, Dublin, and elsewhere, they do not appear to be found anywhere concentrated in great quantities, the specimens having for the most part been found at widely separated intervals, where they lay more or less weathered out of the enveloping matrix. Though naturally mineralised, and with but a small percentage of residual animal matter, they are often beautifully preserved, but occasionally, owing to the hardness and tenacity of the matrix, it has required the utmost patience and skill to chisel out the details of structure, while sometimes it has been found impossible to do so.

Mr. Lydekker is to be warmly congratulated on the completion of this important volume, and we are glad to know that he is busy with volume iii., which is to include an account of the Siwalik Suina and Birds.

AN EARTHQUAKE IN ENGLAND

At last the people of these islands have been enabled to realise the meaning of the term "earthquake," so terrible in its significance in many other parts of the globe. On Tuesday morning, at a time variously given from 9.15 to 9.30, a shock which was really alarming and did considerable damage was felt over the Eastern Counties and as far west as London and even Rugby. The centre of disturbance seems to have been at Colchester, and the wave apparently travelled from south-east to north-west, though impressions vary on this point. At Colchester, in addition to the undulations of the earth, subterranean rumblings were heard, buildings rocked to and fro, the streets were strewn with debris of fallen chimneys, a chapel spire was thrown to the ground, and other signs of seismic disturbance were evident, familiar enough to those who have been in countries where such phenomena are common occurrences. The shock, when it was most intense, commenced with a rumbling sound, increasing in intensity for about twenty seconds, and then suddenly stopped. It extended to Chelmsford, Cambridge, Northampton, Ipswich, Sudbury, Rugby, Leicestershire; it included London and the surrounding district in its sweep, and even caused some alarm in the Strand. At Woolwich it was so strong that some persons attributed the shock and noise to the bursting of a heavy gun.

We have received the following communications with reference to the earthquake:—

One of the most severe earthquake shocks which has occurred in England for many years took place this (Tuesday) morning in the Eastern Counties. The area of its chief operation lay over South Suffolk and North Essex, and the principal focus of the disturbance seems to have been the neighbourhood of Colchester. A great deal of harm has been done to property there: houses are partially unroofed, many chimneys and gable-ends of the very old houses in Colchester have been demolished, part of the spire of the Lion Walk Congregational Chapel (a well-known building), to the amount of twenty feet from the apex, was thrown down, and other details of mischief done are fast coming in. Langenhoe Church, about twenty-four miles from Colchester, is said to be all but demolished, the entire eastern end being shaken down. The Rectory also severely suffered, so that little more than the walls are standing. At Wyvenhoe, near Colchester, the church steeple is thrown down and many houses are much damaged. Other villages around Colchester have more or less suffered: Lexden, Abberton, Greenstead, Hythe, &c., all show evidences of the disturbance in their more or less shattered buildings. The shock was severely felt here at Ipswich. I was sitting down at 9.18 a.m. when the first shock occurred, and it nearly overbalanced me. I felt it must be an earthquake oscillation, although I had never experienced anything like it before, and accordingly waited and watched for the next. The oscillations followed each other for about three seconds, and apparently travelled in a north-north-easterly direction. I underwent quite a new experience, so vivid that I am not likely to forget it. The sensation approached that of nausea. In the town of Ipswich many people were alarmed, for the bells were set ringing, the pictures on the walls shaking, &c. The occurrence is too recent, however, to carefully note the direction of the oscillations. The London Clay in Suffolk and North Essex, when cut into, abounds with small faults and creeps, and this shock may be leaving another such token behind it. J. E. Taylor

Museum, Ipswich, April 22

At about 9.20 this morning I distinctly felt a slight earthquake. The motion though slight was unmistakable, the chair on which I sat, and the whole house, seemed to move to and fro for the space of, as near as I could judge, ten seconds. I regret I cannot give the exact time when I felt the shock, as I had omitted to put my watch in my pocket. A. Percy Smith

Rugby, Tuesday, April 22

This morning the earthquake was very perceptible here at exactly 9.22. It was travelling from north to south in short rapid undulations. It lasted for thirty-three seconds. My chief object in writing is to draw attention to the fact that this is the second earthquake which has shaken

London this year. On Sunday afternoon, January 13, about 4.5 p.m., while sitting in my rooms here along with my wife and my brother, I was suddenly sensible of a severe earthquake; I pulled out my watch to take the exact time, and while I was in the act of drawing their attention to the phenomenon, my wife, who has experienced with myself, numerous shocks in the Malay Archipelago, exclaimed also that an earthquake was occurring. My brother distinctly felt the shock, but was unaware what it was. It was composed of two severe shocks, with an interval of short duration between them. The house was quite still, and nothing was passing in the street, nor for more than twenty minutes did any carriage come along it. Being accustomed for several years to observing earthquake movements, I am perfectly confident of the occurrence of an earthquake at that time; and in the hope that some other observer has noted the fact, I have sent this note to NATURE. HENRY O. FORBES

87, Queen's Crescent, Haverstock Hill, N.W., April 22

MR. E. B. KNOBEL, F.R.A S., F.G.S., writes to the *Times* from Bocking, near Braintree:—"A sharp shock of earthquake was experienced here at about 9.18 a.m. this morning. A slight trembling was first felt, followed by an oscillation sufficient to make one stagger and cause some alarm. Among the incidents which resulted, house bells were set ringing, one or two doors of cottages burst open, and clocks stopped. The safety-valve of a boiler was lifted and steam blown off for an instant. The phenomenon lasted from two to three seconds, though perhaps the latter estimate is slightly in excess of the true duration of the oscillation. The following facts may be useful in determining the direction of the wave. Three pendulum clocks in different houses stopped, the line at right angles to the plane of oscillation of the pendulum being in all cases north-west and south-east. Pendent gaslights in a factory were caused to sway in the same direction, north-west and south-east. A door was burst open, the position of which when closed was north by west and south by east. These facts would indicate a south-easterly origin of the earthquake wave."

A CORRESPONDENT at Southend states that the wave seemed to travel from north to south, while in the neighbourhood of Oxford Street the direction seemed east to west, and so also at Gray's Inn, where a correspondent felt as if the bed were slipping from under him. Doubtless by next week we shall have fuller and more precise details.

NOTES

THE final meeting of electricians to determine the practical units of electricity and light assembles in Paris on the 28th inst., when England will be represented by Sir William Thomson, Messrs. Preece, Hughes, Adams, Jenkin, Foster, Graves, and Hopkinson, and Capt. Abney. The Congress is expected to last for several days.

DR. KOCH and the members of the German Commission sent last autumn to Egypt and India to investigate the cause of cholera have left Alexandria on their return to Europe.

THE Senate of Glasgow University have resolved to confer the degree of LL.D. on Prof. Osborne Reynolds, Victoria University, and Mr. Thomas Muir, High School, Glasgow.

AT Ekhmeem, a large provincial town of Upper Egypt, situate about half way between Assiout and Thebes, Prof. Maspero, returning from his annual trip of inspection up the Nile, has just found a hitherto undiscovered and unplundered necropolis of immense extent. As far as has been yet ascertained, the necropolis dates from the Ptolemaic period; but as the work of exploration proceeds, it will probably be found that it contains more ancient quarters. The riches of this new burial field would meanwhile seem to be almost inexhaustible. Five great tombs or catacombs already opened have yielded 120 mummies, and within the short space of three hours Prof. Maspero verified the sites of over 100 more similar catacombs, all absolutely intact. The necropolis of Ekhmeem, at a rough estimate, cannot contain fewer than five or six thousand embalmed dead. Of these perhaps not more than 20 per cent. will turn out to be of archæological or historical value; but the harvest of papyri, jewels, and other funeral treasures cannot fail to be of unprecedented extent. Ekhmeem is the ancient Khemnis—the Panopolis of the Greeks. Its architectural remains are insignificant.

THE Granton Zoological Station was formally opened last week; the ceremony was to have been performed by Prof. Ernst Haeckel, but illness prevented him from coming to Edinburgh, as he had intended, to be present at the tercentenary celebration.

THE annual meeting of the Iron and Steel Institute will be held on Wednesday, April 30, and May 1 and 2, at the Institution of Civil Engineers, 25, Great George Street, commencing each day at 10.30 a.m. The list of papers and subjects for discussion is as follows:—Adjourned discussions: (1) On the tin plate industry, by Mr. E. Trubshaw, Llanelly; (2) on the coal-washing machinery used by the Bochumer Verein, by Mr. F. Baare, Bochum; (3) on the manufacture of anthracite pig iron, by Mr. J. Hartman, Philadelphia, U.S.A. Adjourned papers: (1) On recent results with gas puddling furnaces, by Mr. R. Smith-Casson, Brierly Hill; (2) on a new form of gas sampler, by Mr. J. E. Stead, F.C.S., Middlesborough. New papers: (3) On the use of raw coal in the blast furnace, by Mr. I. Lowthian Bell, F.R.S., &c., Rounton Grange, Northallerton; (4) on the behaviour of armour of different kinds under fire, by Capt. C. Orde-Browne, Lecturer on Armour at Woolwich; (5) on recent progress in iron and steel shipbuilding, by Mr. William John, Barrow-in-Furness; (6) on the most recent results obtained in the application and utilisation of gaseous fuel, by Mr. W. S. Sutherland, Birmingham. In addition we believe that a paper may be expected on the important subject of iron or steel sleepers, as now used largely in Germany, in place of the timber sleepers with which we are all familiar; and possibly papers on other subjects may be at the last moment forthcoming. It will be seen that the programme presents several features of interest. Mr. Lowthian Bell, we have every reason to believe, will exhibit the conditions attending the use of raw coal instead of coke in the blast-furnace in a clearer and more satisfactory form than has ever before been achieved. Again, the great duel being fought out between armour and guns is always a matter of keen interest, and Capt. Orde-Browne's position as a skilled and yet independent observer of the struggle gives him a special right to speak upon it. He will be able to give the last results obtained with the compound or steel-faced armour now coming so much into fashion. The ordinary business of the meeting includes the election of members, reading of the Council's report, and the presentation of the Bessemer gold medals to Mr. E. P. Martin, late of Blaenavon, but now General Manager of the great works at Dowlais, and to Mr. E. Windsor Richards, General Manager to Messrs. Bolckow, Vaughan, and Co., Middlesborough, to whom we are indebted for the practical realisation of the basic process of steel-making.

COL. KINCAID, Political Agent, Bhopal, writes to us under date March 30:—"We have had a renewal of the after-glow here lately, but not nearly so intense as we had in September October, November, and part of December. The natives of the country have naturally been much exercised by the prolonged phenomenon, and still believe it portends war and tumult." Col. Kincaid also sends us an extract from Malcolm's "History of Persia," referring to an "extraordinary change in the appearance of the sun" in the year 1721, which greatly alarmed the Persians of the period.

MR. SYDNEY HODGES, of Ealing, sends us a letter he has received from Mr. C. St. Barbe, of Wellington, New Zealand, dated February 17, on the green moon. "The phenomenon of a green moon," Mr. St. Barbe writes, "has been distinctly visible here during the last week or two. The colour was sufficiently decided to attract the attention of many people, and the local journals took notice of it. The moon at the time was east of north (though very little), while the crimson after-glow was in the south-west, and consequently at the back of an observer looking at the strange colouring of the moon. I am not aware whether these positions would have anything to do with the question of complementary colours, as I know nothing about such matters, and I am unfortunately unable to say whether the green tint appeared on the moon before the crimson after-glow appeared, as the latter has become such a commonplace occurrence here as hardly to be noticed." Mr. Hodges has also received a letter from his son, who reached New Zealand from Calcutta on February 13. In it he says: "I don't know whether you heard of the volcanic eruptions in Java last September. To show what a quantity of stuff was thrown up, we were sailing for *twelve days* through a sea of pumice-stone. You could see nothing else as far as the horizon on every side, and this four months after the eruption."

DR. L. WALDO, *Science* states, has just completed the erection of a normal clock at the Yale College Observatory, to be used as a mean-time standard in the horological work of that institution. The movement and pendulum are parts of the gravity escapement clock built by Richard Bond (No. 367), and which had a phenomenal record under Mr. Hartnup at Liverpool, and later under Prof. W. A. Rogers of Cambridge. The case, from Dr. Waldo's designs, is built of cast-iron, with planed back and front, to which are clamped the plate-glass doors. The entire case rests upon two brick piers, which rise to the height of the movement, and insure stability to the pendulum suspension. Thermometers, a barometer, and a cup of calcic chloride are placed within the case, which can be exhausted to any barometric pressure desired by an air-pump attached to its side. The escapement and arc of vibration can be observed and adjusted with the greatest accuracy. The clock is erected in the clock-room of the Observatory, which was specially built to secure uniformity of temperature.

