THURSDAY, APRIL 7, 1881

THE ARYAN VILLAGE

The Aryan Village in India and Ceylon. By Sir John B. Phear. (London: Macmillan and Co., 1880.)

IT is now twenty years since a remarkable page in Sir Henry Maine's "Ancient Law" drew attention to the prevalence in India of the village-community, a system of society strange to the modern English mind. Before that work appeared, even special students had little idea how far the ancient communism, under which the Aryan race colonised so much of Asia and Europe, was still to be found not as a mere relic of ancient society, but as the practical condition of modern life among Hindus and Slavs. The historical importance of this early institution is now fully recognised, and our archæologists are alive to the relics of the old village-communities in England. Not only are these seen in the public commons, but here and there in certain fields where, after harvest, the neighbours still have the right of turning their cattle in among the stubbles, while even a few of the great old "common fields," where once each family had its free allotted portion, are still to be discerned by the baulks or ridges of turf dividing them into the three long strips, which again were cut crosswise into the family lots. Thus every contribution to the argument on the development of modern landholding from the communism of ancient times, finds interested readers. The present volume is such a contribution, and in several ways new and important. Sir John Phear thoroughly knows and carefully describes native life in Bengal and Ceylon, and one of his points is the remarkable parallelism of the agricultural village, as it has shaped itself in these two widely-separated districts. Up to a certain stage, the development of the village-community has been everywhere on much the same lines, and those not hard to trace. It springs naturally out of the patriarchal family, which, living together on its undivided land, tilling it in common, and subsisting on the produce, becomes in a few generations a family-community. There are now to be seen in and about Calcutta families of 300 to 400 (including servants) living in one house, and 50 to 100 is a usual number. The property is managed by the *karta*, who is usually the eldest of the eldest branch, and what the members want for personal expenses beside the common board and lodging, he lets them have in small sums out of the common fund. Now and then there is a great quarrel, when the community breaks up and the land is divided according to law. It is easily seen how such a joint-family or group of families settling together in waste unoccupied land would expand into a village-community, where new households when crowded out of the family home would live in huts hard by, but all would work and share together as if they still dwelt under one roof. In fact this primitive kind of village-settlement, according to our author, is still going on at this day in Ceylon. In districts where, as in ancient Europe, patches of forest are still felled and burnt to give a couple of years' crop of grain, and where in the lowlands rice-cultivation requires systematic flooding, we find the whole settlement at work in common in a thoroughly socialistic way. The somewhat different communistic system prevails more in India, where the land is still the common property of the village, and the cultivated plots are apportioned out from time to time among the families, but these families labour by and for themselves, pay the rent or tax, and live each on the crop of their own raising. In Bengal a step toward our notion of proprietorship is made, where custom more and more confirms each family in permanent ownership of the fields which their fathers have long tilled undisturbed. Tenant-right, so pertinaciously remembered by the Irish peasant, is older in history than the private ownership of land. Next, in the Hindu village as it now exists, a further stage of social growth appears. Families carrying on certain necessary professions have been set apart, or have settled in the village. The hereditary carpenters and blacksmiths and potters follow their trades, the hereditary washerman washes for his fellow-villagers, and the hereditary barber shaves them, paid partly for their services at fixed customary rates, and partly by having their plots of village-land rent free, or nearly so. All this is intelligible and practical enough, and indeed strongly reminds those of us who got our early politics out of "Evenings at Home," of the boy colonists providing for their future wants under the direction of discreet Mr. Barlow, by taking with them the carpenter and the blacksmith and the rest of the useful members of society. But the village-community as it actually exists in India, or Servia, or anywhere else, only forms the substratum of society, on the top of which appear other social elements whose development it is not so easy to trace with certainty. The "gentleman," with his claims to live in a better house than the others whose business is to drudge for him, seemed absurd to Dr. Aikin's political economy, yet he makes his appearance in the Hindu village-community as elsewhere. Sir John Phear seems disposed partly to account for what may be called the landholding class, as well as the endowed priesthood, as having held a privileged position from the first settlement of the villages, and it is in favour of this view that in such settlements the founder's kin naturally have superior rights over the land to new-comers. But he does not the less insist on another and yet stronger social process which has tended to give to individuals a landlord-right over fields they do not till. When quarrels between two villages end in actual war, the conquering warriors (whose claims however seem to be here somewhat confused with the rights of the chief's family) would be rewarded for their prowess by grants of land carved out of the common lands of the conquered village, and the new lords being absentees would naturally put in tenants who would pay in return a share of the crops. Such metayage, or farming "on shares," is as common in India as in the south of Europe, and is evidently the stage out of which arose our rent-system of landlord and tenant.

One great value of books like the present is in showing the analogies and differences of social institutions which have much of their history in common with our own, but have developed under other conditions. Feudal lordship and feudal sovereignty have in the East overridden the old village-system in ways curiously like those of the West. Thus, as Sir John Phear says, the English manor was the feudal form of the Oriental village; the Bengal zamindar collects rents from his ryots and pays to the superior holder, or the Crown, living on the difference. Singhalese villagers may do suit and service either to a feudal chieftain or a Buddhist monastery, much as in England the fief might have been held either by a fighting baron or a praying abbot. It is interesting to find in Ceylon the notion that the existing tenure of land comes from the king having granted it subject to service, whereas its real history seems just the opposite, that the village-community came first, which the sovereign made himself paramount over and levied land-tax from. This reminds us of the theory of English law, that a cottager pastures his donkey on the common by sufferance of the lord of the manor, whose waste it is; the fact being that the peasant is exercising a relic of his old village-rights which has escaped the usurpation of the feudal system, and outlived it.

Though the village-community is much broken down in the districts so well described by Sir John Phear, it still shows the old framework in the division of the tilled land in allotments to each ryot, and the equitable settlement of rights and duties by the *mandal* or headman and his *panchayat* or village-council, which is one of the most admirable features of the ancient patriarchal system. But on the whole the village commune here shows practical results by no means admirable, and the husbandman's life on the roadless mud-flats of Bengal, minutely drawn by the author in all its details of dreary poverty and ignorance and hatred of improvement, is about as depressing a social picture as can be met with.

EDWARD B. TYLOR

NILE GLEANINGS

Nile Gleanings. By Villiers Stuart of Dromana, M.P. (London: John Murray, 1879.)

THE land of Egypt has of late caused the issue of a multitude of books, and that in consequence of the increased knowledge which half a century of Egyptian research has produced. Classical authorities no longer avail the traveller; he requires translations from the original hieroglyphic inscriptions, an insight into the discovery of a new world of antiquity and an acquaintance with the recent excavations which have revealed to the eye of the traveller an unveiled city of the dead. Scriptural texts alone garnished the older voyages. Above all the accomplished traveller should be acquainted with the various sciences which enable him to detect what is new or salient in the country that he visits, and its development, political institutions, progress, or decay should be seen at a glance even if it demands pages to describe them. The grand Egyptian tour is however a promenade of the land of monuments. Mr. Villiers Stuart's "Nile Gleanings" follow the usual track, and offer to the archæologist, besides the usual discussions on art, hieroglyphs, and language, and an occasional notice on the fauna and flora of Egypt, several new facts of archæological interest. At the description of Meidoum, the period of which is now known to be that of Senofrou, the tomb of Nofre Maat, with its strange figures inlaid with incrustations of red ochre, is new and interesting for its peculiar art and its remote age of the third dynasty; nor less important is the discovery of the flint flakes, the *débris* of the old chisels which sculptured it. Other tombs at the spot were remarkable for their gigantic masonry. These belong indeed to the more recent discoveries, but the traveller paid his respects to the dog mummy pits at Bebe, and the sites of Minieh and Dayr-el-Nakel. Considerable interest attaches to the heretical worshippers of the sun's disk, who flourished about the close of the eighteenth dynasty, and who endeavoured to remove the capital of Egypt from Thebes with "its hundred gates," to Tel-el-Amarna or Psinaula. The idea fashionable amongst Egyptologists has been that Amenophis III of that line, the king, one of whose statues is the celebrated vocal Memnon, commenced an attempted religious reform and tried to substitute the worship of the sun's disk or orb, the Aten as it is called, for that of the god Amen-Ra, or the hidden sun. To this it is supposed that he was invited by the undue influence of his wife, Tai or Taiti. After his death it is conjectured that he was succeeded by his brother, Amenophis IV., and that this Amenophis IV. was a convert of the most pronounced zeal for the worship of the solar orb or pure Sabæanism. For this purpose, from the Amenhept, or the Peaceful Amen, he changed his name to Khuenaten, the Light or Spirit of the Sun. The chief data for this arrangement of the monarchs of the period of the eighteenth dynasty were the stones used for the construction of the Pylon or gateway of Haremhebi or Horus of the same dynasty, which were found to have been taken from an edifice of the so-called disk worshippers at Thebes, and built with their faces inside the wall, exhibiting the erasure of the name of Amenophis IV. and the substitution of Khuenaten in the cartouches for Amenophis. Some objections indeed might have been taken from the fact that the features of Amenophis and Khuenaten were different, it being of course facile to adopt a new faith, impossible to secure fresh features, even such unenviable ones as those of Khuenaten. Mr. Villiers Stuart discovered a new tomb at Thebes, with Amenophis IV. and his queen on one side of the door and Khuenaten with his queen on the other, both dissimilar in features, arrangement, and condition—one perfect, the other mutilated. As both sovereigns could hardly have occupied the same sepulchre, evidently one of the two appropriated the construction of his predecessor. The theory of Mr. Villiers Stuart is that Khuenaten was a foreigner, which has been always asserted, although it is more difficult to decide to which of the races of mankind he belonged; there are however some reasons to believe that after all he may come from Nubia or the South. The discovery of this tomb is in fact the principal new point of the work, and is the one new and important contribution to the obscure history of the heretical division which took place about the thirteenth century B.C.

The various sites of Esneh, Dendera, Assouan, Philæ, and the Nubian temples are well known, but are described in a light and graceful way, and much old material reproduced in a polished and not pedantic form. Necessarily a great deal is already well known to the student, and no inconsiderable portion to the general public. As to chronology the numerous systems and theories which have been started, amounting in all to above 200, allow any choice which suits best the proclivities of the inquirer. The present work has a new date for Rameses II., and throws his reign back to B.C. 1567, but it is difficult if not impossible to reconcile a period so exalted with the ceiling of the so-called Memnonium and the date of the heliacal rising of the dog-star on the calendar of Thothmes III. at Elephantine. Every fact connected with the Exodus is a subject of continual dispute, dates, line of march, names of the Pharaohs, place of the House of Bondage whence the Jews swarmed out. The only safe view to take is that the problem is insoluble, and that its resolution should be tied up with the sheaf of paradoxes collected by De Morgan. Mr. Villiers Stuart found the cultivation of sugar prosperous, by means, though, of that apology for slavery "forced labour," and he is indignant at the sufferings of the unhappy fellaheen, as also at the urgent scheme of taxation and the system of baksheesh and official bribery which pervades the modern as extensively as it did the ancient land of bondage; but *corvées*, it appears, are necessary for the payment of Daira bonds, and "the drachm," as in the Roman times, must be wrung out of the hard hands of peasants. While however glancing at the modern state of Egypt the interest of the writer is concentrated on the Egypt of the past, Pharaohs, their queens and their princesses, and a fair popular account is given of Thebes. His weakness is a love of dabbling in etymology, and venturing out of his depth on general questions of comparative philology. Although, for example, an occasional word may resemble its Greek or Latin equivalent, the construction of the hieroglyphic or old Egyptian and the Coptic is totally different from those two classical tongues, the Egyptian having a closer resemblance to the Semitic than the Aryan or Indo-Germanic languages. As to the Etruscan, the few known facts about its construction point to the Turanian or Tartaric family rather than the Egyptian. The origin of the Egyptians is still involved in obscurity, and belongs to the province of conjectural ethnology. More Caucasian in the north and at the earliest period, more Nigritic on the south and at a later epoch, the Egyptians seem historically a mixed race, a fusion of conterminous races of Northern Africa, and Eastern foreigners, and Nigritic blood. The oldest inhabitants still remain a mystery. One theory is that the Egyptian was the primitive man of a vast continent, the last representative being the aboriginal Australian. Amongst other interesting points are visits to the Dervishes, especially the fortune-tellers, and a description of the ride of the Sheikh of the Saidieh over the bodies of living men, who must have suggested to the apostle, had he seen him, the subject of Death on the Pale Horse. Like the car of Juggernaut, the Sheikh of the Saidieh is said to have been abolished. The ceremony might have been the relic of an old Egyptian one, and Pharaoh riding over his prostrate enemies may have anticipated the Sheik of the Saidieh. Altogether the work is entertaining and amusing; it is not so dry as a guide or handbook, nor so learned as an Egyptological history such as that of Brugsch-Bey, nor so elaborate as Wilkinson's Manners and Customs, and Topography, or other travels by professed Egyptologists; but its style is light and sparkling, and the principal details of history, mythology, and archæology have been fairly mastered. In the minute details of philology it is weak, but they do not affect the general reader, and are easily set right *en passant* by the expert. They will do no harm to scientific research, and they will amuse and to some extent instruct the public. The plates are also fairly done, and their colouring renders them more than usually attractive. It is decidedly agreeable to while away the monotony of a voyage down the river of the desert, as the Nile may be justly styled, and to those whose only travels are round their room, it will convey some pleasing impressions of what a visit to Egypt might show them.

