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 usually represented by a single specimen only. The reptile remains consist of one humerus of the common frog, and numerous bones of toads, the species being undetermined.

The mammalian remains include those of thirty-two species familiar to explorers of British caverns. The remainder belong to twelve species forming part of the existing British fauna, including the domestic cat; three recent European, but not British, species, and three undetermined species of the genera *Capra*, *Ovis*, and *Sus*. On the other hand, certain forms for which some British caves have become famous are totally unrepresented in the Ojcow list, such as *Ursus priscus*, *Gulo luscus*, *Machairodus latidens*, *Cervus megaceros*, *Ovibos moschatus*, *Bos longifrons*, *Hippopotamus major*, *Elephas antiquus*, *Lagomys spelæus*, and *Castor fiber*. Not a single species appears to be represented by remains found in all the caves, and only one—the cave bear—by those found in eight of them. Twenty-two of the species—nearly one-half of the entire number—are restricted to one, not the same, cave.

The remains of the cave bear were not only more widely distributed in the caves, but were far more numerous than those of any of the other mammals, especially in the lower levels of the deposit. The Cave of Jerzmanowice alone is believed to have yielded fully 4000 canine teeth of this species, representing, of course, 1000 individuals at least. The animals were of all ages, from the sucking cub to a patriarch whose skull measured about 19·5 inches long and 12 inches broad across the zygomatic arch. The brown bear appears to have been represented by remains of one individual only, found in the *Mammoth Cave*, which also yielded bones and teeth of the great pachyderm from which it was named. Relics of this species were disinterred in four other of the caves; and it was concluded from the occurrence of numerous ivory tools that mammoths must have existed in considerable numbers. The woolly rhinoceros was found only in two caverns, and its remains do not appear to have been abundant. The cave hyæna was apparently very little, if at all, more prevalent, as it was represented in no more than three of the caves. Next to the cave bear, no animal was more generally distributed than the reindeer, whose relics occurred in six of the caverns—a distinction also reached by the common fox. Count Zawisza's researches have led him to the conclusion that the distinction between an older mammoth period and a more recent reindeer period, as made out from the researches in France, will not apply to these Polish caves.

The traces of man were numerous and varied, consisting of parts of his skeleton, hearths, and implements of various kinds. His bones were found in seven of the caverns, and several skulls were met with in five of them; but, unfortunately, the remains of the animals lying with them were not in all cases accurately noted. Some of these relics were near the surface, others lay deeper, and some were covered with a thick bed of stalagmite. A "skeleton," pressed against the side of the Czajowice Cave, was more than a metre below the surface; and in the Górenice Cave several skulls were also found close to the sides. From a report by Prof. Virchow, to whom the skulls have been submitted, it appears that some of them are dolicocephalic, others mesocephalic; that there is some doubt whether they are of the same age as the deposit containing the implements of the most ancient inhabitants; and that there is no peculiarity indicating any very high antiquity, nor any essential difference in the forms of the skulls from those of the present inhabitants of Poland.

The hearths, which occurred in six of the caves, were in some instances one above another with a thick mass of deposit between them; and some of them contained bones of ox, reindeer, mammoth, boar, and cave bear mixed together, broken artificially, and blackened by fire.

Flint implements and "cores" appear to have been found in all the caves, and Count Zawisza, in his *Mammoth Cave* alone, disinterred about 2000. The raw material was no doubt obtained from the Upper Oolitic Limestone of the district, in which flint nodules abound. The author speaks of the tools as being "Palæolithic" in all cases, but this must probably be understood as a synonym for "unpolished," and not taken necessarily in a chronological sense in all cases. It must be stated, however, that one flint tool was found with a vertebra of the cave bear in the same bed of firm crystalline stalagmite.

Of other stone tools, two axes were met with, one in each of the Wierszchow Caves: one, made of serpentine, was perforated to receive a helve; the other was of diorite. They were the only polished stone tools the caverns yielded. Several roundish cuboidal stones, the size of a man's fist, and believed to be "corn-crushers," were found. One of these also was of diorite. There were also "polishing stones," or "rubbers," some of fine-grained sandstone and others of black clay slate, apparently used for finishing bone tools.