CAPTAIN BLAKISTON, who has been resident in Japan for more than twenty years, has recently issued an amended list of the birds of that country, with the ornithology of which he certainly possesses a better practical acquaintance than any living man. The list is founded on a previous catalogue, published in 1882 by Capt. Blakiston and Mr. H. Pryer, but the species are now arranged geographically, so as to show the distribution of birds through the different islands of Japan. The author draws attention to the natural division in the fauna of Japan, which is marked by the Strait of Tsungaru, to the southward of which the true Japanese avifauna is emphasised, while north of this strait the avifauna is Siberian in character.

THE following meetings of the Society of Arts have been arranged:—Ordinary meetings (on Wednesday evenings)—April 30, "The New Legislation as to Freshwater Fisheries," by J. W. Willis-Bund. May 7, "Bicycles and Tricycles," by C. V. Boys. May 14, "Telpherage," by Prof. Fleeming Jenkin, F.R.S. May 21, "Telegraph Tariffs," by Lieut.-Col. Webber, R.E. May 28, "Primary Batteries for Electric Lighting," by I. Probert. In the Foreign and Colonial Section the following paper will be read on April 29, "The Transvaal Gold Fields; their Past, Present, and Future," by W. Henry Penning. In the Applied Chemistry and Physics Section on May 8 a paper will be read on "Cupro-Ammonium Solution and its Use in Waterproofing Paper and Vegetable Tissues," by C. R. Alder Wright, F.R.S., D.Sc.; and on subsequent evenings in the Indian Section the following papers will be read:—"Economic Applications of Seaweed," by Edward C. Stanford, F.C.S. May 9, "Indigenous Education in India," by Dr. Leitner. May 30, "Street Architecture in India," by C. Purdon Clarke, C.I.E. This paper will be illustrated by means of the oxy-hydrogen light.

DURING the next few weeks the following Penny Lectures will be delivered on Tuesday evenings at the Royal Victoria Coffee Hall, Waterloo Road:—April 22, "Camping out on the Thames," by the Rev. P. H. Wicksteed. April 29, "A Visit in the *Sunbeam* to the West Indies," by Sir Thomas Brassey, M.P. May 6, "Ice, and its Work in Earth-shaping," by Dr. W. B. Carpenter. May 13, "Fire, Electricity, and other Forms of Power," by Mr. Vernon Boys. May 20, "A Working Man's Dinner," by Prof. H. G. Seeley. May 27, "The Recent Eruption of Krakatão," by Mr. J. Norman Lockyer.

WE have received two pamphlets on the vivisection question, viz. "Vivisection in its Scientific, Religious, and Moral Aspects," by E. P. Girdlestone (Simpkin, Marshall, and Co., pp. 68, price one shilling), and "The Utility and Morality of Vivisection," by G. Gore, LL.D., F.R.S. (F. W. Kolkmann, 2, Langham Place, W., pp. 32, price sixpence). These pamphlets are alike in that their authors argue the question on general grounds of common sense. The essay by Mr. Gore is issued by the Association for the Advancement of Medicine by Research, and is an admirable contribution to the subject of which it treats. Not being himself a physiologist, Mr. Gore's pleading is of all the more force from its non-professional character; while the fact of his being so busy a worker in other departments of science, as well as a man who has made a special study of the methodology of research, or "the art of discovery," enables him to speak not only with authority, but with unusual lucidity. The calmly forcible style in which he writes contrasts favourably with the hysterical vituperation which he quotes from the other side. This pamphlet ought to be read by every one who desires to obtain a rational as well as a truly moral view of the subject.

THE fourth edition of Henfrey's "Elementary Course of Botany" will be published by Van Voorst early in May. The morphology of flowering plants has been revised and added to by Dr. Maxwell Masters, who has also made great additions to the physiological portions, while Mr. A. W. Bennett has rewritten the sections relating to Cryptogamia. This new edition will be still further enriched by numerous additional illustrations.

HARTLEBEN of Vienna has issued the first part of a work on the oceans and their life, entitled "Von Ocean zu Ocean, eine Schilderung des Weltmeeres und Seines Lebens," by A. von Schweiger-Leichenfeld.

AT a recent meeting of the Asiatic Society of Japan (reported in the *Japan Weekly Mail*), Mr. O. Korschelt read a paper on "The Chemistry of Japanese Lacquer." The paper opened with a brief account of the source and preparation of the lacquer, and of the conditions under which it hardens to the best advantage. The interest of the paper lay, however, in the very complete discussion of the chemical constituents of the substance, and the synthetic determination of which of these were most essential. The summary of results was given in these terms:—1. The raw lacquer juice is an emulsion which contains—(*a*) a peculiar acid called urushic acid (*urushi*, the native name for lacquer), (*b*) a gum, (*c*) a nitrogenous body, (*d*) water, and (*e*) a volatile acid in traces. 2. The hardening of the lacquer juice, which takes place when the latter is exposed in a thin layer of moist air of 20° to 27° C., is due to the oxidation of urushic acid into oxyurushic acid. 3. This oxidation is caused by the nitrogenous body, which is an albuminoid and acts as a ferment.

4. The oxidation is not accompanied by hydration. The water must be present only to keep the ferment in solution, which else would not act. 5. The oxidation takes place within narrow limits of temperature, ranging from about zero Centigrade to that of the coagulation of albumen. 6. The gum seems to have a favourable influence in keeping the other substances in emulsion; but in the hardened lacquer its presence is injurious, causing it, when in contact with water, to rise in blisters. 7. By a mixture of the raw juice with urushic acid, the quantity of gum present is diminished, and the dried lacquer is enabled better to resist the injurious influence of water, besides obtaining a greater transparency. 8. The admixture of more than five parts urushic acid with one part juice weakens the action of the ferment, and so deteriorates the quality of the lacquer. 9. The gum is very similar to gum-arabic, but gives a sugar with two-thirds only of the reducing power of arabinose. 10. The ferment has the composition of albumen, except that it contains much less nitrogen. 11. Diastase and the ferment in the saliva cannot replace the lacquer ferment. 12. The difference between good and bad lacquers seems to depend mainly on the relative quantities of urushic acid and water present, the inferior lacquer having less acid and more water than the superior kind. 13. The durable quality of lacquer is a property of the oxyurushic acid, which is singularly negative in its actions, resisting all solvents tried, and affected by strong nitric acid only. In the course of the discussion which followed it was observed that probably the direct effect of the investigations would be the improvement of the lacquer process, which was peculiarly a Japanese art; also that lacquer poisoning was due to the urushic acid, which only gradually disappeared during the hardening process, the best and oldest lacquers having none at all. Sugar of lead was mentioned as the best antidote for the poison.

THE last number of *Naturen* contains an interesting report by Herr L. Stejneger of the result of his last summer's exploration of Ostrof Mednij, or Copper Island, the smallest of the Komandorski group (Commodore Islands). On his arrival the chief town was found to be nearly empty, its numerous roomy and gaudily painted houses and church having been deserted while the inhabitants had gone for the fishing season to the "Lesjbitscha," or fur-seal fishing-grounds, on the other side of a rocky promontory. The dense mists which never fail at that season interfered with the naturalist's field work, but he was so fortunate as to discover a new species of Anorthura, differing equally both in form and colouring from the earlier described *A. alascensis* of of Prof. Baird, and from the Japanese *A. fumigata*, which is believed to belong also to the Aleutian Islands. Herr Stejneger, who has given this new form the name of *Troglodytes (Anorthura) pallescens*, considers that, although essentially the same as its Norwegian representative, it is still more closely allied to the Eastern Central Asian forms. Since his visit to Copper Island Herr Stejneger has found on Behring's Island another Anorthura, which differs widely from *A. pallescens*, and which he believes may prove to be the same as *A. fumigata*, common in Kamchatka. *A. pallescens* is of frequent occurrence on Copper Island. It builds its nest in the clefts of rocks at inaccessible points, and in the sound of its note, as well as in its general habits, it resembles its European kindred. The rosy finch (*Leucosticte griseinucha*), supposed to be American, was found on the Aleutian Islands, and has not been observed, as far as we know, in any other part of the Old World. Its brilliant colouring, hoarse, unmelodious song, and its preference for steep, inaccessible, rocky peaks which abound on Copper Island, make it one of the most characteristic of the local birds. Herr Stejneger has largely availed himself of the opportunities opened to him of studying the various representatives of Otariidæ and Phocidæ, which abound on the Aleutian shores, and in his paper on *Callorhinus ursinus* (the Kólik, sea-cat of the Russians, and well known as the fur-seal of the American and English traders), he has given the readers of *Naturen* an extremely interesting and comprehensive description of the appearance, habits, and commercial importance of these valuable animals. He graphically describes the forcible tactics employed by the older seals, "Sichatchi" (Russ. husbands), in keeping the juniors, "Cholustjaki" (bachelors), within their allotted grounds, and supplies many hitherto unknown details concerning distinctive characteristics dependent upon differences of age, &c.

THE last number (thirtieth) of the *Mittheilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens* (Yokohama) commences with an article on mines and mining in Japan, by Herr Metzger—the third important work on this subject published by Germans. The writer, who has been for five years at the copper mines at Ani, professes merely to supplement the previous writings of his countrymen. Herr Metzger's account of Japanese practical mining is somewhat melancholy reading; on all hands he finds ignorance, incompetence, waste. There is a total absence of technical officials, everything appears to be in the hands of contractors, the mining law is in a most unsatisfactory condition, and the position of the foreign mining engineer is such that he can do little to remedy evils which he sees plainly. In this respect the complaint is everywhere the same. "The scope of the foreigner is much less than might be expected under the circumstances. It seems at present to be the full intention of the Japanese to do everything themselves; and at the most to use their Europeans as advisers, although their contracts call them engineers, &c. It not unfrequently occurs that foreigners get the impression that the advice of Japanese of the lowest rank, with or without technical training, is of equal weight with their own." Herr Metzger further alleges that since Europeans have been withdrawn the production of the gold mines of Sada has considerably diminished. He asserts that by avoiding the extraordinary waste caused by ignorance and mismanagement, the mineral production of the whole country could be increased by at least fifty per cent. Herr Lehmann writes on the indoor games of the Japanese. From the reports of the meetings it appears that the capital of Japan had its Fisheries Exhibition last year. There were 15,205 exhibitors—an unexpectedly large number; and, as a consequence, the Exhibition was divided into forty-seven separate exhibitions, corresponding to the various administrative divisions. This method rendered a journey through the Exhibition wearisome by constant repetition, and added greatly to the difficulties of a systematic study of the exhibits, which were not lessened by the absence of a catalogue. The number of articles connected with fishing amounted to 3967, while the various goods made from fish and water plants reached 6474. The fishing population of Japan is given at 1,601,406. Some interesting information respecting the rearing of fish in Japan is also given.

THE Tiflis *Isvestia* contains an interesting paper on the population of the Caucasus, a new census having been made in the course of the year 1882 in several of the larger provinces of the country. It appears from this census, although incomplete, that the population has much increased since the last census of 1877. In 1867 the whole population of the Caucasus was reckoned at 4,661,800; it rose to 5,391,700 in 1876-77. It is now more than 6,500,000—the total being reckoned at 6,449,850—which figure is still considered below the reality. This large increase of more than 1,200,000 in five or six years is partly due to the recent annexations (162,980 in the province of Kars, and 92,450 in the district of Batoum), to immigration, to natural increase, and to the incompleteness of the former census. As to the natural increase, due to the surplus of births over deaths, it is estimated at an average of 13 per thousand every year in the Government of Tiflis (1875 to 1880), and at 12 per thousand in the Government of Erivan. Altogether, the mortality is, however, very great, and it is compensated only by a great number of births. As to the density of population, the 224,221 square kilometres occupied by the Northern Caucasus have 10·3 inhabitants per square kilometre, which figure reaches as much as 13·6 in Transcaucasia (248,445 square kilometres), where the density of population is the same as in European Russia. The Governments of Kutais (the valley of the Rion), Erivan, and Tiflis have respectively 33·6, 20·8, and 17·8 inhabitants per square kilometre.

AMONG the recent additions to Chinese scientific literature are translations of Margutti's "Elementary Chemistry" and Fresenius's "Chemical Analysis." These works have been translated into Chinese by M. Billequin, one of the professors of the Jung Wên Kwan, or Foreign College, at Pekin.

THE Secretary of State for India in Council has appointed Mr. David Hooper, F.C.S., of Birmingham, to the Nilgiri Government Cinchona Plantations in the Madras Presidency.

THE additions to the Zoological Society's Gardens during the past week include a Ludio Monkey (*Cercopithecus ludio*) from West Africa, presented by Mr. F. W. Robinson; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. E. Drew; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. J. C. Martin; a Central American Agouti (*Dasyprocta isthmica*) from Central America, presented by Mr. Hugh Wilson; a Herring Gull (*Larus argentatus*), European, presented by Mr. Thomas Daws; a Common Viper (*Vipera berus*), British, presented by Mr. H. German; a Burchell's Zebra (*Equus burchelli* ♀) from South Africa, three Michie's Tufted Deer (*Elaphodus michianus* ♂ ♀ ♀), four Darwin's Pucras (*Pucrasia darwini* ♂ ♂ ♂ ♀), an Elliot's Pheasant (*Phasianus ellioti* ♂) from China, deposited; three Corn Buntings (*Emberiza miliaria*), British, purchased.