LETTERS TO THE EDITOR

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

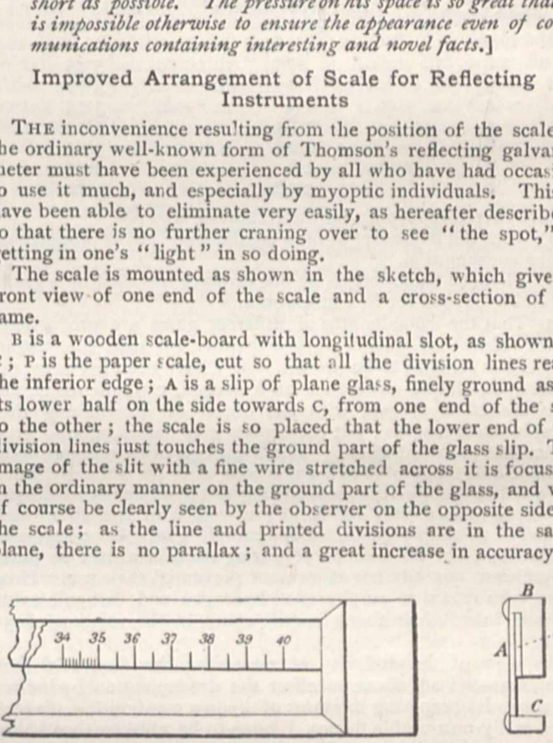
[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Improved Arrangement of Scale for Reflecting Instruments

THE inconvenience resulting from the position of the scale in the ordinary well-known form of Thomson's reflecting galvanometer must have been experienced by all who have had occasion to use it much, and especially by myoptic individuals. This I have been able to eliminate very easily, as hereafter described, so that there is no further craning over to see "the spot," or getting in one's "light" in so doing.

The scale is mounted as shown in the sketch, which gives a front view of one end of the scale and a cross-section of the same.

B is a wooden scale-board with longitudinal slot, as shown at C; P is the paper scale, cut so that all the division lines reach the inferior edge; A is a slip of plane glass, finely ground as to its lower half on the side towards C, from one end of the slip to the other; the scale is so placed that the lower end of the division lines just touches the ground part of the glass slip. The image of the slit with a fine wire stretched across it is focussed in the ordinary manner on the ground part of the glass, and will of course be clearly seen by the observer on the opposite side of the scale; as the line and printed divisions are in the same plane, there is no parallax; and a great increase in accuracy of



reading the position of the hair line is obtained, owing to the greater ease of observing that two lines coincide when end on to one another than when superimposed; and further, from the circumstance that the room need not be darkened.

This arrangement has been introduced at the beginning of this year by me in the testing-room of Messrs. Siemens Brothers and Co. at Woolwich, and has been most readily accepted by all my assistants, and I venture to say that any who adopt this arrangement will never return to the previous form.

I may state that I place the lamp and its slit on one side and reflect the beam of light on to the galvanometer by a mirror or total reflection prism, and further by means of two long plane mirrors reduce the actual distance between the galvanometer and scale, so as to have everything close to the observer's hand. The scale I have adopted is divided into half millimetres, and it is perfectly easy to read to a quarter of a division, and with a hand magnifying-glass still further.

This method is of course applicable to any physical instruments which are read by a reflected spot, and as there are no "patent rights" it is placed at the disposal of all.

Charlton F. JACOB

A Note on Flame-Length

THREE years ago, whilst endeavouring to make use of flame-length as a means of testing the economic values of different qualities of coal-gas by the determination of their specific flame-lengths, I was led to the discovery of some simple relations, the further study of which will perhaps one day help to simplify the theory of flames. By specific flame-length I mean the length of flame of a combustible gas burning in a normal atmosphere at a standard rate through a simple circular orifice under such conditions as to produce a symmetrical, vertical, steady flame capable of being measured. These conditions are not difficult to obtain in the case of coal gas. In fact for a very long time a flame-length test has been in use amongst gas-makers, but as the comparison has not always been made on the basis of volume the results have not always been satisfactory. The system I advocated was that of stating the flame-length for some standard rate. It occurred to me at that time that the flame-length should be proportional to the consumption or rate of issue of the gas. On submitting this theory to experiment I obtained satisfactory evidence that such was the case, as the following table taken at chance from a series of experiments will show:—

Flame-length. Inches.	Rate of consumption per hour. Cubic feet.	Calculated rate for 10″ flame. Cubic feet.
2	·75	3·75
3	1·13	3·77
4	1·5	3·75
5	1·85	3·70
6	2·25	3·75
7	2·6	3·71
8	2·98	3·72

I have therefore formulated the following laws:—

1. That the flame-length of a combustible gas is proportional to the consumption.

2. That the flame-length is the distance travelled by a gas in obtaining oxygen for its consumption.

3. That the flame-lengths of different gases are proportional to the relative amounts of oxygen required for their combustion.

The last remains to be proved, and I have been led to experiment upon simple gases such as hydrogen, carbonic oxide, and sulphuretted hydrogen, with the object of determining their specific flame-lengths; but these gases give flames offering great difficulties in measurement. The flames given by coal-gas under suitable and easily-obtained conditions offer no difficulty, but I have not been able at present (owing to the difficulty mentioned above) to obtain very satisfactory results with the above-mentioned three simple gases. Other simple gases have suggested themselves, but the cost of preparing them in a state of purity in sufficient quantity has at present prevented their use. However, with regard to sulphuretted hydrogen and carbonic oxide, I have found their flame-lengths stand in the relation of 3·2 to 1.

In view of the difficulty of measuring the flames of these simple gases I am about to effect the determination by indirect means. By preparing mixtures of known composition that will give easily-measurable flames, I hope to be able to throw some light upon this subject of flame-lengths.

March 22 LEWIS T. WRIGHT

Future Development of Electrical Appliances

As many of your readers have doubtless read Prof. Perry's interesting paper on the future development of electrical appliances, a remark on one or two points might not be out of place. In speaking of the application of electricity to railway travelling, Prof. Perry says that the weight of the train would be much reduced under the proposed conditions, and rail friction would be minimised. It strikes us that to have light trains would not be altogether an advantage, for several reasons. The lighter the train the less profitable would be the *vis viva* against a strong wind (and the latter is an important element in railway locomotion). Again, the stability of a heavy carriage is much greater than that of a light one, and a heavy engine in front of the train must steady the whole system. It would be interesting to ascertain from a practical engineer whether a train of six coaches with self-propelling powers could safely run at a speed of fifty-eight miles an hour. GEORGE RAYLEIGH VICARS

Woodville House, Rugby

Prehistoric Europe

I AM sorry to have to ask you again to allow me to correct some statements made by Prof. Dawkins in the matter of the Victoria Cave explorations (NATURE, vol. xxiii. p. 482).

1. He says that "the antiquity of man in the Victoria Cave is solely due to the *perfervidum ingenium* of Mr. Tiddeman. It was first based on a fragment of fibula which ultimately turned out to belong to a bear. Then it was shifted to the cuts on two small bones." It is not, I believe, usual in the arena to hand over your own broken disabled weapon to your adversary to defend himself with when you take a new one. Yet this appears to be one of Prof. Dawkins's tactics. Who, reading the above remark, would believe that Prof. Dawkins ever held the following opinion? "Although the fragment [of the fibula] is very small, its comparison with the abnormal specimen in Prof. Busk's possession removes all doubt from my mind as to its having belonged to a man who was contemporary with the cave-hyena and the other Pleistocene animals found in the Cave" ("Cave-Hunting," p. 120.)

So far from the evidence having been "shifted" to the two small bones, on the breaking down of the fibula evidence, the latter event happened in 1878, whereas attention was called to the former in the Reports for 1875-6, the respective years of their discovery.

2. "The bones are recent," says Prof. Dawkins. "This is evidently a very old bone," said Prof. Busk, after inspecting and experimenting on one of them submitted to him; and the whole of the circumstances of its discovery confirm that opinion.

3. "The cuts have been probably made by a metallic edge." That is a mere opinion, and to show what it is worth I may remark that at the discussion at the Anthropological Institute in 1877, when Prof. Dawkins stated that the marks looked as if they had been made with a Sheffield whittle, another member, at least equally distinguished, and apparently equally desirous to oppose the evidence, said that the marks seemed to have been made by a rock slipping across the bones.

4. Prof. Dawkins states that there were frequent slips of the materials after I took charge of the work. He has, I think, been misinformed, for his own visits to the Cave during that period were not sufficiently frequent to warrant any such statement, and our endeavour was to work the Cave in such a method as would entirely prevent the possibility of such accidents and the mixture of the remains.

5. Prof. Dawkins goes on to show:—(1) Either that Dr. Geikie and I believe that "there is evidence of inter-glacial or pre-glacial man, possessed of domestic animals, and probably using edged tools of metals" (which we certainly do not); or that (2) in his opinion goat has never existed anywhere save as a domesticated animal, for his remarks proceed upon one or other of these two assumptions.

6. Bones of goat were far from uncommon in the hyena-bed of the Cave, and found under such circumstances as would render their slipping down from higher beds quite impossible. The same is the experience of that distinguished explorer, M. E. Dupont, Director of the Geological Survey of Belgium, in the caves of that country:—"J'en maintiens absolument la co-existence avec ces espèces perdues" (*Journ.* Anthropol. Inst., vol. vii. No. 2, p. 168). Unfortunately the non-existence of goats in Pleistocene deposits in Great Britain has been elevated to a dogma, and when the animals are found in such association it is immediately assumed that they have slipped from above—a confession to a very slipshod method of working—or, that the beds have previously been disturbed. All such cases should be most carefully inquired into and observed at the time without prejudice.

7. Again, Prof. Dawkins says that I wrote that the fact of the finding of reindeer with the earlier Pleistocene animals was "noteworthy," and that it is now too late to recall it. I do not recall my statement, but I should like it quoted correctly. "Your reporter had an impression that the reindeer remains occurred at some height above the hyena-bed.[1] Be that as it may, Prof. Dawkins's opinion[2] is entitled to great weight, and is indeed the view generally held. At the same time, considering that hyena and reindeer are not uncommonly found together in caves, when, as in this case, we see them mixed together at one or both ends of a section, but separated through an interval of seventy feet in length by a thickness of deposits, we may regard the fact as at least an interesting one, and, when found, noteworthy" (Brit. Assoc. Reports, 1876, p. 118). Prof. Dawkins shall have the whole of that. I will not recall even the middle sentence. R. H. TIDDEMAN

Hastings, March 26

[1] This was also the opinion of Mr. Jackson, our painstaking superintendent, who was daily at the Cave.

[2] *i.e.*, of the co-existence of these animals.

Induction Current from Leyden-jar Discharge

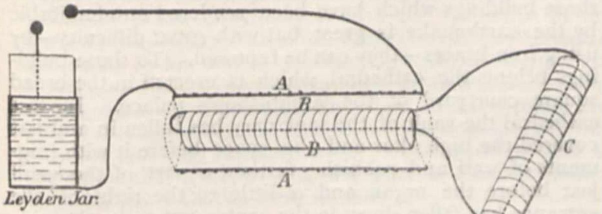
I WAS led to try the following simple experiments with the current induced from Leyden jar discharge, from the knowledge of what is the case in the Ruhmkorf's coil induced currents.

I have since found the experiments have often been tried before; but all may not be aware how simply and easily the results are shown.

After trying flat coils I found it more convenient to coil stout insulated wire round glass tubes. A few yards of stout wire round a tube A one foot long and 1¼ inches diameter gave me my primary coil; a similar tube B of less diameter to put inside A formed my secondary; and a third coil C enabled me to examine the current induced in B, with respect to its magnetising power, at a distance, away from the influence of the primary A. An electrical machine, a Leyden jar or two, a number of unmagnetised knitting-needles marked with paper at one end, and a compass-needle to test polarity, are also required.

The experiments are as follows:—

(1) With coil A alone show that a needle is magnetised according to Ampère's law; if we regard the direction of current to be from the + coat of the jar to the − coat.



(2) Now arrange the coils as shown, A as primary, B as secondary, C in the circuit of B, and a needle in C. Let there be *no* break in the circuit of B and C.

Then the magnetism induced in knitting-needle shows by (1) an action as of a current *inverse* to that in A.

(3) Now interpose a break in circuit of B and C, so that induced current gives a spark. We now get the needle oppositely magnetised, showing a direct induced current; and the magnetisation is *far stronger* than in (2).

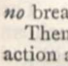
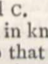
This points to the two opposite induced currents both passing when there is no air-break; and the inverse having the strongest magnetising action; but the result weak. An air-break stops the inverse current, and the far greater effect of the direct current un-neutralised by the inverse is very marked; it can easily be shown to a class, for example.

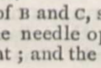
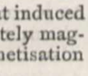
I may add that I have been unable to try what results one gets with galvanometers from lack of instruments.

Cheltenham W. LARDEN

Classification of the Indo-Chinese and Oceanic Races

IT is surprising that Mr. Murton should have had any difficulty about the characters used by me to indicate the word *Papûwah*. The form in question is identical with his own, the apparent difference being due to the two different characters respectively employed by us to express the labial *p*. In the Arabic alphabet there is no sign for this letter, because the sound does not occur in the Arabic phonetic system. Hence other Muhammadan nations using the Arabic alphabet supply the missing letter in various ways, the Persians, Afghans, and Indians by the form

, the Malays usually by . Hence the two apparently

different but really identical forms  and 

which have puzzled Mr. Murton and his Malays of Singapore.

A. H. KEANE.

Crabs and Actinia

THE account of the actinia on the claws of a crab in your last number (p. 515) is of interest as raising the point as to what benefit the crab derives from its friends. In the *Annals of Natural History*, many years ago, I wrote that, having for a long period kept *Adamsia palliata* with *P. Prideauxii* in confinement, I had no doubt but that the white tentacles of the anemone were a bait which attracted various small animals within reach of the crab's claws, though it did not, as Möbius seems to think, in any way aid the crab in capturing its prey.