Two glass beads, with inlaid threads of clear-coloured glass, were found in the Kozarnia Cave; and from their great depth in the deposit a considerable antiquity is claimed for them. It is believed they must have been of foreign origin. The Zbójecka Cave yielded three amber beads, rather flat, not quite symmetrical, but smoothed.

Of articles made of bone, there were rods artificially sharpened at one end, and, in some cases, perforated at the other; a knife made of a lower tusk of boar; a canine tooth of bear artificially perforated at the lower end, a stout needle having a large eye; straight hollow bones of birds, cut transversely at one end and broken at the other: a straight rod of ivory sharpened at both ends, and as "round as if turned in a lathe"; perforated teeth, including one of boar (ground flat on one side), wolf, fox, and elk; four imperfectly rounded and smoothed beads; and seven ivory rods, compressed and lancet-shaped, the largest a foot long and 1·5 inch in greatest breadth. These rods were all found in one and the same bed, which contained charcoal, rough flint tools, and bones of wolf, polar fox, and reindeer. Long bones, broken artificially lengthways, were found in great numbers, as well as pieces of antlers having cut surfaces.

One fragment of the shell of *Cypræa tigris*, an Indian Ocean species, presented itself. It is supposed to have been obtained by the Cave-men by barter.

Pottery occurred in nearly every cave and at all levels. The lowest, roughly hand-made, slightly burnt, and unglazed, included part of a pot-like vessel, so porous as to render it improbable that it could have been intended to contain any liquid. Among specimens of later date, and 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 hit 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 *Odobœnus 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 hyperborœus*, *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*, *Odobœnus 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 $+15^\circ$ 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 $-1^\circ\!\cdot\!4$ to $-2^\circ\!\cdot\!0$, 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 $-0^\circ\!\cdot\!8$. 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 $-2^\circ\!\cdot\!1$, and $-3^\circ\!\cdot\!7$ 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 subregions; 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.

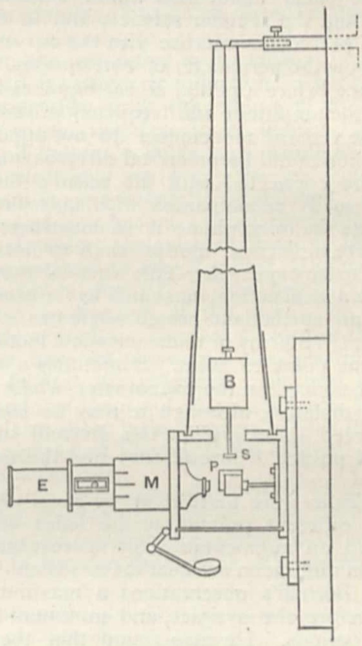
Naturally produced tremors differ from those just spoken of by the fact that their distribution is not so superficial, and not only are they to be observed in the most substantial structures which engineers can design, but they are to be equally well seen in cellars and in the walls of rocky caves. Some 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 progre s 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 oper tions 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 cœruleus*), 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 (*Dromæus novæ-hollandiæ*), 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 attacked 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 sandstone; 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.

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.

[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.

ON THE MEASUREMENT OF ELECTRIC CURRENTS[1]

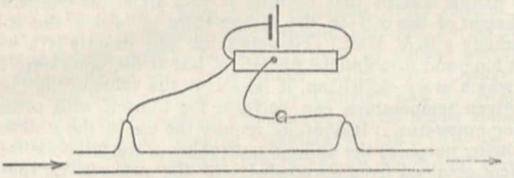
PERHAPS the simplest way of measuring a current of moderate intensity when once the electro-chemical equivalent of silver is known, is to determine the quantity of metal thrown down by the current in a given time in a silver voltameter. According to Kohlrausch the electro-chemical equivalent of silver 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—

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N N N
S S S
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but when this influence is withdrawn we should have—

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N S N
S N S
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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 sulponates 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 1⅜ 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 underterminative 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.

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