OUR ASTRONOMICAL COLUMN

SOUTHERN COMETS.—Dr. Oppenheim of Berlin has published elements of the comet discovered by Mr. Ross of Elsternwick, Victoria, on January 7, founded upon the Melbourne observations in *Astron. Nach.*, No. 2579, though, as he remarks, they were calculated with difficulty, owing to the existence of three oversights in the seven positions there given; hence their connection for an orbit would involve a troublesome tentative process. The position for January 17 is in error nearly two degrees.

Mr. Tebbutt has also computed elements from his own observations at Windsor, New South Wales, on January 19, 23, and 28, which represent closely the observation on February 2, the last he was able to obtain, the comet having become very faint; on January 19 he had considered it just beyond naked-eye vision. He remarks upon the discordance of his elements with those calculated by M. Barachi of the Melbourne Observatory, and observes: "I cannot account for these discrepancies, unless there be some error in the Melbourne data." We subjoin both orbits:—

	Tebbutt	Oppenheim
Perihelion Passage, 1883,	Dec. 25·30038	Dec. 25·3027
	° ′ ″	° ′ ″
Longitude of perihelion	125 44 24 ...	125 46 12
,, ,, ascending node	264 24 0 ...	264 25 14
Inclination	65 0 55 ...	65 0 51
Log. perihelion distance ...	9·491046 ...	9·49094

Motion retrograde.

The time of perihelion passage is for the meridian of Greenwich, and the longitudes are referred to the mean equinox of 1884·0. It will be seen from the close agreement of the two orbits how completely Dr. Oppenheim succeeded in eliminating the Melbourne errors from his work.

In a communication to the *Observatory* of the present month Mr. Tebbutt refers to a notice in the Sydney journals copied from a Tasmanian newspaper, reporting that a bright comet had been seen at New Norfolk at 4 a.m. on December 27, bearing about east, and a few degrees above the horizon; he had searched for it in the morning sky without success. In the *Sydney Morning Herald* of March 5, Mr. Tebbutt writes:—"Within the past few days I have received, through Commander J. Shortt, R.N., the Meteorological Observer at Hobart Town, communications respecting a fine comet which was seen in Tasmania on December 25 and 27 in the morning sky. It is described as rising above the eastern horizon a few minutes before the sun; and I am strongly inclined to the opinion that this is no other than the comet whose elements I have just communicated" (the comet found by Mr. Ross). There are difficulties, however, in the way of accepting this identification, judging from such information as we have to hand. The great increase of light near perihelion passage is not explained by the elements of the comet of January 7, which by theory would only have possessed five times the intensity of light that it had at the first Melbourne observation on the evening of January 12.

THE OBSERVATORY OF PALERMO.—In *Pubblicazioni del Real Osservatorio di Palermo, anni* 1882-83, Prof. Cacciatore, the director, has collected a large number of interesting observations made chiefly in the year 1882. Prof. Riccò's astro-physical observations of the planet Jupiter extend from December 1881 to June 1883, and his descriptions of the appearance of the disk are accompanied by eighteen well-executed tinted lithographs. An extensive series of observations of the great comet of 1882, also illustrated, follows; it was last perceived with difficulty on April 7, 1883. After the conjunction of the comet with the sun it was again sought for; with a power of 110 on the refractor, and in the best condition of atmosphere, the search was unsuccessful on three evenings in September. There are other cometary and planetary observations and an appendix with the meteorological results obtained at the auxiliary station of Valverde.

GEOGRAPHICAL NOTES

THE meetings of the International Polar Conference began in Vienna last week under the presidency of Herr Heinrich Wild, the Director of the Physical Central Observatory of St. Petersburg. In his address the President praised the great merits of Count Wilczek with regard to Polar research, referred to the lamented death, since the last conference, of the Secretary of the Polar Commission, Capt. Hoffmeyer of Copenhagen, and finally gave an outline of the work done since the St. Petersburg meeting by the various expeditions and observing stations. Herr R. Müller, Director of the Hydrographic Office at Pola, was elected secretary in the place of Capt. Hoffmeyer, deceased. The principal subject discussed at the first meeting was the determination of the minimum extent to which each expedition party is bound to work out and publish its own observations at its own expense, and the establishment of a universal form of publication of results for their easier comparison. First of all the meteorological observations were discussed in this regard. The debate turned on the uniform way of noting down the obligatory observations at each station, *i.e.* the observations of temperature, atmospheric pressure, humidity, wind, clouds, hydrometeors, rainfall, and temperature of the ground, snow and ice. Among those who have arrived at Vienna are the following:—MM. R. Lenz (Professor at the St. Petersburg Technological Institute), H. Mohn (Director of the Christiania Meteorological Institute), R. H. Scott (Director of the London Meteorological Office), Lieut. P. H. Ray of Washington, Lieut. E. von Wohlgemuth (Vienna), Herr Wijkander, Prof. Guido Cora (Turin University), Capt. Dawson (Chief of the Fort Rae Expedition), Dr. Giese of Hamburg (Chief of the German Antarctic Expedition), H. Paulsen of Copenhagen (Chief of the Danish Polar Station at Godthaab), Lieut. Payen (Paris), Dr. Snellen (Director of the Utrecht Meteorological Observatory), Aksel S. Steen (of the Christiania Meteorological Institute), Count Hanns Wilczek (Vienna). The following were expected to arrive shortly:—Prof. G. Neumayer of Hamburg (Director of the German Seewarte), Prof. E. Mascart (Director of the Paris Meteorological Central Bureau), Dr. Börger (of the Kiel Marine Observatory), Prof. Lemstrom (Helsingfors), E. Riese (Chief of the Finnish Polar Station at Sodankyla).

THE *St. Petersburger Zeitung* contains the following details concerning the expedition which Col. Prjevalsky is now leading in Thibet. The points of departure of the expedition were Kiakhta and Ourga. From thence it was to go to Tsaidam by Alashan and Koko-Nor. In Tsaidam, at the foot of Burkhan Buda, it was the intention to establish a camp, and leave behind a section of the party and of the escort. Col. Prjevalsky, with his companions, will push forward to the sources of the Yellow River, and even to the towns of Chambo and Batanou. If the circumstances are propitious, the expedition will devote the spring and summer of 1884 to the exploration of the region of Sifanei, between Koko-Nor and Batanou, where it will surely find abundant natural riches to explore. In autumn the expedition will return to its encampment. A part of the baggage will be sent to Gast, in Tsaidam, where they will establish a second camp. From Gast the expedition will traverse Northern Thibet in the direction of Lhassa, and will try to penetrate as far as the Lake Tenegri-Pora, to reach afterwards, if circumstances permit, either the province of Dsang, or to the Brahmaputra. If not successful, however, the expedition will return part of the way and then go northwards to Ladak and to Lake Daigro-Jum-Tcho. From thence it will return to Gast, and try afterwards to go across the plateau of Thibet in another direction. From Gast, which they expect to reach in the spring of 1885, a part of the expedition will go towards Lob-Nor, and the other part towards Keria, that they also may reach Lob-Nor by way of Tcherkin. The two sections of the expedition will afterwards go together to Karakorum, and along the Khoton, and then return by Alsa to Asiatic Russia, near the Lake Issak-kul. Col. Prjevalsky left St. Petersburg on August 3, 1883, accompanied by Sub-Lieutenant Roborovsky, his assistant, and a volunteer, Kozloff. At Ourga they were joined by twenty soldiers for an escort, and on November 8 they left Ourga to cross the Desert of Gobi. The telegram just received from Alashan (dated January 20) tells of the safe arrival there of the expedition.

GEOGRAPHERS will be glad to find in the last volume of the *Izvestia* of the Caucasus Geographical Society a number of astronomical determinations of positions of places in the Transcaspian region, by M. Gladysheff. We find in the list a number of points in the oases of Akhal-tekke and Merv, and in Khorassan, and notice that the exact position of Sarakhs (western corner of the citadel) is 36° 32′ 14″·5 N. lat. and 61° 10′ 10″ E. long., 860 feet above the sea; that of Merv (garden at Kaushut-khan-kala) 37° 35′ 18″·3 N. lat. and 60° 47′ 16″ E. long., 900 feet above the sea; and that of Meshed (cupola of Imam Riza) 36° 17′ 25″·6 N. lat. and 59° 37′ 27″ E. long. The same volume contains a great number of heights measured in Asia Minor by Russian officers.

THE last issue of the *Izvestia* of the Russian Geographical Society contains a preliminary report of a journey made by MM. Adrianoff and Klementz in the still little-known islands to the south-west of Minusinsk; a note by MM. Hedroitz and Lessar, being a reply to M. Konshin's paper on the Kara-kum sands and the former bed of the Amu; a note, by M. Malakhoff on the remains of prehistoric man on the Nyeman, close by Druskeniki; the necrology of Admiral Putyatin, by Baron Osten-Sacken; and a note by M. Piltchikoff, on a magnetic anomaly between Kursk and Kharkoff.

ON THE PROGRESS OF GEOLOGY[1]

IN addressing you to-night at the opening of the session 1883 of Canterbury College, may I be allowed to appeal first to your kind indulgence? On an occasion like this you have a right to expect that only the best and most refined English should reach your ear; and if this to-night is not the case, you will, I trust, be lenient with me, as only very few foreigners have ever been able to master the beautiful and expressive English language so thoroughly that they would not now and then offend the ear of an educated audience.

When I look round me in this fine hall, and see before me such a large audience, of which a number consists of graduates of Canterbury College, it appears almost like a dream and not a reality—a reality of which we have every reason to be proud.

It is about sixteen years ago that a few earnest men, having the intellectual advancement of Canterbury at heart, met and proposed to found a university in Christchurch; but they were told by a not inconsiderable number of our citizens, some in high positions, that we were about a hundred years in advance of the wants of the colony. However, we persevered, and at last succeeded; and the best proof of the correctness of our views is the number of the graduates of the New Zealand University, of whom there are now twenty-one Masters of Arts and forty-nine Bachelors of Arts, together seventy; of whom Canterbury College can claim twenty-nine of its own, many of whom would be an ornament to any university of the home country.

And although the greater portion of our graduates mostly apply the knowledge gained to the education of others, they continue their studies for their further intellectual progress long after they have gained their well-earned degrees.

To my mind no more ennobling or higher sphere can be selected by anybody than that of the teacher. What mental energy, what moral devotion are required in the teacher, who can only be successful if he has his whole heart in the work, so that the chain of human sympathy, the most powerful tie in mankind, unites him with his pupil. In a young country, where wealth is generally considered to give power, position, and influence, and the "*auri sacra fames*" is much developed, only a refined mind can gladly and willingly turn away from those pursuits by which wealth is more easily obtained, in order to devote himself entirely to the education of the young.

Moreover, nothing shows us more clearly than teaching that we have only put our foot on the first step of the ladder leading to knowledge. We remain students our whole life; and I trust that none of our graduates will ever overrate the step gained, but that they will consider that the degree obtained has only given them an insight into the dominion of Knowledge, and has shown them how much they have still to learn; and that in fact they have become masters of the art how to learn to the advantage of themselves as well as of others.

Before entering into the subject I have chosen for to-night's address, I wish to make only a few remarks upon the development the University of New Zealand ought to take, so as to satisfy the present and future wants of our population. It was only to be expected that in the beginning its founders should have been guided by the curriculum of the great centres of learning in Great Britain, although even then some of the newer improvements were not adopted; but I may point out that under the different circumstances in which we live in a colony, we ought to have more cosmopolitan views, and profit by the experience of those States and communities which our conditions resemble most. In fact, the University of New Zealand ought to be eclectic, and to select for assimilation in its constitution the best as to manner and matter of teaching from all parts of the world.

According to my views it ought not to be at present the highest aim of a university course to offer a mass of knowledge of a chaotic character in a number of subjects, but to make the student acquainted with the general principles of the stock of knowledge possessed by the world and its application to life; to know in what direction that general stock is most deficient, and in what manner it can be augmented and made more useful both intellectually and practically.

The study of philosophy, in the highest and most general acceptance of the term, is one of the greatest wants for any university that intends to educate thinkers, men and women who not only wish to use their acquired knowledge for earning their daily bread, but to advance the human understanding.

Advancing to the subject upon which I wish to address you to-night, I have thought that some remarks on the progress geology has made and is daily making would not be inappropriate. I should also like to show, though owing to the short time assigned to me this can only be done in a fragmentary manner, how from an empirical science it has gradually been raised to be an inductive science fully deserving, as far as actual observations go, to claim the position of an exact science.