In the South Sea Islands I saw a splendid specimen of a crab carrying a large actinia. The habit of the crab was to conceal itself entirely in the sand, leaving the actinia waving its tentacles on the surface. No sooner however did a small crab, annelid, or other creature come within reach than the crab, shooting its claw out of its concealment in the sand, struck out, and in most cases captured it. Here there was no doubt of the use of the actinia as a decoy. H. STUART WORTLEY

Patent Office Museum, South Kensington, W, April 4

Migration of the Wagtail

WITH reference to the statement of Herr Adolf Ebeling (*apud* the correspondence from the New York *Evening Post*, quoted in your issue of February 24, vol. xxiii. p. 387), that the fact that wagtails in their wintering "came to Africa, and especially to Nubia and Abysssinia, was then unknown to us," permit the remark that as "*then*" must refer to a date not earlier than 1850 (when Heuglin went to Egypt), the appearance of wagtails on the west coast of Africa, as far south as Cape Verd, had been observed more than half a century before.

In the *Annales de Chimie* for July, 1793, M. Prélong, one of the lieutenants of Stanislas, Chevalier de Boufflers, and director of the hospital at Gorée, records the arrival on September 14, 1788, of a flight of *bergeronnettes* from the north. In connection with this M. Prélong remembered that Adanson had seen swallows at Senegal October 9, 1750 (?), while he himself could testify to their leaving his native *pays* (the Hautes-Alpes) towards the end of September. Prélong took ship for home in the middle of May, 1789, and was accompanied by his feathered friends the wagtails. N. J.

New York, March 15

Sound of the Aurora

UPON this subject it may not be out of place to recall the fact that the passage of large meteors is not uncommonly described as accompanied by a hissing sound. I have met with statements of this kind in the case of meteors which were proved to have been twenty, thirty, or forty miles distant from the observer, and the sound of which, therefore, if it had reached him at all, must have reached him after such an interval of time that he would have been very unlikely to connect the two phenomena. Moreover the sound described in these cases is of a totally different character from the true sound of meteors, which is spoken of by those who have heard it as a heavy roaring or rumbling sound.

The explanation of the alleged "hissing" is not difficult when we remember that the untrained observer of a bright meteor (although it may be distant fifty or a hundred miles from him) invariably regards it as a near object, falling, it may be, into the next field, or behind a neighbouring hill. Regarding it in this light, he attributes to it, by a well-known mental process, a sound such as a firework at the same distance might be expected to produce.

May not the "rustling" of the aurora be equally a subjective phenomenon? GEORGE F. BURDER

Earthquake Warnings

IN *Comptes rendus*, lxxxi. October, 1875, I find it stated, on the authority of M. Rivet, Telegraph Superintendent at Fort de France, Martinique, that when that island was visited by repeated earthquake shocks in September, 1875, each shock was preceded by a very marked disturbance of the electric telegraph needles. M. Rivet suggested that in this way warnings otherwise unattainable of impending shocks might be obtained.

It would be interesting to learn whether this observation has been confirmed by recent experience on the Continent.

Such warnings might often be the means of averting loss of life and property, and in cases like that at Ischia would, by their occurrence or non-occurrence, afford some additional clue to the real nature of the forces at work. H. M. C.

Charlton, March 31

ON THE EARTHQUAKES AT AGRAM IN 1880-81

[At our request Prof. Szabo, Professor of Geology and Mineralogy in the University of Budapest, has prepared for the pages of NATURE the following account of the recent earthquakes at Agram. This account is a thoroughly reliable one, as it is drawn up from information obtained from Dr. von Hantken, the Director of the Hungarian Geological Survey, and Mr. Schafarrik (Prof. Szabo's assistant), both of whom were officially deputed to visit the district and inquire into the whole of the facts.]

On November 9, 1880, at 7h. 33m. 53s., a very violent earthquake passed over the south-western quarter of Hungary and also Bosnia and Herzegovina. The limits of this large territory are approximately as follows:—West, the peninsula of Istria and the town of Trieste; north, Vienna and Gödöllö (north-east from Budapest); east, the flat lands between the Danube and the Theiss; and south it reached far beyond Serajewo, because the earthquake was felt in this town also very strongly. It is said by some that the earthquake was even observed in Budweis (in Bohemia) and in Debreczen (east-north-east from Budapest). This territory is approximately equal to a circle, the radius of which is forty geographical miles long, and therefore its area is nearly 5000 square miles. From all information received up to the present time it may be asserted that the earthquake was not equally felt over the whole territory, but mostly in the centre of the circle—in the environs of Agram, where the damage occasioned was considerable.

According to the testimony of trusty witnesses the earthquake began on the day mentioned above with a strong shock in an upward direction, which was accompanied simultaneously with a perceptible and loud subterranean noise; this was followed by a subsidence; then came a perpendicular shock from below; and lastly came an oscillatory movement of the earth in an east-south-east to west-north-west-direction. This movement, which lasted nearly ten seconds, was so intense that in the town of Agram not only all the larger public buildings, but with few exceptions every dwelling-house, was damaged more or less.

One peculiarity of this first shock is that not only were objects of small weight removed out of their original positions, and this was especially the case with objects standing on a flat surface, but it also produced a certain rotatory motion upon them (contrary to the hand of a watch); even some trustworthy witnesses affirm that the first shock had a rotatory effect on them.

Chimneys are the objects which are the most easily damaged by earthquakes, and so in Agram there was scarcely a chimney to be seen after the earthquake which had not been either cracked or entirely ruined. The number of fallen chimneys amounts to nearly a thousand. An enormous amount of damage was also done to the roofs of houses; one could see from the roof-tiles placed on laths that they had been shaken by the oscillation, and were partially broken and fallen down, especially those which were situated towards the east or west. All this happened in the morning when the streets were mostly crowded with people, and one must be astonished indeed that the great quantity of falling masonry, parts of walls, stone cornices, huge beams of wood, and pieces of broken glasses, &c., did not hurt more people; altogether only twelve were severely wounded (broken arms, hands, feet, head wounds, &c.), but only in two cases did the injuries prove fatal; about twenty suffered slight contusions. In the surrounding country three men died, and some suffered from various injuries.

Among the public buildings and the larger dwelling-houses in Agram not one has actually fallen to ruin, but the number of those houses, whose outward walls were obliged to be supported by long beams on every side, is considerable; much more terrible, however, is the view of destruction inside the buildings; the mortar from the walls of the rooms is for the greatest part fallen down, and the thinner walls have been shaken so much that some of them are totally fallen to ruin. About twelve buildings were so ruined by the earthquake that it was necessary to forbid their reconstruction, and the Senate of the town found itself compelled to order their entire demolition. Here is the corner house belonging to Mr. Priester, with two storeys facing the Marie-Valerie Street and Jellacsics Square, whose western frontal wall has separated itself from the other parts of the house, and is entirely bent towards the Marie-Valerie Street; the house of Mrs. Zorgách in the Petrijani Street is ruined and must be demolished; the building of the Military Academy in Ujlak has been a real and sad ruin. In the upper part of the town the following edifices are designated to be demolished:—Br. Ozegovich's house, the Mednyanszka Barracks, a certain part of the military "General-Commando" building, &c. The number of those buildings which have been rendered uninhabitable by the earthquake is great, but with great difficulty—by using iron braces—they can be renewed. To these buildings belong the cathedral, which is erected in the broad square courtyard of the archbishop's palace. In this cathedral the vault of the sanctuary has fallen in and has covered the high altar and the space before it with fragments of wall and rubbish; further, a part of the vault just before the organ and a little to the right of the entrance has fallen down in the centre nave; in the side nave a very heavy horizontally-placed buttress split, fell down, and broke through the tombs where the coffin of a canon was; besides these more striking damages the main wall was split in several parts. The archbishop's palace itself has been damaged to such an extent that the archbishop and the canons were obliged to leave their apartments for a long time. In the same manner the Franciscan and St. Mark's Churches were also damaged. One can also add among the others St. Catharine's Church, which has been sadly damaged, as also the edifices of the University and of the "Realschule," and many other private houses. The high chimneys of the gas-factory and of Grator's brick-kiln were only partially damaged at the upper part.

After these come those houses which, though they were very greatly damaged, yet the people were not obliged to quit them; and lastly follows the great number of those buildings which sustained only smaller damages (for instance, little rifts near the windows or along the corners of the walls, through mortar, &c., falling down). The proportion between the number of the edifices which became uninhabitable and had to be demolished, in comparison with those which were damaged in a greater degree and those which were slightly damaged, is about 1 : 1 : 4. This arithmetical proportion nevertheless cannot at all express the damage that happened, because among the two first categories are the most valuable buildings, viz. the churches, barracks, the largest and newest houses, while the mass of the third category consists of small low buildings; one must attend to the above descriptions because it is impossible to set strict bounds between the single categories, for there were many houses whose ground-floors were totally free from chinks, the first- and second-floors already showed gradually more chinks in the walls, while the third-floor presented a terrible picture of destruction. The damage to edifices caused by earthquakes depends on their solidity, on their height, and on their situation. As regards the solidity, they found that the weaker the walls were, and where iron braces were not applied, the more were the buildings damaged; as regards the height, on the occasion of this earthquake it was observed that the second-floor was more damaged than the first, and the third more than the second; and finally as to the situation, there are some remarkable examples, houses forming south-east and north-west corners were exceedingly damaged, viz. south-east was the direction where the first shock came from.

In the environs of Agram the earthquake appeared with no less strength than in the town itself, but the damage to the surrounding country is not so general, because here are the peasants' cottages all built of wood. Here therefore only the churches, the parsons' houses, schools, castles, and gentlemen's private houses were the objects on which the earthquake left visible marks.

All the buildings of any strength in the villages which are situated at the south-east slope of the mountain called Sleme, north from Agram, were damaged in a more or in a less degree; there is for instance the well-known place for pilgrimages, Remete (5 km. north of Agram), where the walls of the church, which is ornamented inwardly with very beautiful frescoes, and of the steeple are strongly gaped in all directions, while the vaulted roof of the nave is totally fallen down; so is also the residence of the parson; the damage caused in these two edifices amounts, according to an official valuation, to 38,000 florins. In Grancsina (7 km. north-east from Agram) the steeple, falling down in an easterly direction, broke through the roof and the vault of the church, so that now one can see only the four very ruptured walls. On the other side of the mountain Sleme, in a certain part of Croatia named Zagoria, many castles were ruined.

The circle, where the earthquake caused the heaviest losses has approximately the following bounds:—South-west, Karlstadt; west, Landstrass, Gurkfeld; north-north west, Rohitsch; north, Warasdin, Csáktornya; north-east, Kaproncza (Kopreinitz); east, Belovár; south-east, Sziszek, which corresponds to a territory of about 120 square miles; the centre of this circle was the place where the first shock emanated from. The data kept in the surrounding parts relative to the direction and the greatest intensity of the shock indicate the territory which lies to south-east from Agram, and forms the alluvium of the River Save as the starting-point of the whole phenomenon. Here the crevice in the earth appeared also, caused by the strongly-oscillated motion. A little to the east from the village of Resnik (east-south-east from Agram) was the crevice in the alluvium of the Save. It was 5 kilometres long, and had several interruptions, and extended in a south-east direction, from which here and there some smaller crevices radiated. This chief crevice, which continued through the Save as far as the village of Scitarjevo, showed in some places a few days after the earthquake openings one to two feet broad, but for the most part the crevice was filled with bluish alluvial sand, which was forced out, mixed with water by the opening and closing of the crevice being formed by the oscillation of the soil, the water forcing its way through this dense pulp, produced by its upheaval those small flat craters which many people are inclined to declare volcanoes of mud. The dimension of these small craters is very variable; their diameters differ between 2 and 75 c.m., their height 1 to 30 c.m.; and, calculating from these numbers the cubic contents of the largest flat cone, we receive nearly 0·5 cubic metres; this little quantity of the out-pressed material is enough to exclude the hypothesis that these cones were the result "of a slow action for some hours." If hydro-sulphuric gas was present during this phenomenon, as some believe, it is not known, because we want positive and trusty evidence on this point. Moreover it is not impossible that there should be an appearance of small quantities of hydrosulphuric gas dissolved in the water of an alluvial slimy soil, because such water generally contains decaying substances and finely-dispersed sulphates, but one can in no case suppose that a great quantity of hydrosulphuric gas would have produced the crevices and ejected the sand mixed with water.

Beyond this territory of 120 square miles the earthquake was felt with a gradually diminishing strength, and in many places the motion was so weak that a great many of the inhabitants did not remark it. Among these can be mentioned Fiume, where they felt only a very slight shock; then Budapest and Vienna, where only one or two became attentive to this phenomenon.

Beyond the territory of 120 square miles, where they suffered the strongest shocks, there are yet some environs, though far enough from the centre, where destruction also happened, for instance in Styria, and in Hungary, in the neighbourhood of Pécs (Fünfkirchen). To explain the connection of these cases with the entire phenomenon deeper researches must be made.

It remains to communicate shortly the statics of the earthquake.

1. November 9, at 7h. 33m. 53s. in the morning, the first shock enduring 10 seconds with a subterranean noise. This one has caused all the damage.

2. November 9, at 7h. 37m. in the morning: an oscillatory motion without a noise.

3. November 9, at 8h. 27m. 55s. in the morning: slight motion.

4. November 9, at 10h. 50m. in the evening: very slight motion.

5. November 10, at 6h. in the morning: very slight motion.

6. November 11, at 11h. 26m. in the forenoon: a strong oscillation, which effected some damage.

7. November 16, at 12h. 4m. in the morning: a sufficiently strong shock accompanied with a dull noise.

8. November 16, at 12h. 44m. }
9. " " 12h. 49m. } in the morning:
10. " " 1h. 9m. }
11. " " 4h. 24m. }

weak oscillations, of which only the last had a little more strength than the others.