If we consult "The Cyclopædia, or an Universal Dictionary of Arts and Sciences," by E. Chambers, F.R.S., London, four large folio volumes, of which the first appeared in 1779 and the fourth in 1783, an excellent work, for which some of the most eminent men of the last century wrote, we find that the word geology, or geognosy, did not exist at that time, the principal information upon the formation and constitution of our earth being contained in the articles on basaltes, earth, fossils, geography, lithology, marine remains, mineralogy, mountain, rocks, stone, and volcano.

The explanation of the formation of "stones" is in many instances exceedingly erroneous, and appears ludicrous to us; whilst the explanation of the nature and occurrence of fossils is given quite correctly, although the theory of Tournefort, pro-

[1] An opening address delivered to the students of Canterbury College on March 28, 1883, by Julius von Haast, Ph.D., F.R.S., Professor of Geology and Palæontology in Canterbury College (N.Z. University).

posed in 1702 to the Royal Academy of France, that all stones, fossils included, were derived from liquid stone seeds, is gravely considered and rejected.

The description of volcanoes, both active and extinct, is also given in a lucid manner; but the opinions as to the cause of vulcanicity are sometimes very peculiar, including the theory of Dr. Lister—that they are originated by an inflammable mineral called pyrites.

The origin of basalt (basaltes) is correctly given, according to the researches of Desmarest in Auvergne, and Raspe in Germany, so that before Werner no erroneous views on that subject were held.

But it is a most remarkable fact that there was not even an attempt made to give an explanation of stratigraphical geology, and how the different rocks were formed, or to connect certain sets of fossils with certain rocks in which they occur; so that in many respects we can claim that geology is a child of the last hundred years.

Abraham Gottlob Werner, the great teacher of the Freiberg Academy of Mining, may be considered one of the founders of modern geology. In 1785 he delivered the first course of geognosy, as distinct from mineralogy, and by his great knowledge of all matters connected with the latter science and mining, and his excellent method of teaching, he had an enormous influence upon the advancement of geology. Therefore, as far as I am aware, the word geognosy was first used two years after the last volume of Chambers' "Cyclopædia" appeared.

A great retrograde step was, however, made by Werner when he brought out his famous theory of the aqueous origin of basalt, usually named the theory of Neptunism. After the war between the Neptunists and the Plutonists (those who maintained the igneous origin of basalt) had been raging for some years, most of the disciples of Werner—acting as partisans, and instead of trying to elucidate the truth, were only bent upon making by all means in their power the cause advocated by them victorious—for a time managed to get the upper hand. Those scientific men, who knew from their own experience that Werner's doctrines on the subject were incorrect, preferred to retire from the contest, and refused to fight with the same unfair weapons.

Of equal, if not of greater importance, are the labours of James Hutton, who, in 1788, published his "Theory of the Earth," in which, for the first time, the complicated structure of the surface of the earth is explained by the agency of natural forces, still at work at the present day. With this the foundation of modern geology was securely established, and though in some respects the great Scotch philosopher went too far, his system was, nevertheless, the only true one on which his successors could build that branch of knowledge now claiming a prominent rank amongst its sisters as an inductive science. And when William Smith, the modest English land surveyor, in 1790 published his "Tabular View of the British Strata," in which the first attempt was made to connect certain fossils with certain strata, an attempt turning out a masterpiece of patient research and skill, a further great step was made in advance, and instead of merely theorising on disconnected facts, the greater portion of geological students began to rely more upon the facts collected by them and others, than upon speculative views, however fascinating they might be.

In entering upon a short review of the physics relating to the great system of which our earth is only a very inconsiderable speck, we find that although men of the highest scientific merit had tried to explain the origin and nature of the Cosmos, and the laws by which it is governed, not one speculation had been adopted at the time of the publication of the "Cyclopædia" of Chambers, as possessing all the necessary precision for the entire satisfaction of inductive reasoning.

It was only at the end of last century that Pierre Simon Laplace published his two great works, "Exposition du Système du Monde" in 1796, and "La Mécanique céleste" in 1799. This cosmogony, usually called the "Nebular Hypothesis," has hitherto stood the test of inquiry nearly a whole century; all the facts—and they are innumerable—tending invariably to testify at least to the great probability of its general correctness. In justice I ought here to mention that Immanuel Kant published in 1755 his cosmical theories in his work "Allgemeine Naturgeschichte und Theorie des Himmels," in which the great Königsberg philosopher came to the same conclusions afterwards so convincingly demonstrated by the French mathematician.

But when we leave the Cosmos and confine ourselves to our small planet, we find ourselves surrounded by such difficulties that we appear just as far now from a true conception of the constitution of the earth's interior as our predecessors were at the beginning of this century.

Numerous theories, based upon careful calculations, as to the thickness of the crust of the earth have been advanced. Some physicists give to our earth so thin a crust that it has been compared to the rind of an orange, the fruit inclosed in it representing the molten matter of the globe; others affirm that the crust is of much greater thickness, while there are some who maintain that our planet has cooled so thoroughly that it now forms a mass of rock of various density from the surface to the very centre. Other theories (or, better stated, hypotheses) giving to our globe a crust of more or less thickness, with a hard metallic nucleus in the centre, and matter in a high state of fusion filling the space between both, have been advocated by other scientific men, and mathematical proofs in support have not been wanting. However, objections apparently fatal to them all have been brought forward at one time or another by physicists, astronomers, or geologists, according to their particular line of study, and we can therefore only wait patiently and follow attentively the careful researches continued in all civilised countries, applying at the same time every new discovery to the elucidation of a problem, the more tantalising as its solution has for many years appeared to be within our grasp.

The great hopes that the deep borings lately obtained in artesian wells, or careful temperature observations in deep mines, would supply us with some material for advancing this question, by offering important and reliable data of a uniform character, have not been fulfilled. It appears, on the contrary, from the deep borings at Sperenberg, in Germany, reaching nearly to 4200 feet, that the increase of heat exhibits a remarkable retardation of its rate the deeper we descend. And even if we take convection and conductivity of the rocks into account, there are scarcely two localities where the same ratio of increase in the temperature has been observed, in some that ratio being more than treble that of others. There may once have been a uniform cooling of the original crust of the earth, now almost entirely removed or remodelled, but there is no doubt that this difference in the increase of temperature depends now either upon local generation of heat by hydro-chemical action or mechanical agencies of enormous power still at work. Thus in localising the variable increase of temperature, the *vera causa* both for the crumpling and metamorphism of rocks, for the formation of mountain chains, as well as for the origin of volcanic action, might be traced with more reliance than to seek to establish a general law that most probably no longer existed when the strata accessible to our examination were formed.

Leaving the dominion of theory and returning to the actual work of the geologist in the field, I need scarcely say that the task already accomplished has been truly gigantic. Patient research in the civilised countries of Europe, in the United States of North America, and most of the English colonies, as well as the work of travellers to almost every part of the globe—of the latter I wish only to allude to Baron von Richthofen's excellent late researches in China—have made us acquainted with such remarkable and innumerable data that it is impossible for any man, however studious he may be, to gain more than an imperfect knowledge of the material already accumulated.

The relations of the plutonic, metamorphic, sedimentary, and volcanic rocks to each other have been clearly defined, and most valuable facts have been brought together, from which the past history of our globe is being constructed, while the palæontologist has done his work equally well in classifying the wonderfully complex animal and vegetable life, always in harmony with the conditions of the earth's surface, gradually and during untold ages reaching, by evolution, the present stage of existence and perfection.

It would lead me too far to enter into a discussion of all the theories advanced as to the cause or causes by which mountain chains and seas have been formed, and volcanoes and earthquakes—because in most instances the two latter are intimately connected with each other—have been originated. Elie de Beaumont's theory of the sudden upheaval of parallel mountain chains, first published in 1833, although at one time finding great favour on the continent of Europe, was never adopted by any geologist of note, the teachings of Hutton and Lyell leaving no room for the doctrines of the paroxysmal school. Moreover, when the size and direction of mountain chains were taken into account, and the rocks composing them were carefully examined, it was found that the explanations offered by the eminent French geologist could not be adopted.

Many valuable publications have been issued upon these subjects, of which those of Robert Mallet may in many respects claim our greatest attention. Another work of great value is that of Prof. E. Suess, the eminent Professor of Geology in the University of Vienna, "Die Entstehung der Alpen," the formation of the Alps, in which this difficult question is treated in a masterly manner. Prof. Green's "Physical Geology" contains also an exhaustive *résumé* of the physics of the earth's crust, in which all the newest researches and theories are thoroughly examined and sifted by an excellent observer and practical geologist. However, there is another distinguished geologist and physicist, Constant Prevost, whom I should not omit to mention, he having already explained, in 1822, the elevation of mountain chains by tangential and lateral pressure, now mostly adopted as the correct theory. The deep-sea dredgings have also offered us considerable material to elucidate the former history of our globe, both from a stratigraphical and palæontological point of view.

The oscillation of land and sea is another subject of great importance that has hardly received that attention it deserves, whether we take the so-called glacial period into account or not. There may be with many geologists the fear of appearing heterodox if they state their belief that the hydrosphere is, like the lithosphere, subjected to considerable oscillations, by which great changes in the climate of the globe may have been brought about in past geological ages. For years I have held and stated this opinion.

However, I find that lately a great deal of attention has been paid to this subject. Thus, for instance, Ph. Fischer, Heinrich Bruns, and others, in discussing pendulum observations, have come to the conclusion that the sea-level is not a regular spheroid, but may vary many hundreds of feet even along the same parallel of latitude. Dr. Penck will also explain raised beaches and other signs of the glacial period by the oscillation of the sea-level. Penck's views in this respect are different from those of Adhemar and Croll.

Another factor for explaining great changes on the earth's surface, brought about in geological periods long past, has lately been put forward under the name of Tidal Evolution, a very ingenious theory, first worked out in its entirety by G. H. Darwin. It is based upon the action of the moon, once a part of our planet, on the earth, producing the tides and retarding its motion, as well as upon the reaction of the earth upon its satellite. Gradually the moon was driven away from our planet, and the length of day has thus at the same rate become more considerable.

However, when Prof. Robert Ball, in Dublin, and others attempt to make out that the former much larger tides, when the moon was closer to the earth, formed a powerful agent for the destruction of rocks existing at that time, and for the formation of newer beds from them, by which the thickness of the older sedimentary and fossiliferous strata can be explained, I think we have to pause before we can accept such a sequence.

Moreover, according to Sir William Thomson, there has not been any great change in the ellipticity of the earth's figure since its consolidation, consequently Mr. Darwin's views as to higher tides have to be modified, as he presupposes a more considerable ellipticity for his calculations. However, even assuming Prof. Ball's calculation, that when the moon was only 40,000 miles distant from the earth the tides at that time would rise and fall between 600 and 700 feet twice in twenty-four hours, to be correct, I have no doubt that it was long before the Cambrian or lowest fossiliferous rocks with which we are acquainted were deposited. The occurrence of numerous fossils in the oldest beds, belonging to animals that could live only in clear water, and minute ripple marks on the rocks, speak clearly against Prof. Ball's hypothesis.

This speculation in physical geography has already been tested by various geologists to account for the so-called marine denudation. This expression was first introduced by Sir Andrew Ramsay for the higher portions of ridges over large areas, that, if laid down on an imaginary plane, appear to have once formed one surface with a very gradual slope in one direction.

However, this peculiar appearance can, as I have repeatedly suggested in former publications, be easily explained by the fact that when the land gradually rose above the sea-level, abrasion on a gigantic scale must have taken place, by which, in the case of our Southern Alps, the whole had the appearance of a shallow dome, of which the western side was much steeper than the eastern, till the subaërial erosion by atmospheric agencies, or, as I called it, ridge making, took place.

Before leaving this subject, to which I have devoted more time than perhaps I ought to have done, I may add that many speculations have been built upon it. Thus, Mr. O. Fisher attempts to prove that the ocean basin represents the scar whence the mass forming the moon separated from the earth.

Another cause of gradual retardation in the rotation of our planet, and to which, as far as I am aware, very little attention has hitherto been paid, is the increase of the bulk of our planet by meteorites and cosmic dust.

There is not the least doubt in my mind that matter, even in the most diffused state, cannot leave the outermost or gaseous portion of our planet, but that an enormous amount of matter in the form of meteorites must have been accumulated year by year. If we add to this the cosmic dust falling upon the surface of the earth, which, according to a calculation by Nordenskjöld, may amount to half a million tons yearly, the size of our planet must have been gaining in dimensions and weight to an almost inconceivable degree, even since a rich and diversified flora and fauna inhabited it. But even assuming that Nordenskjöld's estimate is far too high, and reducing it to a tenth, or to 50,000 tons yearly, the result of any calculation upon this basis is most astounding. Thus, if we take only a period of twenty millions of years, a short interval in the life-history of our planet, the cosmic dust falling during that time would add not less than 1,000,000,000,000 or one billion of tons.

And this result is obtained without accounting in any way for the further addition by the fall of meteorites, without doubt of very considerable magnitude. Such a factor, as Prof. von Nordenskjöld forcibly points out in his last work, ought certainly not to be overlooked if we wish to account for various changes in the form, position, and rate of rotation of our planet since it began to consolidate.