So it lasted continually during December. Even in this year (1881) in January and February feeble shocks recurred after longer interruptions; the last shock was recorded in the newspapers from March 4

Budapest, March 18

THE ST. PETERSBURG DYNAMITE MINE

THE following account of the mine recently discovered in St. Petersburg, extracted from Russian sources, gives a remarkable picture of the state of society in the empire, where able chemists and expert miners can be found to engage in such desperate undertakings.

It appears from a sketch-plan which accompanied the translation put into our hands, that the mine extended from one side of Malaya Sadobaya Street to the centre of the roadway; the total length of the mine gallery being fifteen paces, the street must be thirty paces, say seventy-five feet wide.

The gallery terminated in a chamber about double its diameter, and in this was found the charge contained in a case twenty-two inches long and eight inches diameter, weighing sixty-five pounds, and beside this a glass jar contained about thirty pounds more of the explosive substance, apparently an excess quantity over that required for the actual explosion. The explosive consisted of a species of dynamite made by mixing nitro-glycerine with powdered charcoal. This is more powerful in its effects than the ordinary substance, in which an inert body, generally a soft infusorial earth, takes the place of the charcoal. The description of the fuse, as contained in the Russian account, is very obscure, but so far as can be made out it would appear to have consisted of a wide heavy glass tube containing an explosive, described some time back in NATURE, and prepared by mixing nitro-glycerine with about 10 per cent. of guncotton, the result being a very explosive substance of a partially gelatinous character. In the midst of this, and surrounded by a mixture of potassic chlorate and antimonious sulphide, was a sealed glass tube containing concentrated sulphuric acid and a leaden weight. The whole was then apparently connected with the dynamite in the case by means of an india-rubber tube also containing explosives. If this was the actual construction the *modus operandi* of the conspirators was very simple, for the heavy glass tube had only to be allowed to fall, when the lead would have broken the sulphuric acid tube, and the chlorate mixture would have at once inflamed, and the explosion of the jelly would have communicated by means of the rubber tube with the torpedo. At the same time it is very difficult to imagine the reasons which could have induced the conspirators to adopt so crude a method when, as it appears from the account, they had at their disposal in the room adjoining that from which the mine was driven no less than four galvanic batteries, with which the explosion could have easily been instantaneously effected by those on the watch for the passage of the intended victims, a method of operation much more consonant with the skilled character of the other parts of the work. It is however very difficult to understand a description such as this when derived from a non-scientific source, as may be imagined when one of our daily contemporaries stated that the fuse contained "*bartholley salts*," and another "chlorate of potash and *sulphide of ammonium*."

Whatever may have been the real mode intended to have been used by the conspirators, the results would have been sufficiently frightful, as it is probable that the charge found would have made a "crater" of about fifty feet in diameter.

The jelly contained in the glass tube was, when analysed, found to contain about 4 per cent. of camphor. This was added to render the mass less sensitive to any accidental shock which it might incur, and is an ingenious application of principles laid down by Abel (*Proc.* Roy. Soc. xxii. p. 163) in his well-known paper on "The History of Explosive Compounds," in which, though not actually mentioning the dilution of a liquid or semi-liquid explosive by the solution in it of another body, he clearly indicates the probable effects of such a treatment. That men of education and ability should so apply their undoubted powers must be a matter of regret to every student of science.

FISH-CULTURE IN THE UNITED STATES

IT is a common saying that everything in America is on a larger scale than in this country. The longest rivers, the largest lakes, the highest mountains, the broadest plains, the most stupendous waterfalls, and the biggest hotels, are all to be found in the New World. Fortunes are made with a rapidity which is unparalleled in Europe; and men who only lately were penniless adventurers are losing or winning millions in New York. The latest example of the scale on which everything in America is conducted may be found in a volume of more than 1000 pages, printed in the Government printing-office, bound in the Government "bindery" of the United States, and containing the Annual Report of the United States Commission on Fish and Fisheries. The volume, it may be added, has been preceded by five others of almost equal length; and gives a remarkable idea of the importance which the Americans attach to fish-culture.

It would obviously be impossible to attempt, within the compass of a newspaper article, any adequate review of a work of this character. But we may perhaps indicate its nature by rapidly describing its contents. The volume, then, is roughly divisible into two parts. The first 64 pages contain the Report of the Commission; the last 988 pages are occupied with appendices and an index. Forty-four appendices of unequal importance are thus published. The greater portion of them consists of translations or reproductions of papers published in other countries and having more or less reference to the work of the Commission. For instance, there is a report by Herr Wallem (the well-known Norwegian Inspector of Fisheries) on the American Fsheries; by Prof. Sars on the Norwegian Deep-sea Expedition of 1878; by Mr. Stirling of Edinburgh on the Recent Outbreak of Salmon Disease; and by other authorities on various subjects. In addition the appendices contain original papers by Messrs. Livingston Stone, C. G. Atkins, and other American fish-culturists on matters more or less connected with fish-culture in the United States. Thus the volume undoubtedly contains a vast mass of information. Much of it indeed is written in a style which in this country would be considered more suitable to a review than to an official report. But the American system of government is so different from our own that an Englishman cannot easily form an impartial opinion on this point.

Herr Wallem estimates the yearly profit, by which we think he means the gross yield, of the fisheries of the United States at 27,300,000 dollars. In this sum is "naturally not included what foreign nations capture on the banks of America, nor what the fisheries of Canada yield. If one should take both these factors into the calculation the amount mentioned may perhaps be increased by one half, because the French fisheries alone on the Newfoundland Islands have a yearly profit of $1,365,000 to $1,638,000, and the Canadian fisheries yield $10,920,000 to $12,285,000 yearly." Herr Wallem adds in a note that "for comparison it may perhaps be instructive to state that the Norwegian Marine Fisheries may be estimated at $12,285,000 to $13,650,000 yearly, and the French at $15,015,000 to $16,380,000." If these figures may be accepted as correct on the high authority of Herr Wallem, the American fisheries must be worth about 5,500,000*l.* a year; the French fisheries 3,250,000*l.*; the Norwegian fisheries 2,600,000*l.*; and the Canadian fisheries 2,250,000*l.* We have unfortunately no statistics at our command which would enable us to compare these values with the produce of our own fisheries, but we do not believe that any competent authority would place their value at less than 6,300,000*l.*; and we believe that most persons would be disposed to name a higher sum. Englishmen, therefore, may have the satisfaction of reflecting that the fisheries of the British Islands are still the most important in the world; though the fishermen of the United States are fast overtaking British fishermen.

Those persons who are most familiar with the British fisheries are aware that for years past complaints have been made of the injury done both to fish and fishermen by the operations of trawling. It is very singular that trawling is also objected to in the United States; and the Commissioners print in their appendices a petition from the fishermen of Block Island on the subject. But the similarity between the complaints disappears on examination. A trawl in England is a large purse-net, attached to a heavy beam raised upon trawl heads or irons at either end, and dragged along the bottom of the sea. A trawl in Scotland is simply a draft or seine-net; a trawl in America is a long line baited with hooks and left on the bottom of the sea. It is very odd that these three distinct modes of fishing are all objected to in the different countries in which they are employed. In Scotland the drift-net fishermen object to the trawl or seine-nets; in England the drift-net fishermen and the line fishermen object to the beam trawls. In America the hand-line fishermen object to the set-line fishermen, whom they call trawlers. Among the fishermen of the three countries there is a cry against trawling, and the fishermen of the three countries are all alluding to distinct modes of fishing. These complaints may, centuries hence, puzzle some antiquarians, who may naturally assume that these races, speaking the same language, mean the same thing by the same word. They all are due to the jealousy usually felt by the introduction of new machinery in any industry. The set-line fishermen, who complain of the beam trawls in this country, form the very class which the hand-line fishermen complain of in America under the name of trawlers; and the Governments of both countries may safely disregard both complaints, since one of them is the most effective answer to the other.

We have reserved for the close of this article all reference to what the Commissioners would consider the most important portion of their Report. The Americans are the greatest fish-breeders in the world, and fish-breeding is conducted in the United States at a cost and to an extent of which in this country we can have little idea. According to the Report, the Commissioners distributed in 1878 no less than 15,700,000 shad and 4,460,000 Californian salmon, besides other fish. Such prodigious efforts will excite surprise among persons who are acquainted with the difficulties of obtaining even a few thousand ripe salmon eggs, and we naturally turn for information as to the results which have ensued from such unprecedented efforts. Here however we find, as it seems to us, the least satisfactory portion of the Report. The Commissioners claim indeed that no less than 500 salmon were taken in the mouth of the Connecticut River in 1878, a river which they imply had had few or no salmon in it for many years. It is possible therefore that the Commissioners' efforts may have been successful in restocking that river with salmon; though we own that we should feel more certain of this if the fish had been taken in the river itself, and not in the mouth of it. But when they go on to infer that they may increase the yield of shad, and even of herring and of cod, we read with admiration of their energy, but without being convinced by their reasoning. In this country, at any rate, the best observers are satisfied that cod, herring, and other fish are annually bred in numbers compared with which the fifteen millions of fry of the United States Commission would represent an insignificant fraction, and that the destruction which is going on among them by natural causes is so vast that even the capture of white bait by the ton-load makes no appreciable addition to it. The arguments which Malthus, at the commencement of the century, used to illustrate the principles of population are thought in this country to be strictly applicable to fish. Sea-fish, like all other animals, are undoubtedly increasing in greater proportion than their food; and it is obvious therefore that unless man can increase their food it is only lost labour to increase their number.

We have thus reviewed, at some length, a few of the leading facts in this long and interesting Report. With many of the conclusions in it we are unable to agree; but we cannot part from it without expressing a feeling of almost envy at the elaborate pains which the Government of the United States is taking to understand the best methods of developing the great industries of their seas. In this country we do not even take steps to obtain the best statistical information on the subject. Might we not in such a matter with advantage follow the example of our Transatlantic kinsmen?

THE PARIS OBSERVATORY[1]

ABOUT two years ago Rear-Admiral Mouchez, director of the Paris Observatory, resolved to bring together for exhibition the instruments scattered in various parts, and by joining to that collection the portraits of great astronomers and methodically grouping all the documents relating to the history of astronomy which could be procured by bequest or otherwise, to lay the basis of a special museum of very great interest. This proposal, having received the approval of the Minister of Public Instruction, is now being realised. One of the large rooms on the first floor of the Observatory has already been fitted up and occupied, and through the kindness of Admiral Mouchez, who himself did us the honour of giving full details of his new collection, we are able to publish the description.

[1] From an article by M. Gaston Tissandier in *La Nature*, and M. Mouchez's official Report of 1880.

The first hall of the Astronomical Museum is very artistically decorated. It is circular in form, and well lighted by several windows. The ceiling will probably be adorned by a painting representing the transit of Venus over the Sun. There are nine paintings in the room, representing Louis XIV., founder of the Observatory, and directors and eminent astronomers who have

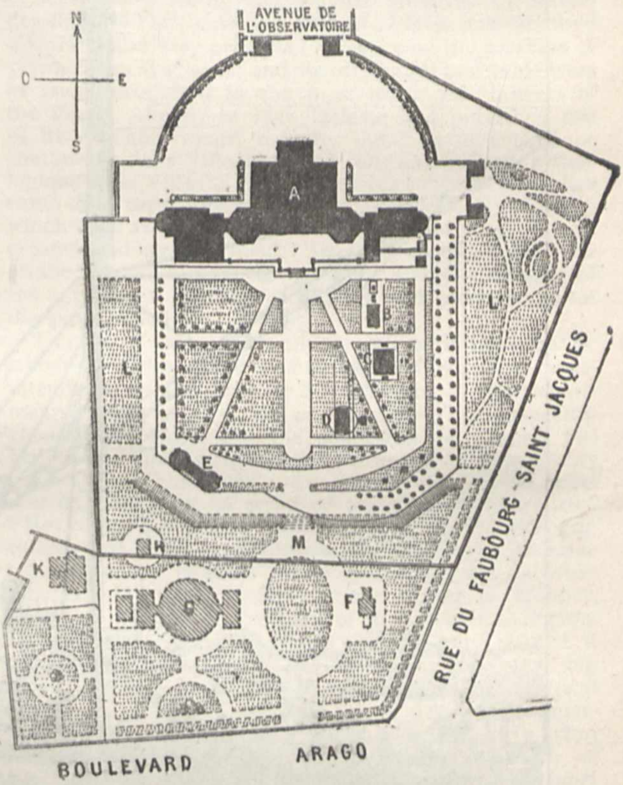


FIG. 1.—Plan of the Observatory, with the proposed extension on the south side to the Boulevard Arago Present state: A, the Observatory; B, the "sidérostat," C, the meridian circle; D, the great telescope; E, equatorials; M, ditch to be filled up; L L', ditches. Ground to be annexed; F, the Bischoffsheim equatorial; G, the great refractor of 0·74m. aperture; H, Fortin's circle; K, the astronomers' dwelling-house.

succeeded each other to the present day: Cassini, Lalande, Delambre, Laplace, Bouvard, Arago, Delaunay, and Leverrier; the latter painted after death by Giacomotti, is the gift of M. Bischoffsheim. In the embrasures of the windows are displayed astronomical paintings representing groups of nebulæ, Saturn's rings, lunar volcanoes, clusters of stars, the remarkable drawings of Jupiter and Mars executed by MM. Henry, &c.

On the oak mantelpiece stands a magnificent Louis-Quatorze clock made by Coypel and recently restored by M. Passerat, a specimen of art so unique that virtuosos would certainly attach a great value to it. Round the room are observed several globes mounted on marble and oak pillars, two being especially worthy of attention: the celestial sphere of Gerard Mercator (1551), and the terrestrial sphere of the same geographer (1541). On the latter globe may be seen figured a certain number of the great lakes of Central Africa already known and their positions well indicated in the middle of the sixteenth century. These spheres, which constitute documents of great importance historically, were recently discovered at the Brussels library through a folio pamphlet bought in 1868, and have been reproduced with great accuracy, by M. Malou.

The objects exhibited are carefully classified in glass cases, so that they can be examined by the visitor without being touched. In the first case, which is set apart for optical instruments, is observed Fresnel's great lens; also some of the object-glasses made use of by Cassini, and other valuable objects presented to the Observatory by Mme. Laugier, such as the optical apparatus made use of by Arago; the photometer, prismatic mirrors, and the polarimeter, by means of which the great astronomer enriched science with so many beautiful discoveries.

The second case contains objects relating to the history of the "metric system," comprising a standard metre and several curious specimens of foreign measures. The other glass cases, arranged in a circle round the room, contain various astronomical instruments, among which we may mention the apparatus made use of by M. Cornu to measure the velocity of rays of light, a large theodolite of Rigaud, another of Bruner, one of the first sextants ever constructed; also several instruments of more modern date, the first portable meridian circle of M. Mouchez, Gambey's theodolite, &c.

The case in the centre of the room is especially

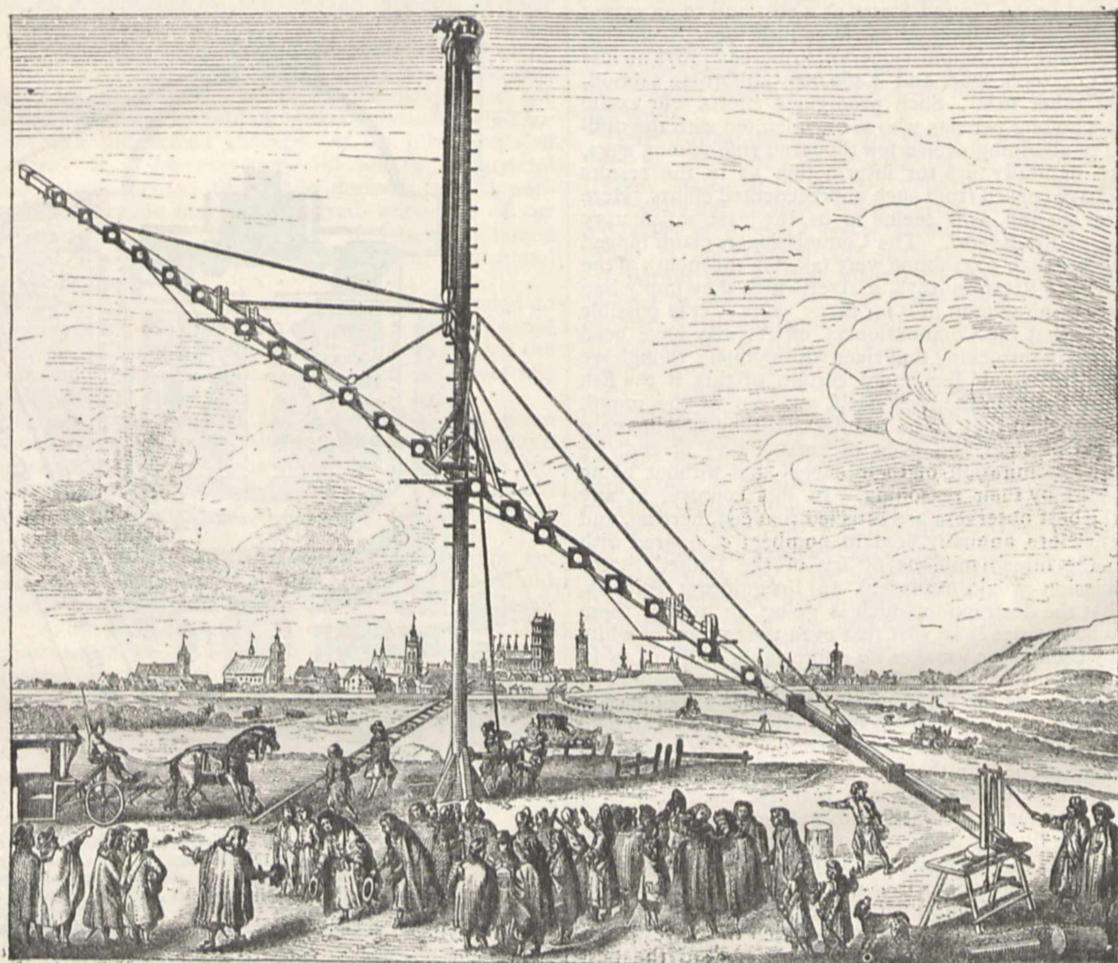


Fig. 2.—Aërial telescope of the seventeenth century, after Hevelius, from an engraving in the new Astronomical Museum of the Observatory of Paris.

noticeable: it contains a curious collection of German instruments of the sixteenth century, in perfect preservation. The attention is at once attracted by several instruments of gilt brass, most artistically carved, which were made at Nüremberg in the sixteenth century. Amongst them we observed a curious mechanical arrangement for casting dice, which was probably used for some demonstration of the doctrine of probability and chances; a valuable sun-dial of carved brass, dated 1578, full of groups of allegorical personages; a species of altazimuth; a handsome repeating-circle, highly ornamented, and bearing the two-headed eagle of Germany; some astrolabes, quadrants, mariner's-compasses, a small ivory sun-dial of the sixteenth century, presented by M. Eichens. The history of all these instruments except the last is unknown; but it is supposed that they were either presented to Louis XIV. or are what is left from the spoil of the First Empire having escaped the notice of the Allies in 1815.

On the lower part of this case are shown photographs of old engravings representing the astronomical instruments of former ages. One of those curious pictures is reproduced above (Fig. 2), showing the astronomical telescope with a simple object-glass of long focus which was constructed in the seventeenth century, and of which an engraving was published by Hevelius. It may serve to convey an idea of the singular and gigantic instruments which astronomers of bygone times made use of.

In a room on the floor above there is a special exhibition of a large number of photographs, which is being constantly increased by new additions. They consist of photographs of all the ancient instruments copied from engravings of the period; and all the foreign instruments in present use, taken from nature. There are also drawings representing the principal observatories in the world.

Such is the commencement of the astronomical museum of the Paris Observatory. It will be completed by organising a second circular room resembling that which we have just rapidly passed under review. This new room will be adorned with portraits of the most illustrious of foreign astronomers:—Newton, Galileo, Tycho-Brahe, Kepler, Copernicus, Herschel, Bradley, and others. It will also contain a special exhibition of large astronomical instruments; notably a quadrant of Lalande's, a sextant of Lacaille's, a quadrant of Langlois' which was used by the North Pole Committee, and a meridian telescope of Delambre.

It would be useful to bring together in the Paris Observatory those instruments which are scattered here and there in various other national institutions, so as to complete a collection already so rich in valuable objects. The directors will also gratefully accept of any bequests that may be addressed to them from private individuals, as was done by Mme. Laugier with reference to the instruments of Arago and Delambre which she had in her possession.

After our survey of the new Astronomical Museum, it now remains to say a few words regarding the extension of the observatory, which is about to be made by annexing the ground on the Boulevard Arago (Fig. 1). This waste land contains a superficies of at least 9000 metres, and when the ditch which at present divides it from the Observatory garden is filled up, it will be united to the rest of the institution without any separation. On these grounds will be erected the great ·75 m. telescope, the arrangements for which are already well advanced; also the equatorial presented by M. Bischoffsheim, the circle of Fortin, which long rendered excellent service, and was dismounted in 1862 to make room for the the great meridian-circle, and several instruments for the special use of the pupils.

The plan which we give above (Fig. 1), from official documents, shows what the Paris Observatory will be as a whole when the projected improvements are completed.

We regret that the works are being so slowly carried on, notwithstanding the praiseworthy energy evinced by the directors of the Observatory. A ditch to be filled in, a garden to be laid out, a few buildings to be erected, all amount to but very little. But before the masons cut a stone or the gardeners trace an alley there is a path to be traversed which is not exactly the shortest or quickest, viz. that of administrative and official routine.

ACHILLE DELESSE

WE regret to have to record the death of this eminent geologist, which took place, after a long illness, on March 24. Delesse was born at Metz, and was educated at the lyceum of that town, afterwards proceeding, at the age of twenty, to the École Polytechnique at Paris. He was a diligent and successful student, and in 1839 took his degree as a mining engineer. He then travelled for some time through his own country, in Germany, Poland, and the British Islands, and in 1845 was appointed Professor of Geology and Mineralogy at Besançon, where he also practised as a mining engineer. It was during his residence here that he wrote his "Notice sur les Charactères de l'Arkose dans les Vosges," and his "Mémoire sur la Constitution minéralogique et chimique des Roches de Vosges," both of which works appeared in 1847. After a stay of five years at Besançon Delesse returned to Paris, where he was employed as a mining engineer, and was especially engaged in superintending the quarrying operations about the city for nearly eighteen years. In 1855 he prepared the report on building materials in connection with the Exposition Universelle of that year in Paris. In 1864 he was nominated Professor of Agriculture, Drainage, and Irrigation in the École des Mines. Delesse's earliest researches were directed to pure mineralogy, and he paid great attention to the subjects of pseudomorphs and the association of minerals, and this led him to study the question of the metamorphism of rocks. The outcome of this period of study was his well-known work, "Recherches sur l'Origine des Roches," published in 1865, in which he argued ably and forcibly in favour of the view that crystalline rocks owe many of their characters to the action of superheated water, and are not produced by simple dry fusion. This important work of Delesse has exercised a marked and very beneficial influence on the progress of petrographical science, and its originality and value were at once recognised by the most advanced thinkers of the time. Already in 1858 Delesse had published two of his valuable maps, namely, the "Carte géologique soutteraine de la Ville de Paris" and the "Carte hydrologique de la Ville de Paris," and his subsequent studies came to be especially directed into the channels of inquiry which were associated with the professorship that he had created and so ably filled. In 1868 appeared his work on the Rainfall of France, and other memoirs treating of the agricultural bearings of geology were produced about the same period.

The war of 1870 caused an interruption in the scientific labours of Delesse, and we find him at this period superintending the construction of cartridges in the departments. But in 1878 he was appointed an Inspector-General of Mines, and the south-east of France was assigned to him as his district. During the last twenty years Delesse has issued, in conjunction with MM. Langel and de Lapparent, a series of annual volumes entitled "Revue de Géologie," a work of such value that we regret to hear that it is to be discontinued in the future. Delesse received many honours in recognition of his valuable labours. He was an officer of the Legion of Honour, and filled the post of President of the Geological Society of France. As long ago as 1859 he was elected a Foreign Member of our own Geological Society. He was also for two years President of the French Geological Society, and he occupied the chair during the International Congress of that Society in 1875. In 1879 Delesse was elected a Member of the Academy of Sciences. In Delesse France has lost one of her most distinguished and widely-known scientific men.

PROFESSOR HELMHOLTZ'S FARADAY LECTURE

ON Tuesday evening Prof. Helmholtz gave the Faraday Lecture of the Chemical Society at the Royal Institution. We have so recently (NATURE, vol. xv. p. 389) given a full account of the life and work of the eminent German worker in various departments of science, that it is unnecessary to go over the ground again. A very fair estimate of his position was given in a leading article in the *Times* of Saturday last; and we are glad to notice that the leading journal now is glad to draw attention to men of science whose work is deserving of public notice. The University of Cambridge did itself the honour of conferring upon Prof. Helmholtz the degree of LL.D. on Thursday last, on which occasion the public orator, Mr. Sandys, made the following elegant and appropriate speech:—

"Dignissime domine, domine Procancellarie, et tota Academia:

"Singularum quidem scientiarum terminos protulisse, plurimis concessum est; uni vero plurimarum fines extendisse raro contigit. Atqui hodie virum salutamus, qui rerum naturae regionem plusquam unam feliciter occupavit, qui primum physiologiae penetralia perscrutatus, deinde physicorum studiorum campo amplissimo potitus, ipsam denique mathematicorum arcem fortiter expugnavit, ex alia deinceps in aliam provinciam progressus, velut militum Romanorum ille maximus, 'victrices aquilas alium laturus in orbem.'

"Militarium medicorum ordini adhuc adscriptus, argumentum magnum intra unius libelli fines artiores complexus, ostendit vim illam, quae nonnunquam viva vocatur, in universa rerum natura esse conservatam, partes eius aliam ex alia posse generari, summam esse immutabilem. Quid huius ingenio excogitatas commemorem quaestiones illas hydrodynamicas, quid vortices illos qui scientiae mathematicae ad interiora pertinent? Illa vero magna opera, quorum in uno sensus audiendi clarissime explicatur, in altero videndi sensus pulcherrime illustratur, omnes, nisi fallor, aut vidistis ipsi, aut fama certe audivistis. Pulchrum est (uti hunc ipsum confitentem legimus), pulchrum profecto est, e scopulo quodam excelso late tumultuantem oceanum prospicere, fluctusque procul albescentes, modo breviores, modo longiores, oculis discernere: pulchrius autem in physiologiae templo intimo versatum, oculorum ipsorum structuram exquisitam introspicere, et, lucis legibus obscuris ordine lucido evolutis, fluctuantes luminis motus metiri variamque colorum venustatem explicare: omnium fortasse pulcherrimum, in iisdem arcanis morantem, undas illas aeris quas nulla nisi mentis acie contemplari possumus, inter sese audiendo distinguere; sonitus cuiusque, dum tremit vibratque, intervalla numerare; universam denique musices theoriam et mathematicis et physicis et physiologicis probavisse argumentis.