I am well aware that several scientific men, who have carefully examined some of the cosmic dust, have come to the conclusion that it is in most cases of terrestrial origin; but the fact remains that some of the dust collected shows its cosmic origin by its constituent parts, and that all the meteorites reach us from far beyond the atmosphere of our earth.

The importance of the great doctrine of evolution as first fully established by Darwin cannot be overestimated by the palæontologist. Applying the leading facts of the origin and distribution of animal and vegetable life, as at present existing, to the numberless past generations preserved in the marvellous stone-book of Nature, he is able to unravel more fully their history, to account for the missing leaves, and to estimate at their just value those few remaining, and of which he now and then is privileged to decipher a small portion. Darwin himself, in his classical chapter "On the imperfection of the geological record," in his "Origin of Species," has pointed out to us in his usual masterly manner how to avail ourselves of the scant material at our command, and how future discoveries, adding to the palæontological stock, will open out new vistas in the past history of our globe.

I need scarcely add that every new addition to our knowledge will assist us to gain more fully day by day an insight into the harmonious unity of the whole.

It is not yet a quarter of a century (1859) since the "Origin of Species" appeared, but if we compare our knowledge of palæontology at that time with that obtained at present, we find that striking progress has been made. Instead of a collection of facts, more or less loosely connected, we now possess a system of remarkable strength and harmony, a powerful aid to an inductive science like geology.

Evolution might be compared to an architect, who succeeds in raising an edifice of pure and noble proportions, placed upon a stable and firm foundation, from a large accumulated material of finely and ingeniously wrought building stones stored up promiscuously without any apparent plan or order.

Since the appearance of the "Origin of Species" I have always held this opinion; and I may be allowed to mention that as far back as 1862, in my opening address as first president of the Philosophical Institute, I spoke of this incomparable book as "the great work of the age."

The researches of the palæontologist have shown already convincingly that there are innumerable intermediate links between present species and those which lived in past ages. I may here, to give only one instance, refer to Huxley's important researches into the relations of the members of the family Equidæ, the Anchitherium, Hipparion, and Equus. At the same time the gulf between the different classes of vertebrates is being gradually bridged over by careful research. Thus Prof. O. C. Marsh has shown that the jurassic bird Archæopteryx from Solenhofen is closely connected with the Dinosaurs, generally considered to be most nearly allied to birds. Archæopteryx has besides true teeth in sockets, bi concave vertebræ, the pelvic bones are separate, and the metatarsals either separate or at least imperfectly united. American fossil birds, such as Ichthyornis, have also bi concave vertebræ (like fishes and some Saurians), and teeth in sockets. The skull of *Otontopteryx toliapicus*, found in the Isle of Sheppey, in the London Clay, has also true teeth in sockets.

There is, however, in palæobotany still a great deal that is in many respects unsatisfactory and inconclusive. This is mainly owing to the fragmentary material at our command, consisting mostly of leaves, the determination of which in many instances may lead us to wrong inferences. To give only one instance, I wish to refer to O. Feistmantel's latest researches on the palæozoic and mesozoic flora of Australia, with which our own fossil flora is closely connected.

The eminent palæontologist of the Indian Geological Survey comes to the conclusion that Phyllotheca, in Europe and Siberia of jurassic age, is palæozoic in New South Wales, and upper mesozoic in Victoria; Glossopteris, palæozoic in Australia, is jurassic in India and Russia. Noeggerathiopsis, beginning to appear in palæozoic beds in Australia, is represented by the jurassic Rhiptozamites in Siberia.

It is unquestionable that such conclusions, before they can be adopted, have to be confirmed by evidence of a still more reliable character than the present material for comparison can have afforded.

Returning to the physical conditions under which the surface of our globe has been formed and is still forming, I may here point out that since evolution has been adopted by most scientific men as a beacon to guide them to truth, the greater portion of the so-called uniformitarian school of geologists, following in the footsteps of Lyell, has become somewhat modified in its views, and may now be called the evolutional school. But let me hasten to add that Lyell himself, with his great love for truth, may be claimed as one of its first disciples, he having reviewed his own writings by the light Darwin held up to us, which is sure to advance geology even more than we can at present realise.

There is one question of great importance, in the solving of which both the geologist and the palæontologist have to go hand in hand with the archæologist. There is no doubt that the human race existed already in pliocene times; and if we can trust the reports of discoveries in Portugal and other portions of Southern Europe, man may have lived as early as the miocene age.

However, we want further and clearer evidence before this latter view can be adopted. If we consider the enormous space of time that separates us from our first ancestors, the oldest historical facts preserved seem to us as of to-day; and taking into account the wonderful progress the human race has made from the condition of the cave-dwellers, with their rude stone implements, to our present state of civilisation, we ought to look proudly upon the position mankind has attained. And we can therefore scarcely conceive the high degree of perfection, both physically and mentally, the human race may reach in future.

Although, as far as our researches go, the autochthones of New Zealand cannot boast of great antiquity when compared with the inhabitants of the Northern Hemisphere or of the tropical regions, there is nevertheless strong reason to believe that this country has been inhabited for a much longer time than was formerly generally assumed.

It is, however, possible, that some of the traces we have hitherto found of the oldest occupancy of these islands may have been left behind by occasional visitors, adventurers in search of new countries, or by crews of wrecked ships coming from distant shores.

But we have only begun to examine these questions; and although, as is always the case, the wiseacres will first shake their heads, if our researches are only continued without fear and without preconceived conclusions, we may be certain that valuable results will be in store for us.

The existence of loess beds, often of considerable thickness, in numerous parts of New Zealand, of which many have begun to be deposited before the beginning of our great glacier period, will be of great use, and offer us an excellent field for research in this direction. These beds being of subaërial origin, not only the remains of land animals are preserved in them, but we shall find in them also the traces of man. I may here mention the strange fact that the true nature of these beds has for a long time been misunderstood and misinterpreted by most English geologists. Even in the last edition of Lyell's "Elements of Geology," the loess of the Rhine is described as fluviatile loam, whilst the author himself shows that only the remains of land shells and land vertebrates are embedded in it. It has always been inconceivable to me how such an error should have remained so long uncorrected; the more so as, as far back as 1847, Alex. Braun, in "Leonhard and Bronn's Neues Jahrbuch," has shown the true state of things, and German geologists have repeatedly furnished new facts in illustration and given analyses of loess and of recent and older fluviatile deposits of the Rhine for comparison.

But, as I have previously pointed out, the peculiar nature of the loess deposits—the minute vertical capillary structure caused by the empty spaces once filled by the rootlets of innumerable generations of grasses—is a sure guide even to a tyro in geology. This structure amongst these localities is well exhibited in the fresh cuttings near Lyttelton.

I fear that the time allotted to me will not allow me to enter more fully into a review of what has already been accomplished to make geology an inductive science, and what remains still to be done, but I may be permitted to allude to one of the principal causes that retarded geology from taking its present position. This was the fear of the student to enter into antagonism with the established religious cosmogony. It is unnecessary to allude to the middle ages, because the stake or disappearance in the dungeons of the holy inquisition were the rewards of fearless physical research, and men like Galileo and Descartes were obliged to use often evasive language, unworthy of such great thinkers, in order to preserve their lives or freedom, and therefore my remarks will only apply to our own times. In proof of this I wish only to quote one work, "Vestiges of the Natural History of Creation," of which the first edition appeared in 1844. If we read this book at the present time, we can scarcely understand how it could have created such intense indignation amongst a large portion of the community, or that so much could have been written against it. Lyell himself, when publishing his "Principles of Geology," a work of a true philosopher, was, judging from some letters in his biography, very careful not to hurt too much the prejudices of his time, not wishing to mar the usefulness of his work. Even at the present time are there not thousands and thousands of well-meaning but narrow-minded persons, at once entering into strenuous opposition when there is any reference made to scientific cosmogony differing from that they have been accustomed to from their youth, and that cannot stand before the light of modern research?

However, the great principle of liberty for the teacher, so well expressed by the German word "Lehrfreiheit," cherished by the whole Teutonic race, a principle even preserved in the German universities during the darkest days of absolutism, is a safeguard of inestimable value, possessed fortunately also by our New Zealand University, the *Alma Mater* for whose advancement to the highest attainable position and general utility we ought willingly to devote our whole strength and best energies.

DUST-FREE SPACES [1]

WITHIN the last few years a singular interest has arisen in the subject of dust, smoke, and fog, and several scientific researches into the nature and properties of these phenomena have been recently conducted. It so happened that at the time I received a request from the Secretary of this Society to lecture here this afternoon I was in the middle of a research connected with dust, which I had been carrying on for some months in conjunction with Mr. J. W. Clark, Demonstrator of Physics in University College, Liverpool, and which had led us to some interesting results. It struck me that possibly some sort of account of this investigation might not be unacceptable to a learned body such as this, and accordingly I telegraphed off to

[1] Lecture to the Royal Dublin Society by Dr. Oliver J. Lodge, April 2.

Mr. Moss the title of this afternoon's lecture. But now that the time has come for me to approach the subject before you I find myself conscious of some misgivings, and the misgivings are founded upon this ground: that the subject is not one that lends itself easily to experimental demonstration before an audience. Many of the experiments can only be made on a small scale and require to be watched closely. However, by help of diagrams and by not confining myself too closely to our special investigation but dealing somewhat with the wider subject of dust in general, I may hope to render myself and my subject intelligible if not very entertaining.

First of all, I draw no distinction between "dust" and "smoke." It would be possible to draw such a distinction, but it would hardly be in accordance with usage. Dust might be defined as smoke which had settled, and the term smoke applied to solid particles still suspended in the air. But at present the term "smoke" is applied to solid particles produced by combustion only, and "dust" to particles owing their floating existence to some other cause. This is evidently an unessential distinction, and for the present I shall use either term without distinction, meaning, by dust or smoke, solid particles floating in the air. Then "fog": this differs from smoke only in the fact that the particles are liquid instead of solid. And the three terms, dust, smoke, and fog, come to much the same thing, only that the latter term is applied when the suspended particles are liquid. I do not think, however, that we usually apply the term "fog" when the liquid particles are pure water: we call it then mostly either mist or cloud. The name "fog," at any rate in towns, carries with it the idea of a hideous, greasy compound, consisting of smoke and mist and sulphur and filth, as unlike the mists on a Highland mountain as a country meadow is unlike a city slum. Nevertheless the finest cloud or mist that ever existed consists simply of little globules of water suspended in air, and thus for our present purpose differs in no important respect from fog, dust, and smoke. A cloud or mist is, in fact, fine water-dust. Rain is coarse water-dust formed by the aggregation of smaller globules, and varying in fineness from the Scotch mist to the tropical deluge. It has often been asked how it is that clouds and mists are able to float about when water is so much heavier (800 times heavier) than air. The answer to this is easy. It depends on the resistance or viscosity of fluids, and on the smallness of the particles concerned. Bodies falling far through fluids acquire a "terminal velocity," at which they are in stable equilibrium—their weight being exactly equal to the resistance—and this terminal velocity is greater for large particles than for small; consequently we have all sorts of rain velocity, depending on the size of the drops; and large particles of dust settle more quickly than small. Cloud-spherules are falling therefore, but falling very slowly.

To recognise the presence of dust in air there are two principal tests: the first is the obvious one of looking at it with plenty of light, the way one is accustomed to look for anything else; the other is a method of Mr. John Aitken's, viz. to observe the condensation of water vapour.

Take these in order. When a sunbeam enters a darkened room through a chink, it is commonly said to be rendered visible by the motes or dust particles dancing in it; but of course really it is not the motes which make the sunbeam visible, but the sunbeam the motes. A dust particle is illuminated like any other solid screen, and is able to send a sufficient fraction of light to our eyes to render itself visible. If there are no such particles in the beam—nothing but clear, invisible air—then of course nothing is seen, and the beam plunges on its way quite invisible to us unless we place our eyes in its course. In other words, to be visible, light must enter the eye. [A concentrated beam was passed through an empty tube, and then ordinary air let in.]