"Ille igitur qui tot provinciarum confinia lustravit, tot scientiarum fines propagavit, a nostra praesertim Academia, cuius alumni totiens ex eodem studiorum campo laureas reportarunt, ea qua par est reverentia hodie excipitur. Qui Academiae nostrae nemora, et iuventutis Academicae ludos et certamina iampridem admiratus est, idem fortasse severiora nostra studia quo melius noverit, eo benignius indies aestimabit. Vos certe, qui, talium virorum exemplar procul venerati, etiam nostras inter silvas verum quaeritis, quanquam hodie nemora illa nostra gravis umbra contristat, tamen inter ipsas lacrimas non sine gaudio virum magnum vidistis, quaque soletis benevolentia laudatum audivistis.

"Vobis igitur praesento Academiae Berolinensis Professorem illustrem, HERMANNUM LUDOVICUM FERDINANDUM HELMHOLTZ."

The Society of Telegraph Engineers are to give a *conversazione* in honour of the distinguished electrician at University College, Gower Street, on the evening of the 11th inst. The large library and entrance hall will be lit up by electric light, and it is hoped there will be a full display of all the recent novelties in electrical science.

As might have been expected, there was a distinguished audience on Tuesday evening to listen to Prof. Helmholtz at the Royal Institution. Prof. Roscoe, the President of the Chemical Society, in introducing the lecturer, made the following remarks:—

"Ladies and Gentlemen, Fellows of the Chemical Society—The cordial welcome which you have just given to Prof. Helmholtz shows me that he needs no formal introduction at my hands. His name is honoured wherever science is valued, and both his face and his voice are well remembered in this room. It may therefore suffice if I say that eminent as an anatomist, as a physiologist, as a physicist, and as a mathematician, we chemists are now about to claim him also as our own.

"Prof. Helmholtz, in the name of the Chemical Society, and on behalf of its Fellows here assembled, I beg to welcome you amongst us; I have the honour to present you with the Faraday Medal of the Society, and to request that you will favour us with your lecture, to which we shall all listen with pleasure and profit."

The Faraday Lecture[1]

THE majority of Faraday's own researches were connected, directly or indirectly, with questions regarding the nature of electricity, and his most important and most renowned discoveries lay in this field. The facts which he has found are universally known. Nevertheless, the fundamental conceptions by which Faraday has been led to these much-admired discoveries have not been received with much consideration. His principal aim was to express in his new conceptions only facts, with the least possible use of hypothetical substances and forces. This was really a progress in general scientific method, destined to purify science from the last remnants of metaphysics. Now that the mathematical interpretation of Faraday's conceptions regarding the nature of electric and magnetic force has been given by Clerk Maxwell, we see how great a degree of exactness and precision was really hidden behind his words, which to his contemporaries appeared so vague or obscure; and it is astonishing in the highest degree to see what a large number of general theories, the methodical deduction of which requires the highest powers of mathematical analysis, he has found by a kind of intuition, with the security of instinct, without the help of a single mathematical formula.

The electrical researches of Faraday, although embracing a great number of apparently minute and disconnected questions, all of which he has treated with the same careful attention and conscientiousness, are really always aiming at two fundamental problems of natural philosophy, the one more regarding the nature of physical forces, or of forces working at a distance; the other, in the same way, regarding chemical forces, or those which act from molecule to molecule, and the relation between these and the first.

The great fundamental problem which Faraday called up anew for discussion was the existence of forces working directly at a distance without any intervening medium. During the last and the beginning of the present century the model after the likeness of which nearly all physical theories had been formed was the force of gravitation acting between the sun, the planets, and their satellites. It is known how, with much caution and even reluctance, Sir Isaac Newton himself proposed his grand hypothesis, which was destined to become the first great and imposing example, illustrating the power of true scientific method.

But then came Oerstedt's discovery of the motions of magnets under the influence of electric currents. The force acting in these phenomena had a new and very singular character. It seemed as if it would drive a single isolated pole of a magnet in a circle around the wire conducting the current, on and on without end, never coming to rest. Faraday saw that a motion of this kind could not be produced by any force of attraction or repulsion, working from point to point. If the current is able to increase the velocity of the magnet, the magnet must react on the current. So he made the experiment, and discovered induced currents; he traced them out through all the various conditions under which they ought to appear. He concluded that somewhere in a part of the space traversed by magnetic force there exists a peculiar state of tension, and that every change of this tension produces electromotive force. This unknown hypothetical state he called provisionally the electrotonic state, and he was occupied for years and years in

[1] Abstract prepared by the author.

finding out what was this electrotonic state. He discovered at first, in 1838, the dielectric polarisation of electric insulators, subject to electric forces. Such bodies show, under the influence of electric forces, phenomena perfectly analogous to those exhibited by soft iron under the influence of the magnetic force. Eleven years later, in 1849, he was able to demonstrate that all ponderable matter is magnetised under the influence of sufficiently intense magnetic force, and at the same time he discovered the phenomena of diamagnetism, which indicated that even space, devoid of all ponderable matter, is magnetisable; and now with quite a wonderful sagacity and intellectual precision Faraday performed in his brain the work of a great mathematician without using a single mathematical formula. He saw with his mind's eye that by these systems of tensions and pressures produced by the dielectric and magnetic polarisation of space which surrounds electrified bodies, magnets or wires conducting electric currents, all the phenomena of electro-static, magnetic, electro-magnetic attraction, repulsion, and induction could be explained, without recurring at all to forces acting directly at a distance. This was the part of his path where so few could follow him; perhaps a Clerk Maxwell, a second man of the same power and independence of intellect, was necessary to reconstruct in the normal methods of science the great building, the plan of which Faraday had conceived in his mind and attempted to make visible to his contemporaries.

Nevertheless the adherents of direct action at a distance have not yet ceased to search for solutions of the electromagnetic problem. The present development of science, however, shows, as I think, a state of things very favourable to the hope that Faraday's fundamental conceptions may in the immediate future receive general assent. His theory, indeed, is the only existing one which is at the same time in perfect harmony with the facts observed, and which at least does not lead into any contradiction against the general axioms of dynamics.

It is not at all necessary to accept any definite opinion about the ultimate nature of the agent which we call electricity.

Faraday himself avoided as much as he could giving any affirmative assertion regarding this problem, although he did not conceal his disinclination to believe in the existence of two opposite electric fluids.

For our own discussion of the electro-chemical phenomena, to which we shall turn now, I beg permission to use the language of the old dualistic theory, because we shall have to speak principally on relations of quantity.

I now turn to the second fundamental problem aimed at by Faraday, the connection between electric and chemical force. Already, before Faraday went to work, an elaborate electro-chemical theory had been established by the renowned Swedish chemist Berzelius, which formed the connecting-link of the great work of his life, the systematisation of the chemical knowledge of his time. His starting point was the series into which Volta had arranged the metals according to the electric tension which they exhibit after contact with each other. A fundamental point which Faraday's experiment contradicted was the supposition that the quantity of electricity collected in each atom was dependent on their mutual electro-chemical differences, which he considered as the cause of their apparently greater chemical affinity. But although the fundamental conceptions of Berzelius' theory have been forsaken, chemists have not ceased to speak of positive and negative constituents of a compound body. Nobody can overlook that such a contrast of qualities, as was expressed in Berzelius' theory, really exists, well-developed at the extremities, less evident in the middle terms of the series, playing an important part in all chemical actions, although often subordinated to other influences.

When Faraday began to study the phenomena of decomposition by the galvanic current, which of course were considered by Berzelius as one of the firmest supports of his theory, he put a very simple question, the first question indeed which every chemist speculating about electrolysis ought to have answered. He asked, What is the quantity of electrolytic decomposition if the same quantity of electricity is sent through several electrolytic cells? By this investigation he discovered that most important law, generally known under his name, but called by him the law of definite electrolytic action.

Faraday concluded from his experiments that a definite quantity of electricity cannot pass a voltametric cell containing acidulated water between electrodes of platinum without setting free at the negative electrode a corresponding definite amount of hydrogen, and at the positive electrode the equivalent quantity of oxygen, one atom of oxygen for every pair of atoms of hydrogen. If instead of hydrogen any other element capable of substituting hydrogen is separated from the electrolyte, this is done also in a quantity exactly equivalent to the quantity of hydrogen which would have been evolved by the same electric current.

Since that time our experimental methods and our knowledge of the laws of electrical phenomena have made enormous progress, and a great many obstacles have now been removed which entangled every one of Faraday's steps and obliged him to fight with the confused ideas and ill-applied theoretical conceptions of some of his contemporaries. We need not hesitate to say that the more experimental methods were refined, the more the exactness and generality of Faraday's law was confirmed.

In the beginning Berzelius and the adherents of Volta's original theory of galvanism, based on the effects of metallic contact, raised many objections against Faraday's law. By the combination of Nobili's astatic pairs of magnetic needles with Schweigger's multiplicator, a coil of copper wire with numerous circumvolutions, galvanometers became so delicate that the electro-chemical equivalent of the smaller currents they indicated was imperceptible for all chemical methods. With the newest galvanometers you can very well observe currents which would want to last a century before decomposing one milligram of water, the smallest quantity which is usually weighed on chemical balances. You see that if such a current lasts only some seconds or some minutes, there is not the slightest hope to discover its products of decomposition by chemical analysis. And even if it should last a long time the feeble quantities of hydrogen collected at the negative electrode can vanish, because they combine with the traces of atmospheric oxygen absorbed by the liquid. Under such conditions a feeble current may continue as long as you like without producing any visible trace of electrolysis, even not of galvanic polarisation, the appearance of which can be used as an indication of previous electrolysis. Galvanic polarisation, as you know, is an altered state of the metallic plates which have been used as electrodes during the decomposition of an electrolyte. Polarised electrodes, when connected by a galvanometer, give a current which they did not give before being polarised. By this current the plates are discharged again and returned to their original state of equality.

This depolarising current is indeed a most delicate means of discovering previous decomposition. I have really ascertained that under favourable conditions one can observe the polarisation produced during some seconds by a current which decomposes one milligram of water in a century.

Products of decomposition cannot appear at the electrodes without motions of the constituent molecules of the electrolyte throughout the whole length of the liquid. This subject has been studied very carefully and for a great number of liquids, by Prof. Hittorff, of Münster, and Prof. G. Wiedemann, of Leipsic.

Prof. F. Kohlrausch, of Würzburg, has brought to light the very important fact that in diluted solutions of salts, including hydrates of acids and hydrates of caustic alkalis, every atom under the influence of currents of the same density moves on with its own peculiar velocity, independently of other atoms moving at the same time in the same or in opposite directions. The total amount of chemical motion in every section of the fluid is represented by the sum of the equivalents of the cation gone forwards and of the anion gone backwards, in the same way as in the dualistic theory of electricity, and the total amount of electricity flowing through a section of the conductor corresponds to the sum of positive electricity going forwards and negative electricity going backwards.

This established, Faraday's law tells us that through each section of an electrolytic conductor we have always equivalent electrical and chemical motion. The same definite quantity of either positive or negative electricity moves always with each univalent ion, or with every unit of affinity of a multivalent ion, and accompanies it during all its motions through the interior of the electrolytic fluid. This we may call the electric charge of the atom.

Now the most startling result, perhaps, of Faraday's law is this: If we accept the hypothesis that the elementary substances are composed of atoms we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity. As long as it moves about on the electrolytic liquid each atom remains united with its electric equivalent or equivalents. At the surface of the electrodes decomposition can take place if there is sufficient electromotive power, and then the atoms give off their electric charges and become electrically neutral.

Now arises the question, Are all these relations between electricity and chemical combination limited to that class of bodies which we know as electrolytes? In order to produce a current of sufficient strength to collect enough of the products of decomposition without producing too much heat in the electrolyte, the substance which we try to decompose ought not to have too much resistance against the current. But this resistance may be very great, and the motion of the ions may be very slow, so slow indeed that we should need to allow it to go on for hundreds of years before we should be able to collect even traces of the products of decomposition; nevertheless all the essential attributes of the process of electrolysis could subsist. If you connect an electrified conductor with one of the electrodes of a cell filled with oil of turpentine, the other with the earth, you will find that the electricity of the conductor is discharged unmistakably more rapidly through the oil of turpentine than if you take it away and fill the cell only with air.

Also in this case we may observe polarisation of the electrodes as a symptom of previous electrolysis. Another sign of electrolytic conduction is that liquids brought between two different metals produce an electromotive force. This is never done by metals of equal temperature, or other conductors which, like metals, let electricity pass without being decomposed.

The same effect is also observed even with a great many rigid bodies, although we have very few solid bodies which allow us to observe this electrolytic conduction with the galvanometer, and even these only at temperatures near to their melting-point. It is nearly impossible to shelter the quadrants of a delicate electrometer against being charged by the insulating bodies by which they are supported.

In all the cases which I have quoted one might suspect that traces of humidity absorbed by the substance or adhering to their surface were the electrolytes. I show you therefore this little Daniell's cell, in which the porous septum has been substituted by a thin stratum of glass. Externally all is symmetrical at both poles; there is nothing in contact with the air but a closed surface of glass, through which two wires of platinum penetrate. The whole charges the electrometer exactly like a Daniell's cell of very great resistance, and this it would not do if the septum of glass did not behave like an electrolyte. All these facts show that electrolytic conduction is not at all limited to solutions of acids or salts.

Hitherto we have studied the motions of ponderable matter as well as of electricity, going on in an electrolyte. Let us study now the forces which are able to produce these motions. It has always appeared somewhat startling to everybody who knows the mighty power of chemical forces, the enormous quantity of heat and of mechanical work which they are able to produce, and who compares with it the exceedingly small electric attraction which the poles of a battery of two Daniell's cells show. Nevertheless this little apparatus is able to decompose water.

The quantity of electricity which can be conveyed by a very small quantity of hydrogen, when measured by its electrostatic forces, is exceedingly great. Faraday saw this, and has endeavoured in various ways to give at least an approximate determination. The most powerful batteries of Leyden jars, discharged through a voltameter, give scarcely any visible traces of gases. At present we can give definite numbers. The result is that the electricity of 1 mgrm. of water, separated and communicated to two balls, 1 kilometre distant, would produce an attraction between them, equal to the weight of 25,000 kilos.

The total force exerted by the attraction of an electrified body upon another charged with opposite electricity is always proportional to the quantity of electricity contained in the attracting as on the attracted body, and therefore even the feeble electric tension of two Daniell's elements acting through an electrolytic cell upon the enormous quantities of electricity with which the constituent ions of water are charged, is mighty enough to separate these elements and to keep them separated.

We now turn to investigate what motions of the ponderable molecules require the action of these forces. Let us begin with the case where the conducting liquid is surrounded everywhere by insulating bodies. Then no electricity can enter, none can go out through its surface, but positive electricity can be driven to one side, negative to the other, by the attracting and repelling forces of external electrified bodies. This process going on as well in every metallic conductor is called "electrostatic induction." Liquid conductors behave quite like metals under these conditions. Prof. Wüllner has proved that even our best insulators, exposed to electric forces for a long time, are charged at last quite in the same way as metals would be charged in an instant. There can be no doubt that even electromotive forces going down to less than $\frac{1}{100}$ Daniell produce perfect electrical equilibrium in the interior of an electrolytic liquid.

Another somewhat modified instance of the same effects is afforded by a voltametric cell containing two electrodes of platinum, which are connected with a Daniell's cell, the electromotive force of which is insufficient to decompose the electrolyte. Under this condition the ions carried to the electrodes cannot give off their electric charges. The whole apparatus behaves, as was first accentuated by Sir W. Thomson, like a condenser of enormous capacity.

Observing the polarising and depolarising currents in a cell containing two electrodes of platinum, hermetically sealed and freed of all air, we can observe these phenomena with the most feeble electromotive forces of $\frac{1}{1000}$ Daniell, and I found that down to this limit the capacity of the platinum surfaces proved to be constant. By taking greater surfaces of platinum I suppose it will be possible to reach a limit much lower than that. If any chemical force existed besides that of the electrical charges which could bind all the pairs of opposite ions together, and required any amount of work to be vanquished, an inferior limit to the electromotive forces ought to exist, which forces are able to attract the atoms to the electrodes and to charge these as condensers. No phenomenon indicating such a limit has as yet been discovered, and we must conclude therefore that no other force resists the motions of the ions through the interior of the liquid than the mutual attractions of their electric charges.

On the contrary, as soon as an ion is to be separated from its electrical charge we find that the electrical forces of the battery meet with a powerful resistance, the overpowering of which requires a good deal of work to be done. Usually the ions, losing their electric charges, are separated at the same time from the liquid; some of them are evolved as gases, others are deposited as rigid strata on the surface of the electrodes, like galvanoplastic copper. But the union of two constituents having powerful affinity to form a chemical compound, as you know very well, produces always a great amount of heat, and heat is equivalent to work. On the contrary, decomposition of the compound substances requires work, because it restores the energy of the chemical forces, which has been spent by the act of combination.

Metals uniting with oxygen or halogens produce heat in the same way, some of them, like potassium, sodium, zinc, even more heat than an equivalent quantity of hydrogen; less oxidisable metals, like copper, silver, platinum, less. We find therefore that heat is generated when zinc drives copper out of its combination with the compound halogen of sulphuric acid, as is the case in a Daniell's cell.

If a galvanic current passes through any conductor, a metallic wire, or an electrolytic fluid, it evolves heat. Mr. Prescott Joule was the first who proved experimentally that if no other work is done by the current the total amount of heat evolved in a galvanic circuit during a certain time is exactly equal to that which ought to have been generated by the chemical actions which have been performed during that time. But this heat is not evolved at the surface of the electrodes, where these chemical actions take place, but is evolved in all the parts of the circuit, proportionally to the galvanic resistance of every part. From this it is evident that the heat evolved is an immediate effect, not of the chemical action, but of the galvanic current, and that the chemical work of the battery has been spent in producing only the electric action.

If we apply Faraday's law, a definite amount of electricity passing through the circuit corresponds to a definite amount of chemical decomposition going on in every electrolytic cell of the same circuit. According to the theory of electricity the work done by such a definite quantity of electricity which passes, producing a current, is proportionate to the electromotive force acting between both ends of the conductor. You see therefore that the electromotive force of a galvanic circuit must be, and is indeed, proportional to the heat generated by the sum of all the chemical actions going on in all the electrolytic cells during the passage of the same quantitity of electricity. In cells of the galvanic battery chemical forces are brought into action able to produce work; in cells in which decomposition is occurring work must be done against opposing chemical forces; the rest of the work done appears as heat evolved by the current, as far as it is not used up to produce motions of magnets or other equivalents of work.

Hitherto we have supposed that the ion with its electric charge is separated from the fluid. But the ponderable atoms can give off their electricity to the electrode, and remain in the liquid, being now electrically neutral. This makes almost no difference in the value of the electromotive force. For instance, if chlorine is separated at the anode, it will remain at first absorbed by the liquid; if the solution becomes saturated, or if we make a vacuum over the liquid, the gas will rise in bubbles. The electromotive force remains unaltered. The same may be observed with all the other gases. You see in this case that the change of electrically negative chlorine into neutral chlorine is the process which requires so great an amount of work, even if the ponderable matter of the atoms remains where it was.

The more the surface of the positive electrode is covered with negative atoms of the anion, and the negative with the positive ones of the cation, the more the attracting force of the electrodes exerted upon the ions of the liquid is diminished by this second stratum of opposite electricity covering them. On the contrary, the force with which the positive electricity of an atom of hydrogen is attracted towards the negatively charged metal increases in proportion as more negative electricity collects before it on the metal, and the more negative electricity collects behind it in the fluid.

Such is the mechanism by which electric force is concentrated and increased in its intensity to such a degree that it becomes able to overpower the mightiest chemical affinities we know of. If this can be done by a polarised surface, acting like a condenser, charged by a very moderate electromotive force, can the attractions between the enormous electric charges of anions and cations play an unimportant and indifferent part in chemical affinity?

You see, therefore, if we use the language of the dualistic theory and treat positive and negative electricities as two substances, the phenomena are the same as if equivalents of positive and negative electricity were attracted by different atoms, and perhaps also by the different values of affinity belonging to the same atom with different force. Potassium, sodium, zinc, must have strong attraction to a positive charge; oxygen, chlorine, bromine to a negative charge.

Faraday very often recurs to this to express his conviction that the forces termed chemical affinity and electricity are one and the same. I have endeavoured to give you a survey of the facts in their mutual connection, avoiding, as far as possible, introducing other hypotheses, except the atomic theory of modern chemistry. I think the facts leave no doubt that the very mightiest among the chemical forces are of electric origin. The atoms cling to their electric charges and the opposite electric charges cling to the atoms. But I don't suppose that other molecular forces are excluded, working directly from atom to atom. Several of our leading chemists have begun lately to distinguish two classes of compounds, molecular aggregates and typical compounds. The latter are united by atomic affinities, the former not. Electrolytes belong to the latter class.

If we conclude from the facts that every unit of affinity of every atom is charged always with one equivalent either of positive or of negative electricity, they can form compounds, being electrically neutral, only if every unit charged positively unites under the influence of a mighty electric attraction with another unit charged negatively. You see that this ought to produce compounds in which every unit of affinity of every atom is connected with one and only with one other unit of another atom. This is, as you will see immediately, indeed, the modern chemical theory of quantivalence, comprising all the saturated compounds. The fact that even elementary substances, with few exceptions, have molecules composed of two atoms, makes it probable that even in these cases electric neutralisation is produced by the combination of two atoms, each charged with its electric equivalent, not by neutralisation of every single unit of affinity.

But I abstain from entering into mere specialities, as, for instance, the question of unsaturated compounds; perhaps I have gone already too far. I would not have dared to do it if I did not feel myself sheltered by the authority of that great man who was guided by a never-erring instinct of truth. I thought that the best I could do for his memory was to recall to the minds of the men, by the energy and intelligence of whom chemistry has undergone its modern astonishing development, what important treasures of knowledge lie still hidden in the works of that wonderful genius. I am not sufficiently acquainted with chemistry to be confident that I have given the right interpretation, that interpretation which Faraday himself would have given perhaps, if he had known the law of chemical quantivalence, if he had had the experimental means of ascertaining how large the extent, how unexceptional the accuracy of his law really is; and if he had known the precise formulation of the law of energy applied to chemical work, and of the laws which determine the distribution of electric forces in space as well as in ponderable bodies transmitting electric current or forming condensers. I shall consider my work of to-day well rewarded if I have succeeded in kindling anew the interest of chemists for the electro-chemical part of their science.

At the conclusion of the lecture Prof. Roscoe made the following remarks :—

"The pleasing duty now devolves upon me of proposing a vote of thanks to our distinguished friend for his interesting, suggestive, and most appropriate address.

"Prof. Helmholtz has shown us that Faraday's conception of electricity is in exact accordance with the most modern developments of this science. He has told us that although Faraday was unacquainted with the technical details of mathematics, all his conclusions are capable of the most exact mathematical expression, and that our great experimentalist possessed the spirit and thoughts characteristic of a truly mathematical mind. But our lecturer has gone further, for upon Faraday's well-known law of electrolysis he has founded a new electro-chemical theory, which reveals to us chemists, conclusions of the utmost importance. He tells us as the results of the application of the modern theory of electricity to Faraday's great experimental law, that the atom of every chemical element is always united with a definite unvarying quantity of electricity. Moreover—and this is most important—that this definite amount of electricity attached to each atom stands in close connection with the combining power of the atom which modern chemistry terms quantivalence. For if the amount of electricity belonging to the monad atom be taken as the unit, then that of the dyad atom is two, of the triad atom three, and so on.

"Hence then, thanks first to Faraday and now to Helmholtz, chemists have now a new and unlooked-for confirmation of one of their most important doctrines from the science of electricity.

"These, Ladies and Gentlemen, are indeed sufficient grounds for our claiming Prof. Helmholtz as a chemist, and justify me in requesting that he will allow his name to be placed on the list of Honorary Fellows of the Chemical Society.

"I have much pleasure in proposing a hearty vote of thanks to the Faraday Lecturer for the year."

This proposal was seconded by Prof. Tyndall.

NOTES

MR. CLARENCE KING has resigned his position as Director of the Geological Survey of the United States. It has long been no secret that he wished to retire from an appointment which confined him chiefly to executive functions, left him with practically no time for independent scientific work, and hampered him in those mining and other financial operations in which he is understood to have large investments. In a letter dated the 12th ult., addressed to the President of the United States, he says that he believes he "can render more important service to science as an investigator than as the head of an executive bureau." All well-wishers to the cause of geology must hope that this belief will be fully justified; that the relief he obtains from official trammels will enable him once more to devote to geological research the energy and experience which have already borne such good fruit. His tenure of office in the Geological Survey has hardly been long enough to enable him fully to develop the plans he had sketched out for the vigorous prosecution of the Survey as a truly national undertaking, alike creditable to the scientific spirit of the Republic and important to the development of its industrial resources. But he will be held in honourable remembrance as the first head of the National Survey, and as having taken a leading share in its initial organisation. It is reported that Mr. J. W. Powell, so long and well known for his work in the Rio Colorado basin, is to be the new director.

A WISH having been expressed by certain members of the Torquay Natural History Society to have a portrait of Mr. William Pengelly, F.R.S., &c., and he having kindly consented to sit for the same, a committee has been formed for carrying the suggestion into effect. The portrait will, at Mr. Pengelly's request, be placed in the museum of the Society, Torquay. It was at first proposed to limit the list of subscribers to the members of the Torquay Natural History Society, but some members of the Devonshire Association, and other gentlemen, having expressed a wish to join in the work, it has been decided to make the contribution general. Subscriptions will be received by the hon. treasurer, Mr. Robert Kitson, Torquay Bank.

THE Royal Academy of Sciences of Turin gives notice that from January 1, 1879, the new term for competition for the third Bressa Prize has begun, to which, according to the testator's will, scientific men and inventors of all nations will be admitted. A prize will therefore be given to the scientific author or inventor, whatever be his nationality, who during the years 1879–1882, "according to the judgment of the Royal Academy of Sciences of Turin, shall have made the most important and useful discovery, or published the most valuable work on physical and experimental science, natural history, mathematics, chemistry, physiology and pathology, as well as geology, history, geography and statistics." The term will be closed at the end of December, 1882. The value of the prize amounts to 12,000 Italian lire. The prize will in no case be given to any of the national members of the Academy of Turin, resident or non-resident.

THE Literary and Philosophical Society of Manchester has recently completed the first century of its existence. Dr. Angus Smith is writing a history of the Society since its foundation, which will be read at an early meeting, and no doubt published in its *Proceedings*.

WE are glad to learn that the appeal on behalf of G. M. Smerdon, who has done such good work as foreman of the Kent Cavern explorations, has resulted in a sum sufficient to purchase him an annuity of 10*l*.