The other test, that of Mr. Aitken, depends on the condensation of steam. When a jet of steam finds itself in dusty air, it condenses round each dust particle as a nucleus, and forms the white visible cloud popularly called steam. In the absence of nuclei Mr. Aitken has shown that the steam cannot condense until it is highly supersaturated, and that when it does it condenses straight into rain—that is, into large drops which fall. The condensation of steam is a more delicate test for dust than is a beam of light. A curious illustration of the action of nuclei in condensing moisture has just occurred to me, in the experiment—well known to children—of writing on a reasonably clean window-pane, with, say, a blunt wooden point, and then breathing on the glass: the condensation of the breath renders the writing legible. No doubt the nuclei are partially wiped away by the writing, and the moisture will condense into larger drops with less light-scattering power along the written lines than over the general surface of the pane where the nuclei are plentiful and the drops therefore numerous and minute. Mr. Aitken points out that if the air were ever quite dustless, vapour could not condense, but the air would gradually get into a horribly supersaturated condition, soaking all our walls and clothes, dripping from every leaf, and penetrating everywhere, instead of falling in an honest shower, against which umbrellas and slate roofs are some protection. But let us understand what sort of dust it is which is necessary for this condensing process. It is not the dust and smoke of towns, it is not the dust of a country road; all such particles as these are gross and large compared with those which are able to act as condensers of moisture. The fine dust of Mr. Aitken exists everywhere, even in the upper regions of the atmosphere; many of its particles are of ultra-microscopic fineness; one of them must exist in every raindrop, nay, even in every spherule of a mist or cloud, but it is only occasionally that one can find them with the microscope. It is to such particles as these that we owe the blue of the sky, and yet they are sufficiently gross and tangible to be capable of being filtered out of the air by a packed mass of cotton-wool. Such dust as this, then, we need never be afraid of being without. Without it there could be no rain, and existence would be insupportable, perhaps impossible; but it is not manufactured in towns; the sea makes it; trees and wind make it; but the kind of dust made in towns rises only a few hundred yards or so into the atmosphere, floating as a canopy or pall over those unfortunate regions, and sinks and settles most of it as soon as the air is quiet, but scarcely any of it ever rises into the upper regions of the atmosphere at all.

Dust, then, being so universally prevalent, what do I mean by dust-free spaces? how are such things possible? and where are they to be found? In 1870 Dr. Tyndall was examining dusty air by means of a beam of light in which a spirit-lamp happened to be burning, when he noticed that from the flame there poured up torrents of apparently thick black smoke. He could not think the flame was really smoky, but to make sure he tried first a Bunsen gas-flame and then a hydrogen flame. They all showed the same effect, and smoke was out of the question. He then used a red-hot poker, a platinum wire ignited by an electric current, and ultimately a flask of hot water, and he found that from all warm bodies examined in dusty air by a beam of light the up-streaming convection-currents were dark. Now of course smoke would behave very differently. Dusty air itself is only a kind of smoke, and it looks bright, and the thicker the smoke the brighter it looks; the blackness is simply the utter absence of smoke; there is nothing at all for the light to illuminate, and accordingly we have the blankness of sheer invisibility. Here is a flame burning under the beam, and, to show what real smoke looks like, I will burn also this spirit-lamp filled with turpentine instead of alcohol. *Why* the convection-currents were free from dust was unknown: Tyndall thought the dust was burnt and consumed: Dr. Frankland thought it was simply evaporated.

In 1881 Lord Rayleigh took the matter up, not feeling satisfied with these explanations, and repeated the experiment very carefully. He noted several new points, and hit on the capital idea of seeing what a cold body did. From the cold body the descending current was just as dark and dust-free as from a warm body. Combustion and evaporation explanations suffered their death-blow. But he was unable to suggest any other explanation in their room, and so the phenomenon remained curious and unexplained.

In this state Mr. Clark and I took the matter up last summer, and critically examined all sorts of hypotheses that suggested themselves, Mr. Clark following up the phenomena experimentally with great ingenuity and perseverance. One hypothesis after another suggested itself, seemed hopeful for a time, but ultimately had to be discarded. Some died quickly, others lingered long. In the examination of one electrical hypothesis which suggested itself we came across various curious phenomena which we hope still to follow up.[1] It was some months before what we now believe to be the true explanation began to dawn upon us. Meanwhile we had acquired various new facts, and first and foremost we found that the dark plane rising from a warm body was only the upstreaming portion of a dust-free *coat* perpetually being renewed

[1] For instance, the electric properties of crystals can be readily examined in illuminated dusty air; the dust grows on them in little bushes and marks out their poles and neutral regions, without any need for an electrometer. Magnesia smoke answers capitally.

on the surface of the body. Let me describe the appearance and mode of seeing it by help of a diagram. [For full description see *Philosophical Magazine* for March 1884.]

Surrounding all bodies warmer than the air is a thin region free from dust which shows itself as a dark space when examined by looking along a cylinder illuminated transversely, and with a dark background. At high temperatures the coat is thick; at very low temperatures it is absent, and dust then rapidly collects on the rod. On a warm surface only the heavy particles are able to settle—there is evidently some action tending to drive small bodies away. An excess of temperature of a degree or two is sufficient to establish this dust-free coat, and it is easy to see the dust-free plane rising from it. The appearances may also be examined by looking along a cylinder *towards* the source of light, when the dust-free spaces will appear brighter than the rest. A rod of electric-light carbon warmed and fixed horizontally across a bell-jar full of dense smoke is very suitable for this experiment, and by means of a lens the dust-free regions may be thus projected on to a screen. Diminished pressure makes the coat thicker. Increased pressure makes it thinner. In hydrogen it is thicker, and in carbonic acid thinner, than in air. We have also succeeded in observing it in liquids—for instance, in water holding fine rouge in suspension, the solid body being a metal steam tube. Quantitative determinations are now in progress.

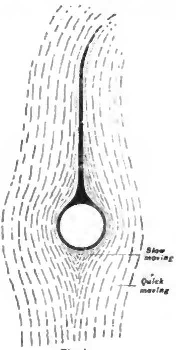


Fig. 1

Fig. 2

Fig. 1 shows the appearance when looking along a copper or carbon rod laterally illuminated; the paths of the dust particles are roughly indicated. Fig. 2 shows the coat on a semi-cylinder of sheet copper with the concave side turned towards the light.

It is difficult to give the full explanation of the dust-free spaces in a few words, but we may say roughly that there is a molecular bombardment from all warm surfaces by means of which small suspended bodies get driven outwards and kept away from the surface. It is a sort of differential bombardment of the gas molecules on the two faces of a dust particle somewhat analogous to the action on Mr. Crookes' radiometer vanes. Near cold surfaces the bombardment is very feeble, and if they are cold enough it appears to act towards the body, driving the dust inward—at any rate there is no outward bombardment sufficient to keep the dust away, and bodies colder than the atmosphere surrounding them soon get dusty. Thus if I hold this piece of glass in a magnesium flame, or in a turpentine or camphor flame, it quickly gets covered with smoke—white in the one case, black in the other. I take two conical flasks with their surfaces blackened with camphor black, and filling one with ice, the other with boiling water, I cork them and put a bell-jar over them, under which I burn some magnesium wire; in a quarter of an hour or so we find that the cold one is white and hoary, the hot one has only a few larger specks of dust on it, these being of such size that the bombardment was unable to sustain their weight, and they have settled by gravitation. We thus see that when the air in a room is warmer than the solids in it—as will be the case when stoves, gas-burners, &c., are used—things will get very dusty; whereas when walls and objects are warmer than the air—as will be the case in sunshine or when open fireplaces are used, things will tend to keep themselves more free from dust. Mr. Aitken points out that soot in a chimney is an illustration of this kind of deposition of dust; and as another illustration it strikes me as just possible that the dirtiness of snow during a thaw may be partly due to the bombardment on to the cold surface of dust out of the warmer air above. Mr. Aitken has indeed suggested a sort of practical dust or smoke filter on this principle, passing air between two surfaces—one hot and one cold—so as to vigorously bombard the particles on to the cold surface and leave the air free.

But we have found another and apparently much more effectual mode of clearing air than this.[1] We do it by discharging electricity into it. It is easily possible to electrify air by means of a point or flame, and an electrified body has this curious property, that the dust near it at once aggregates together into larger particles. It is not difficult to understand why this happens: each of the particles becomes polarised by induction, and they then cling together end to end, just like iron filings near a magnet. A feeble charge is often sufficient to start this coagulating action. And when the particles have grown into big ones they easily and quickly fall. A stronger charge forcibly drives them on to all electrified surfaces, where they cling. A fine water-fog in a bell-jar, electrified, turns first into a coarse fog or Scotch mist, and then into rain. Smoke also has its particles coagulated, and a space can thus be cleared of it. I will illustrate this action by making some artificial fogs in a bell-jar furnished with a metal point. First burn some magnesium wire, electrify it by a few turns of this small Voss machine, and the smoke has become snow; the particles are elongated, and by pointing to the charged rod indicate the lines of electrostatic force very beautifully: electrify further, and the air is perfectly clear. Next burn turpentine and electrify gently: the dense black smoke coagulates into black masses over an inch long; electrify further, and the glass is covered with soot, but the air is clear. Turpentine smoke acts very well, and can be tried on a larger scale: a room filled with turpentine smoke, so dense that a gas-light is invisible inside it, begins to clear in a minute or two after the machine begins to turn, and in a quarter of an hour one can go in and find the walls thickly covered with stringy blacks, notably on the gas-pipes and everything most easily charged by induction. Next fill a bell-jar full of steam, and electrify, paying attention to insulation of the supply point in this case. In a few seconds the air looks clear, and turning on a beam of light we see the globules of water dancing about, no longer fine and impalpable, but separately visible and rapidly falling. Finally make a London fog by burning turpentine and sulphur, adding a little sulphuric acid, either directly as vapour or indirectly by a trace of nitric oxide, and then blowing in steam. Electrify and it soon becomes clear, although it takes a little longer than before; and on removing the bell-jar we find that even the smell of SO_2 has disappeared, and only a little vapour of turpentine remains. Similarly we can make a Widnes fog by sulphuretted hydrogen, chlorine, sulphuric acid, and a little steam. Probably the steam assists the clearing when gases have to be dealt with. It may be possible to clear the air of tunnels by simply discharging electricity into the air—the electricity being supplied by Holtz machines, driven say by small turbines—a very handy form of power, difficult to get out of order. Or possibly some hydro-electric arrangement might be devised for the locomotive steam to do the work. I even hope to make some impression on a London fog, discharging from lightning-conductors or captive balloons carrying flames, but it is premature to say anything about this matter yet. I have, however, cleared a room of smoke very quickly with a small hand machine.

It will naturally strike you how closely allied these phenomena must be to the fact of popular science that "thunder clears the air." Ozone is undoubtedly generated by the flashes, and may have a beneficial effect, but the dust-coagulating and -expelling power of the electricity has a much more rapid effect, though it

[1] See NATURE, July 26, 1883 (p. 297).

may not act till the cloud is discharged. Consider a cloud electrified slightly; the mists and clouds in its vicinity begin to coagulate, and go on till large drops are formed, which may be held up by electrical action, the drops dancing from one cloud to another and thus forming the very dense thunder-cloud. The coagulation of charged drops increases the potential, as Prof. Tait points out, until at length—flash—the cloud is discharged and the large drops fall in a violent shower. Moreover, the rapid excursion to and fro of the drops may easily have caused them to evaporate so fast as to freeze, and hence we may get hail.

While the cloud was electrified, it acted inductively on the earth underneath, drawing up an opposite charge from all points, and thus electrifying the atmosphere. When the discharge occurs this atmospheric electrification engages with the earth, clearing the air between, and driving the dust and germs on to all exposed surfaces. In some such way also it may be that "thunder turns milk sour," and exerts other putrefactive influences on the bodies which receive the germs and dust from the air.

But we are now no longer on safe and thoroughly explored territory. I have allowed myself to found upon a basis of experimental fact a superstructure of practical application to the explanation of the phenomena of nature and to the uses of man. The basis seems to me strong enough to bear most of the superstructure, but before being sure it will be necessary actually to put the methods into operation and to experiment on a very large scale. I hope to do this when I can get to a suitable place of operation. Liverpool fogs are poor affairs, and not worth clearing off. Manchester fogs are much better and more frequent, but there is nothing to beat the real article as found in London, and in London if possible I intend to rig up some large machines and to see what happens. The underground railway also offers its suffocating murkiness as a most tempting field for experiment, and I wish I were able already to tell you the actual result instead of being only in a position to indicate possibilities. Whether anything comes of it practically or not, it is an instructive example of how the smallest and most unpromising beginnings may, if only followed up long enough, lead to suggestions for large practical application. When we began the investigation into the dust-free spaces found above warm bodies we were not only without expectation, but without hope or idea of any sort, that anything practical was likely to come of it: the phenomenon itself possessed its own interest and charm.

And so it must ever be. The devotee of pure science never has practical developments as his primary aim; often he not only does not know, but does not in the least care, whether his researches will ever lead to any beneficial result. In some minds this passive ignoring of the practical goes so far as to become active repulsion; so that some singularly biased minds will not engage in anything which seems likely to lead to practical use. I regard this as an error, and as the sign of a warped judgment, for after all man is to us the most important part of Nature; but the system works well nevertheless, and the division of labour accomplishes its object. One man investigates Nature impelled simply by his own genius and because he feels he cannot help it: it never occurs to him to give a reason for or to justify his pursuits. Another subsequently utilises his results, and applies them to the benefit of the race. Meanwhile, however, it may happen that the yet unapplied and unfruitful results evoke a sneer, and the question, "Cui bono?" the only answer to which question seems to be: No one is wise enough to tell beforehand what gigantic developments may not spring from the most insignificant fact.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following are the University and College lectures in natural science for the summer term:—

In the Physical Department of the Museum Prof. Clifton lectures on the instruments and methods of measurement employed in optics; Mr. Heaton lectures on problems in elementary physics; and practical instruction is given by the Professor and Messrs. Heaton and Walker. At Christ Church Mr. Baynes lectures on conduction of heat, and gives practical instruction on the measurements of electricity and magnetism; at Balliol Mr. Dixon lectures on elementary electricity and magnetism.

In the Chemical Department of the Museum Dr. Odling will hold an informal discussion on chemical constitution, Mr. Fisher lectures on inorganic and Dr. Watts on organic chemistry. At Christ Church Mr. Harcourt lectures on quantitative analysis and Mr. Veley on the relation between the physical properties and the constitution of organic compounds.

In the Morphological Department of the Museum Prof. Moseley lectures on the relations of the anthropoid apes and man, Mr. S. Hickson on the embryology of the chick, Mr. Jackson on Osteological Types, Mr. Poulton on Descriptive Histology, Mr. Morgan on Odontography, and Mr. Barclay-Thompson on the Anatomy of the Sauropsida.

In the Physiological Department Prof. Burdon-Sanderson lectures on the Chemical Processes of the Animal Body; at Magdalen Mr. Yule lectures on Practical Physiology.

Prof. Prestwich lectures on the Strata in the Neighbourhood of Oxford, and gives practical instruction in the field on the days following his lectures.

Prof. Gilbert will give an introductory lecture on May 6, on the Sources of the Constituents of Plants—the Soil, the Atmosphere. Dr. Tylor lectures on the Development of Arts and Sciences.

Prof. Pritchard concludes his course on the Planetary Theory, and will give a public lecture on his recent journey to Egypt in order to measure the absorptive power of the atmosphere on the light of the stars.

SCIENTIFIC SERIALS

American Journal of Science, April.—Recent explorations in the Wappinger Valley limestone of Duchess County, New York, by Prof. William B. Dwight. To the paper is appended a plate of the Wappinger Valley fossils.—Description of the Kettle-Holes near Wood's Hall, Massachusetts, with map of the district showing the positions and direction of the larger diameter of the Holes, by Prof. B. F. Koons.—Examination of Mr. Alfred R. Wallace's modification of the physical theory of secular changes of climate (second paper), by Dr. James Croll. Here the question is studied from the physical standpoint, and it is argued that a geographical change in the crust of the earth is not necessary to remove the Antarctic ice.—A contribution to the geology of Rhode Island (continued), by T. Nelson Dale.—On Mesozoic Dicotyledons (Angiosperms), by Lester F. Ward.—On the tourmaline and associated minerals of Auburn, Maine, by George F. Kunz.—On andalusite from Gorham, Maine, by the same author.—On the white garnet from Wakefield, Canada, by the same author.—Horizontal motions of small floating bodies in relation to the validity of the postulates of the theory of capillarity, by John Le Conte.—The principal characters of American Jurassic Dinosaurs; Part vii., the order Theropoda (with plates 8 to 14), by Prof. O. C. Marsh.—A new order of extinct Jurassic reptiles (*Macelognatha*), (one illustration, *M. vagans*), by the same author.

THE first article in the *Journal of Botany* for April is a monograph, by Dr. Masters, on the singular "umbrella pine" of Japan, *Sciadopitys verticillata*. The most important points which he brings out are that the true leaves of *Sciadopitys* are the homologues of the true or primordial leaves of *Pinus*; that the so-called "needles" of *Sciadopitys*, although occupying the same relative position as the leaves of *Pinus*, are not necessarily morphologically homologous with them; and that the bracts of the cone of *Sciadopitys* are homologous with the true leaves of that plant, and also with the bracts of Abietineæ generally.

THE most important article in the *Nuovo Giornale Botanico Italiano* for January 1884 is one by Sig. A. Borzi, on a parasitic organism of a very low type which he finds in the ordinary cells of *Spirogyra crassa*, and to which he gives the name *Protochytrium Spirogyræ*. In its systematic position it displays, on the one hand, affinities with the Myxomycetes, on the other hand, with such genera of Chytridiaceæ as *Woronina*, *Rozella*, and *Olpidiopsis*. The entire absence of a cell-nucleus identifies it, according to the author, with Klein's family of Hydromyxaceæ, along with *Monas*, *Vampyrella*, *Monadopsis*, and *Protomyxa*. Its ordinary condition is that of a naked mass of protoplasm, endowed with amœboid movements, and living on the chlorophyllaceous contents of the cells of the host, these plasmodia having the power of coalescing like myxamœbæ; but it also has an encysted state, and in certain conditions propagates itself by the production of uniflagellate zoospores.

Rendiconti del Reale Istituto Lombardo, March 6.—Observations made at Milan on the passage of the atmospheric waves produced by the Krakatoa eruption, by E. G. Schiaparelli.—On a sensible deviation observed in the plumb-line between Milan and Genoa, by E. G. Celoria.—On a hitherto neglected sulcus or depression frequently occurring in the frontal bone of the human skull between the boss and the temporal eminence, by Prof. G. Zoja.

March 20.—Obituary notice of the late Quintino Sella, by Prof. T. Taramelli.—Memoir on Antonio Angeloni Barbiani and his literary productions, by E. B. Prina.—Biological notice of *Alosa vulgaris* and *Salmo carpio*, inhabiting the Italian and sub-Alpine lakes, by Prof. P. Pavesi.—On the complete integers of some classes of partially derived equations of any order with two independent variants, by Prof. G. Pennacchietti.—Note on the quantitative determination of alogenous bodies, by P. Ritter-Záhony.—On the two human parasites *Anguillula intestinalis* and *A. stercoralis*, by E. C. Golgi and A. Monti.—Absolute values of the magnetic elements in Milan for the year 1883, by Dr. Ciro Chistoni.

Rivista Scientifico-Industriale, March 15.—Note on Wroblewski's experimental studies on the liquidation of hydrogen.—On the variation in the electric resistance of solid and pure metallic wires according to the temperature, by Prof. Angelo Emo.—On the pretended spontaneous combination of oxygen and hydrogen without increase of temperature effected by the exclusion of light, by L. Ricciardi.—On the migration of *Fuligula rufina* and *Erismatura leucocephala*, Scop., by Dante Roster.

Atti della R. Accademia dei Lincei, March 2.—Report on Alfredo Capelli's monograph on the composition of the groups of substitutions, by S. Battaglini.—Report on Prof. G. Bellonci's memoir on blastopore and the primitive line of the vertebrates, by S. Todaro.—Remarks on a group of curves of the fourth order, by Francesco Brioschi.—An experimental refutation of the hypothesis that every double link between carbon and carbon causes an increase of molecular refraction by a constant quantity, by Rodolfo Nasini.—On the stratification of the serpentine rocks in the Apennines, part i., by Torquato Taramelli.—Note on barometric hypsometry, by Aurelio Lugli.

March 16.—Obituary notice of the late Quintino Sella, by S. Maggiorani.—Meteorological observations at the Observatory of the Campidoglio during the months of January and February.

March 23.—On some unpublished and unknown works of Bartolomeo Marliani, by Enrico Narducci.—A chemical analysis of some brass and bronze objects found at the lacustrine station of Benaco, in Lombardy, by Luigi Pigorini.—Report on the antiquities discovered in various parts of Italy during the month of February 1884, by S. Fiorelli.—On barometric hypsometry, second note, by S. Tacchini.—Absolute values of the magnetic elements in Rome for the year 1883, by S. Tacchini.—On the stratification of the serpentine rocks in the Apennines, part ii., by Torquato Taramelli.

SOCIETIES AND ACADEMIES

London

Royal Society, April 3.—"Spectroscopic Studies on Gaseous Explosions." By Professors Liveing and Dewar.

Having occasion to observe the spectrum of the flash of a mixture of hydrogen and oxygen fired in a Cavendish eudiometer, the authors were struck by the brightness, not only of the ubiquitous yellow sodium line, but of the blue calcium line and the orange and green bands of lime, as well as of other lines which were not identified. The eudiometer being at first clean and dry, the calcium must be derived either from the glass or from some spray of the water over which the gases with which the eudiometer was filled had been confined. It seemed incredible that the momentary flash should detach and light up lime from the glass, but subsequent observations have pointed to that conclusion. Experiments were subsequently made on the flash of the combining gases inclosed in an iron tube, half an inch in diameter and about three feet long, closed at one end with a plate of quartz, held in its place by a screw-cap and made tight by leaden washers.

The tube was placed so that its axis might be in line with the axis of the collimator of a spectroscope, and the flash observed as it travelled along the tube.

It was seen at once that more lines made their appearance in the iron tube than in the glass vessel, and one conspicuous line in the green was identified in position with the E line of the solar spectrum. Several other lines were identified with lines of iron by comparison with an electric spark between iron electrodes. There could be no doubt that the flash in an iron tube gave several of the spectral lines of iron. The authors supposed that this must be due to particles of oxide shaken off the iron by the explosion, and proceeded to try the effect of introducing various substances in fine powder, and compounds, such as oxalates, which would give fine powders by their decomposition in the heat of the flame. Several interesting observations were made in this way. When some lithium carbonate was introduced, not only were the red, orange, and blue lines of lithium very brilliant, but the green line hardly less so. After the lithium had once been introduced into the tube, the lithium lines continued to make their appearance even after the tube had been repeatedly washed. When the lithium had been freshly put in, the red line was observed to be much expanded, very much broader than the line given by lithium in a Bunsen burner reflected into the slit for comparison. The light was dazzling unless the slit was very narrow; and it was noticed that if the spark by which the gas was fired was at the distant end of the tube, so that the flame travelled along the tube towards the slit, there was a reversal of the red line; a fine dark line was plainly visible in the middle of the band. When the spark was at the end of the tube next the slit, no reversal was, in general, seen. Later observations showed that some other metallic lines might be reversed in this way, and photographs taken of the reversals. These observations with the eye on the reversal of the red lithium line were made with a diffraction grating, and were repeated many times. They show that there are gradations of temperature in the flame, and that the front of the advancing wave of explosion is somewhat cooler than the following part. The combination of the gases is not so instantaneous that the maximum temperature is reached at once. When some magnesia was put into the tube the continuous spectrum was very bright, but the iron lines were still brighter. No line which could be identified as due to magnesium was observed with certainty; there was only a doubtful appearance of *b*. With sodium, potassium, and barium carbonates, only the lines usually seen when salts of those metals are introduced into a flame were noticed; but eye observations of this kind are extremely trying, on account of the suddenness of the flash and the shortness of its duration. Thallium gave the usual green line.

Subsequently the interior of the tube was bored out so as to present a smooth bright surface of iron, and the iron lines which were conspicuous in the flash were noted.

For the purpose of identification the pointer in the eye-piece was first placed on one of the strong iron lines given by the electric discharge between iron electrodes, and then, the discharge being stopped but the field sufficiently illuminated, the eye was fixed steadily on the pointer while the gas in the tube was exploded. In this way it was not difficult to see whether any given line was very bright in the flash. The lines thus identified were those having the wave-lengths about 5455, 5446, 5403, 5396, 5371, 5327, 5269 (E), 5167 (b_4). These lines were all many times observed in the way described, and as a rule were always present in the flash. Lines with wave-lengths about 5139 and 4352 were seen, and may possibly have been due to iron, and several more lines were seen occasionally, but were not so regularly seen that they could be well identified. The lines λ 4923 and λ 4919 were specially looked for, but neither of them could be seen. A group of blue lines were noticed, and were afterwards identified by photography, a method much less trying than observations by eye. To give intensity to the photographs ten or twelve flashes were usually taken in succession without any shift of the instrument, so as to accumulate their effects in one photograph. For identification the spark between iron electrodes was also photographed, but with a shutter over the lower part of the slit, so that the image of the spark should occupy only the upper part of the field.

Some sixty of the iron lines in the indigo, violet, and ultra-violet were thus photographed.

As a rule no iron lines above O make their appearance; in a few plates T is visible, and it is possible that other lines may be obscured by the water spectrum, which always comes out and extends from near *s* to below R. Above T no line at all is visible in any of the photographs, though the spark lines come out strongly enough, and several of the strongest groups of iron lines, both of spark and arc lines, are in the region beyond T.

Other experiments were made with explosions of carbonic oxide and oxygen, and with coal-gas and oxygen. The explosions of these gases were attended with much more continuous spectrum, and the metallic lines were not always as well developed as they were with hydrogen and oxygen, but on the whole there were as many metallic lines photographed from the flashes of carbonic oxide as from those of hydrogen.

When the iron tube was lined with copper foil, only one copper line in the visible spectrum, λ 5105, was seen, and in the ultraviolet two lines, λ 3272 and λ 3245·5. All three lines were very strong, and the two ultra-violet lines were in some cases reversed. These lines were also frequently developed when no copper lining was in the tube, probably from the brass of the small side tubes.

Copper also gave a line in the indigo, λ 4281 about, decidedly less refrangible than the copper line, λ 4275, coincident apparently with the strong edge of one of the bands developed when a copper salt is held in a Bunsen burner.

A lining of copper which had been electro-plated with nickel developed only one nickel line, λ 5476, in the visible part of the spectrum, but gave by photography twenty-five lines in the ultraviolet.

When copper wire electro-plated with cobalt was put into the tube twenty-two cobalt lines in the violet and beyond were photographed.

No other metal gave anything like the number of lines that were given by iron, nickel, and cobalt.

A lining of lead gave the lines λ 4058, 3683, and 3639 strongly, and these lines were frequently developed, though less strongly, when there was no lead lining; the metal being without doubt derived from the leaden washers used to make the ends of the tube air-tight.

A strip of silver gave the lines λ 3381·5 and 3278, and these lines were sometimes reversed. No trace of the channelled spectrum of silver was developed even when silver oxalate was put into the tube, and furnished plenty of silver dust after the first explosion.

A magnesium wire about 2 millims. thick and two-thirds the length of the tube gave the *b* lines very well; that is to say b_1 and b_2 were well developed, and b_4 was also seen, but as the iron and magnesium components of b_4 are very close together, and the iron line had been observed before the introduction of the magnesium, it was not possible to say with certainty whether or not the magnesium line were present too. No other magnesium line could be detected. The blue flame line was carefully looked for, but could not be seen. The photographs showed none of the magnesium triplets in the ultra-violet, nor any trace of the strong line λ 2852, which appears in the flame of burning magnesium, and is yet more conspicuous in the arc when that metal is present.

Metallic manganese, introduced into the tube in coarse powder, gave the group at wave length about 4029 with much intensity, but no other manganese line with certainty. In the visible part of the spectrum the channellings in the green due to the oxide were visible.

A lining of zinc produced no zinc line, and zinc-dust gave only a very doubtful photographic impression of the line λ 3342. A strip of cadmium gave no line of that metal either in the visible or in the ultra-violet part of the spectrum.

Tin, aluminium, bismuth, and antimony, also failed to produce a line of any of those substances, and so did mercury which was spread over copper foil made to line the tube.

Thallium spread as amalgam over the copper lining gave the lines λ 3775·6, 3528·3 and 3517·8.

Chromium was introduced as ammonium bichromate, which of course left the oxide after the first explosion. This gave the chromium lines with wave-lengths about 5208, 5205, 5204, 4289, 4274·5, 4253·5, very well and persistently, also the lines with wave-lengths about 3605, 3592·5, 3578·5.

Sodium salts (carbonate, chloride) developed the ultra-violet line λ 3301; and potassium salts give the pair of lines about wave-length 3445; but no more refrangible line of either metal was depicted on the photographs. Lithium carbonate gave, besides the lines in the red, orange, green, and blue, the violet line, λ 4135·5; but no more refrangible line.

Photographs of a flame of mixed coal-gas and oxygen, in which an iron wire was burnt, show, as might be expected, the same iron lines as are developed in the flash of the detonating gases, and of the same relative intensities. These intensities are not quite the same relatively as they are in the arc spectrum. Thus the lines λ 3859, 3745, 3737, 3735, and 3719 come out in great strength, much stronger than the lines λ 3647, 3631, 3618, which are remarkably strong in the arc.

German-silver wire, burnt in the flame of coal-gas and oxygen, gave the same nickel lines as were given by nickel in the detonating gases, as well as those of copper and lead.

Copper wire gave, besides the lines λ 3272, 3245·5, a set of bands in the blue, which correspond with those given by copper salts in flames, and are probably due to the oxide.

The greater part of the lines observed in the flames of the exploding gases have been observed by the authors to be reversed when the several metals were introduced into the arc in a crucible of lime or magnesia; which is quite in accord with the supposition that the metals experimented on are volatile, and emit as well as absorb these particular rays, at temperatures lower than that of the arc.

That iron is volatile at a temperature below the fusing point of platinum, which is about 1700° C., has been pointed out by Watts (*Phil. Mag.*, vol. xlv. p. 86), who observed in the flame of a Bessemer converter almost all the green and blue lines of iron which we have seen in the exploding gases, besides one or two lines which we have not observed or identified. Having regard to this volatility of iron, it does not seem so surprising that iron lines should be observed accompanying those of hydrogen to great heights in the sun's atmosphere as that they should not be always seen there.

Copeland (Copernicus, December, 1882) observed in the spectrum of the great comet of 1882 four lines nearly identical with four of the green lines of iron seen in the detonating gas.

It is remarkable that such volatile metals as mercury, zinc, and cadmium should give no lines in the flame of the exploding gases.

The absence of any metallic lines more refrangible than T in the flame of the exploding gases may be in part due to a falling off in the sensibility of the photographic plates for light of shorter wave-lengths; but as the spark lines of iron seem to be quite as strongly depicted on the plates in regions of the spectrum far above T as they are in the regions below, want of sensitiveness in the plates cannot be the only reason for the absence of higher lines, but probably the emissive power of the metals for these lines is feeble at the comparatively low temperature of the flame.

Gouy (*Comp. R.*, 1877, p. 232), using a modification of Bunsen's burner fed with gas mixed with spray of metallic salts, observed at the point of the inner green flame three or four iron lines which have not been observed in the flame of the detonating gas, the lines b_1 and b_2 of magnesium, two cobalt lines in the blue which are not seen in the detonating gas, one line of zinc, and one of cadmium, and the two strong green rays of silver. Can the appearance of these rays under these circumstances imply that the temperature of the inner green cone of a Bunsen burner, when the proportion of air to coal-gas is near the exploding point, is higher than that of the explosion of hydrogen and oxygen?

The interesting theoretical questions which are suggested by the facts recorded in this paper the authors leave for further discussion.

Linnean Society, April 17.—Alfred W. Bennett, M.A., in the chair.—Messrs. R. Lloyd Patterson and Benjamin Lomax were elected Fellows.—Dr. J. Poland exhibited under the microscope a series of preparations, stained by reagents, illustrating the *Bacillus* of anthrax of man. He remarked on the severely fatal character of the malady, not only in this country but on the Continent and certain places abroad. The *Bacillus*-spores were in many instances doubtless conveyed in the dried skins and hides imported from abroad, and under favourable conditions inoculated those handling the dried hides, &c., the germs developing in the usual manner of the low vegetable organisms.—Dr. R. C. A. Prior drew attention to specimens of *Draba aizoides* obtained from Pennard Castle, Swansea, said to be the only locality where this plant grows wild in England.—The ninth contribution to the ornithology of New Guinea, by Mr. R. Bowdler Sharpe, was read, and it dealt with some few birds obtained by Mr. A. Goldie in the Astrolabe Mountains.—A paper was read by the Rev. J. M. Crombie on the algo-lichen-fungal hypothesis. The author gave a brief sketch of the hypothesis as enunciated by Schwendener, Bornet, and others, noticing the various arguments and illustrations which had been adduced in its support. He then discussed the result which had been obtained from experiments in lichen-culture, whether from the spore or by synthesis—observing that in both cases these were confessedly but small, owing to the very great difficulty of cultivating beyond a rudimentary stage except under the same atmospherical conditions in which they grow in nature. Two fatal objections he said might be taken to the theory: (1) the one having reference to the very peculiar nature of the parasitism it assumed, and the other (2) to the fact that notwithstanding a similarity of appearance there were in reality no true fungal-mycelia nor true algal-colonies in lichens. As to any direct genetic or any indirect parasitical connection between the gonidia of lichens and the hyphal filament, it was further pointed out that none such existed, but that on tracing the evolution of the thallus from the germinating spore, it is seen that the gonidia originate in the cellules of the first parenchymatous tissue formed upon the hypothallus, and that subsequently through the resorption of the lower portion of the cortical stratum they became free, and constituted the thin gonidial stratum. Where seen lying amongst the medullary hyphæ they are often attached to these, not as the result of any copulation, but by means of the lichenin which permeates the whole thallus. The origin of the gonidia and their relation to the rest of the lichen thallus, the author stated in conclusion, thus belonged to the very elements of morphological botany.—There followed a note on a remarkable variation in the leaf of *Banksia marginata* observed by Mr. J. G. Otto Tepper in South Australia; and he questions whether this might not be regarded as the spontaneous production of a new variety or species or the remnant of an extinct form.—Mr. R. A. Rolfe then discoursed on *Hyalocalyx*, a new genus of Turneraceæ from Madagascar. According to Dr. J. Urban (the latest authority) the order consists of five genera and eighty-three species distributed in America from North Carolina and Mexico to the Argentine Republic, and in Africa from Abyssinia to Mozambique and the Cape of Good Hope, while outliers are found in the islands of Zanzibar and Rodriguez. The unique example now added was obtained by Dr. C. Rutenberg on Nossi-bé, a small island on the north-west of Madagascar. Its peculiarities incline Mr. Rolfe to regard it as the type of a new genus with a position between *Mathurina* and *Turnera*; its most remarkable character being its glassy transparent calyx totally destitute of chlorophyll.

Chemical Society, April 17.—Dr. Perkin, F.R.S., president, in the chair.—A ballot was held, and the following gentlemen were elected Fellows:—W. D. Borland, J. C. Bose, W. D. Crumbie, A. F. Dimmock, H. G. Greenish, W. J. Grey, J. Gaskell, J. W. Pratt, A. G. Perkin, W. H. Perkin (jun.), G. H. Wainwright.—The following papers were read:—On the influence of incombustible diluents on the illuminating power of ethylene, by P. F. Frankland. Mixture of ethylene with carbonic anhydride, nitrogen, aqueous vapour, and air, have a lower illuminating power than pure ethylene. Mixtures with oxygen have a greater illuminating power than pure ethylene; carbonic anhydride is the most and air the least prejudicial to the illuminating power.—On trichloropyrogallol, by C. S. S. Webster. The author has prepared mairogallol by the method of Stenhouse and Groves. He finds that the reaction can be separated into two stages, in the first of which trichloropyrogallol is formed. Its reactions are identical with tribromopyrogallol. The author confirms the statements of Stenhouse and Groves in almost every particular.—The synthesis of galena by means of thiocarbamide, by J. Emerson Reynolds. The author has succeeded in coating glass vessels, brass tubes, &c., with a nitrous galenoid coating, by the decomposition of an alkaline solution of lead tartrate with sulphur urea.—On the analysis of Woodall Spa, by W. T. Wright. This spring contains a large amount of bromine (49·7 parts per million) and iodine (5·21 per million); it is much richer in these elements than any other spring in this country.—On the critical temperature of heptane, by T. E. Thorpe and A. W. Rücker. By calculation it is found to be about 281°.

SYDNEY

Linnean Society of New South Wales, February 27.—The following papers were read:—Monograph of the Australian sponges, by R. von Lendenfeld, Ph.D., part I. This paper is introductory to a monograph upon the Australian sponges, large materials for which have already been accumulated by the author, partly from his own collections, and partly from those in the Museums of Christchurch and Dunedin, New Zealand, and of Adelaide, South Australia. The real investigation of this branch of the Cœlenterata may be said to begin with the work of Grant, 1826; to have risen to a new and much higher level under Schulze, 1875-1881, and to have been continued by Lollas, Keller, Vosmaer, Marshall, the author, and others, with continually increasing success up to the present time. A sufficient account of the bibliography of the Spongida is presented in this paper to enable those interested to find any desired information upon the subject, a matter of no small difficulty at present.—The *Scyphomedusæ* of the southern hemisphere, by R. von Lendenfeld, Ph.D., part I. The *Scyphomedusæ* or "jelly-fish" appear to be more numerous in the southern than in the northern hemisphere. Of the 210 known species, 104 have already been found in the former, and as the animals of that hemisphere are not nearly so well known as those of the northern, the number of southern species must doubtless be much greater than that mentioned. Only twenty-six of the 104 southern species are Australian, but this apparent poverty of the Medusæ of our shores is due to the limited investigation that has been made. In this paper all the species of this hemisphere are described.—Notices of some new fishes by William Macleay, F.L.S. Four species are here described. Two of them, *Platycephalus longispinis* and *Urolophus bucculentus* were taken in the trawl in deep water outside the Heads of Port Jackson. The third, *Petroscirtes wilsoni*, was found by Mr. J. D. Wilson at the North Shore; and the fourth, *Athirinosoma jamiesoni*, was a small freshwater fish from the Bæmer, one of the head waters of the Brisbane River.—On the improvement effected by the Australian climate, soil, and culture on the Merino sheep, by P. N. Trebeck. In this paper Mr. Trebeck traces the changes and improvement which wool has undergone in Australia since the first introduction of German and Silesian sheep. Samples of the wool of all the periods and flocks alluded to were exhibited. Mr. Trebeck concludes his paper by stating his opinion that the whole of the country on our western watershed was eminently suitable for the Merino sheep, and that we only required the fostering assistance of an intelligent Government to keep in the front ranks of the wool-producing countries of the world.

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