THE results of appointing a totally inexperienced and unknown man to the head of the Registrar-General's department, just before the taking of the census, are already beginning to be felt. Complaints of mismanagement are rife—whole streets in London not served with the census-papers, and in many cases those which were delivered have not yet been collected, and run some risk of being utilised for fire-lighting purposes. Certainly the interests of the country would have been best served by appointing Dr. Farr to the post of Registrar-General until at least the census work had been completed. Dr. Farr's long experience would have been of immense service, and these useful statistics would have been collected in something like scientific method.

THERE was a desultory talk on the subject of Technical Education in the House of Commons the other night, on the motion of Mr. Anderson to appoint a roving Commission to inspect the technical schools of the Continent. The fact is, as Mr. Mundella pointed out, we know quite well what is wanted here, and if the City Guilds would only spend the amount of money they ought to do, there need be no want of technical instruction for all who are prepared to take advantage of it. As it is, such institutions as Owens College, the Mason College, and others are putting a first-rate scientific technical education within the reach of all classes, and what is really wanted is the teaching of elementary science in all our primary schools. The House was counted out over the motion.

A MEETING for the purpose of forming a society for the advancement of chemical industry was held on Monday afternoon at the rooms of the Chemical Society, Burlington House, Piccadilly, Prof. Roscoe presiding. The chairman explained that for some time the want of a Society had been felt, the object of which was the advancement of chemical industry in the United Kingdom. Its main purpose would be to bring together at stated intervals all those who possessed chemical, physical, and engineering knowledge, and who used this knowledge in the utilisation of chemical action on a manufacturing scale, and who had the charge of or an interest in chemical industries. It might afterwards prove desirable to found a distinct branch of the engineering profession, who might be designated as chemical engineers. He drew attention to the advantages which would doubtless accrue to the various branches of chemical industry by the establishment of such an organisation. Briefly stated, its objects would be to enable persons interested in chemical industries to meet, to correspond, and to interchange ideas respecting improvements in the various processes, to publish information relating thereto by means of a journal or otherwise, to acquire and dispose of property for such purposes, and to do all other things incidental or conducive to the objects aimed at. Prof. Roscoe concluded by moving that it was desirable to form such a society as that suggested. This was seconded by Mr. Perkin and carried. Formal resolutions were then passed with the view of carrying out the object thus agreed upon.

WE take the following significant passage from a paper read by Sir George Campbell, K.C.S.I., M.P., late Lieutenant-Governor of Bengal, to the Society of Arts on March 25 last:—"Most of us who go to India know very little about agriculture of any kind; and of agriculture under the conditions of Indian soil and climate we know nothing whatever. The consequence has been that when we have attempted to show the natives how to improve their agriculture we have generally egregiously failed, and to use a native expression, our faces have been blackened. In this respect I am afraid we are not improving. The old-fashioned civil servant, if not so literary as the new class, and perhaps not much more agricultural, settled down more in the country and learned more of native agricultural habits and ways. Present administrators, I am afraid, know very little of any kind of agriculture, and it is much the same with the native public servant; formerly they knew nothing of English literature, but they knew a great deal of the country; now they are very highly educated, but do not know much more of agriculture than their European superiors."

THE post of Curator of the Herbarium of the Royal Botanic Gardens, Calcutta, has been filled up by the India Office by the appointment, on the nomination of the Director of the Royal Gardens, Kew, of Mr. L. J. K. Brace, of New Providence, Bahamas. Mr. Brace was educated at Christ's Hospital, and held a subordinate post in the colony. Having turned his attention to botany, he was employed by the late Governor, Mr. W. Robinson, to make a collection for Kew of the indigenous vegetation.

OF late years the cultivation of Liberian coffee (*Coffea Liberica*) has been energetically pushed in English coffee-growing colonies and possessions. This has been due to two causes:—First, the cultivation of Arabian coffee (*Coffea Arabica*) has been severely crippled in the New World by the "white fly" (*Cemiostoma coffeellum*), and in the Old by the "leaf disease" (*Hemileia vastatrix*); secondly, Liberian coffee being a more tropical plant, grows well at a zone of altitude below that which Arabian coffee requires. The produce of the plantations of the new species is now coming into commerce. At present it does not find much favour apparently in England, but in America it is better appreciated. Recent sales at New York of Ceylon-grown Liberian coffee have realised 93*s*. per cwt., or 12*s*. above the current quotation for middling plantation coffee (Arabian) in the London market. This is a result of great importance for the West Indian Islands. Liberian coffee has been found in Dominica to possess a comparative immunity from the attacks of the white fly, the ravages of which had all but completely extinguished the coffee-cultivation of the island. Not merely therefore can West Indian coffee cultivation be revived with reasonable prospect of success, but there is the additional encouragement of a ready market easy of access in the United States.

THE death is announced, at the age of seventy-five, of Sir Philip de Malpas Grey Egerton. Sir Philip was an occasional contributor to our pages.

A STRONG shock of earthquake occurred on Sunday afternoon at Chio, which has caused terrible destruction. Many houses in the principal town and thirty villages in the island are said to have been destroyed, and 4000 persons killed. Fresh shocks of earthquake occurred on Monday, and the inhabitants were taking refuge on board the steamers in the harbour. The country around and the town Tsesme, on the mainland, suffered considerably, and shocks were also felt on Monday at Zante, Syra, Smyrna, Carosto, Eubœa, and Tinos. The island of Chio, Scio, or Skio, for the name is thus variously spelt, is situated in the Ægean Sea, separated from the coast of Anatolia by a channel not more than seven miles wide where narrowest, and about fifty-three miles west of Smyrna.

SOME of our readers may be glad to learn that the French Association has resolved to curtail the number of scientific meetings in order to extend the time left for excursions and festivals. The programme includes two receptions by the Mayor of Algiers, one by the Governor-General, and a large Arabian *fête* called *Bita*, dancing and singing by native women, &c. Possibly the reported massacre of the Flatters Expedition may put a stop to these ultra-scientific festivities.

WE notice that the names of Drs. Gladstone and Tribe are down for a paper in the Physical and Chemical Section of the meeting of the French Association at Algiers, as also that of Mr. Rodwell.

AT the ordinary meeting of the Sanitary Insttiute, to be held at 9, Conduit Street, on Wednesday, April 13, at 8 p.m., the Chairman of Council, Dr. Richardson, F.R.S., will give a short address entitled, "Some Brief Suggestions on the Best Mode of dealing with Small Pox and other Infectious Diseases in the Metropolis and other large Towns," to be followed by a discussion.

MR. R. J. FRISWELL writes:—As the following novel "facts" have their origin in *Truth* there can, I presume, be no gainsaying of them. As they are entirely new and are published in a journal not so well known as a scientific paper as it ought to be, will you be good enough to give them a wider currency for the information of chemists. Their value needs no comment:—"The bomb with which the Emperor was killed appears to have been filled with nitro-glycerine, and it is unfortunate that this compound, like gun-cotton, is so easy to make. A certain amount of glycerine is taken, and to this sulphuric and nitric acid are added. Glycerine has an affinity for water. A molecule of water is abstracted, and a molecule of nitrous acid takes its place. Nitro-glycerine may be put into the fire or it may be struck without any dangerous consequence. If however it be set on fire by a fulminant, there is an explosion. If, as stated, the Russian bombs were made of glass, there must have been small projections made in the glass shell when manufactured, filled with fulminating powder. The explosive character arises from this: Nitrogen is composed of molecules in pairs of atoms. Nitric acid contains only one atom in its molecules. Upon this atom being set free from its unstable combination in the glycerine, the two atoms of nitrogen rush together, producing a vast amount of energy of combination in the shape of heat. The gaseous products are thus heated, and an explosion takes place immediately."

A SCHOOL of Gardening and Practical Floriculture has been established at the Crystal Palace, under the superintendence of Mr. Edward Milner.

M. DAUDIGNY, electrical engineer in Paris, has sent to the Municipal Council a petition asking for authority to establish on the top of the Colonne de Juillet a large electric lamp fed by a magneto-electric machine of fifty horse-power. This enormous light is to be diffused by a large reflector of special construction.

A MOST successful experiment in theatre illumination was tried on March 30 and 31, at the Athenæum of the rue des Martyrs, Paris, with the Werdermann incandescent light. The peculiarity of it is that it can be graduated at will for scenic effects, either by introducing resistance coils or varying the velocity of the Gramme machine. These experiments were witnessed by several influential members of the Municipal Council, who on the following morning proposed an inquiry into the propriety of obliging all the theatrical managers to light their halls with electricity.

MR. F. W. PUTNAM sends us a paper on Pueblo Pottery, which he contributed to the February number of the *American Art Review*. There are some well-executed coloured illustrations of specimens of the pottery which show some little taste in colour and ornamentation.

WE have had several replies to our inquiry concerning the late Dr. Thomas Dick's astronomical instruments. They seem to have been disposed of after his death, and only one small instrument can be definitely traced. None of the instruments seem to have been of much scientific value.

MR. JOHNSTON-LAVIS writes, under date March 29:—"Vesuvius is to-night again active, lava running down the north-western slope of the cone. Only the reflection is visible from Naples. On Sunday morning a slight shock, or more correctly subterranean thunder, was felt at Casamicciola, although those in the ruins at the moment only became aware of it by the palor of others present, whose whole attention is arrested by the faintest move or noise."

A SCIENCE Students' Association has been formed in Liverpool, which includes all departments of science in its programme; the president is Mr. A. Norman Tate.

THE system of compressed-air clocks, of the use and construction of which in Paris we gave an account some time ago, is likely to have a trial in London. A Bill has been introduced into Parliament for this purpose. The number of stations proposed for the metropolis is ten.

IN the notice of the meeting of the Mathematical Society in NATURE, vol. xxiii. p. 379, Mr. Wooster Woodruff Beman's name was misspelt Benson.

LIEUT.-COL. H. COLLETT, of Meean Meer, North-West Punjab, has sent us a money-order for 3*l.* towards the John Duncan Fund. We also acknowledge receipt of 1*l.* from M. G. S.

THE additions to the Zoological Society's Gardens during the past week include a Two-Spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. A. Wentworth Forbes; a Golden Sparrow (*Auripasser euchlorus*) from Abyssinia, presented by Mr. J. Abrahams; a Chukar Partridge (*Caccabis chukar*), a Grey Francolin (*Francolinus ponticerianus*) from India, presented by M. J. M. Cornely, C.M.Z.S.; two Indian Antelopes (*Antelope cervicapra* ♂ ♂) from India, deposited; two Æthiopian Wart Hogs (*Phacochœrus æthiopicus* ♂ ♀) from South-East Africa, a Dusky Parrot (*Pionus violaceus*) from Guiana, three Ceylonese Hanging Parrakeets (*Loriculus asiaticus* ♂ ♂ ♀) from Ceylon, a Yellow Troupial (*Xanthosoma flavus*) from Buenos Ayres, purchased; a Fork-tailed Jungle Fowl (*Gallus furcatus* ♂) from Java, on approval; two Four-horned Antelopes (*Tetraceros quadricornis* ♂ ♀), a Burrhel Wild Sheep (*Ovis burrhel* ♂) from India, a Javan Adjutant (*Leptoptilus javanicus*) from Java, a Rock-hopper Penguin (*Eudyptes chrysocome*) from the Falkland Islands, received in exchange.

OUR ASTRONOMICAL COLUMN

THE VARIABLE STARS U CEPHEI AND U GEMINORUM.—We learn from Mr. Knott that Ceraski's short-period variable in Cepheus was at a minimum on March 29 at about 12h. 45m. G.M.T.; clouds prevented observations till 11h. 35m., when it had barely fallen to minimum; for two hours, 11h. 45m.—13h. 45m., the star's light was sensibly constant—about 9·4m. On April 3 Mr. Knott again obtained a pretty complete observation; the time of minimum, taking the middle of the phase, was 12h. 24m. G.M.T.; for nearly 2h. 30m., or from 11h. 10m. to 13h. 36m., the star remained about 9·4m. Guided by these and previous observations the following approximate times of minima are inferred, and it is to be hoped that the series may be well observed:—

	h. m.		h. m.		h. m.
April 8	12 4	April 23	11 2	May 8	9 59
13	11 43	28	10 41	13	9 39
18	11 22	May 3	10 20	18	9 18

This variable has been hitherto called T Cephei in this column, but Mr. Knott draws attention to the circumstance that Ceraski (*Astron. Nach.*, No. 2343) applied that designation last October to another variable discovered by him, the position of which by meridian observations at Moscow was found to be in R.A. 21h. 7m. 57·05s., Decl. + 68° 0′ 8″·4 for 1880·0, and we accordingly follow his suggestion that the short-period variable will be more properly termed U Cephei.

U Geminorum was observed by Mr. Knott at about the maximum, or about 9·3m., on April 2 and 3. Maxima of this very irregular variable star are by no means easy to catch. It precedes the principal component of Σ 1158 by 1m. 26·5s., and is north of it 7′ 31″. Prof. Winnecke gave a series of comparison stars in *Astron. Nach.*, No. 1120. Argelander's position for 1855 is R.A. 7h. 46m. 29·88s.; Decl. + 22° 22′ 41″·5.

While writing upon variable stars we may mention that B.A.C. 4767 is probably to be included among them. It was estimated 4m. by D'Agelet on May 15, 1783; it is called 6m. by Lacaille, Lalande, and Piazzi, and was so estimated in Argelander's Zone, No. 301; but although rated 5·7 in the *Uranometria Argentina* it is not found in Heis's Atlas nor in the Uranometria of Argelander. Its place for the present year is in R.A. 14h. 18m. 1s., with south declination, 24° 15′·6.

THE COMET OF 1812.—Several years since, Mr. W. E. Plummer of the University Observatory, Oxford, after a new reduction of the observations made at Paris and Viviers, which we possess in their original form, found the period of revolution about 1½ years less than that given by Encke, so that it is quite possible that the comet may arrive again at perihelion within the present year. We have already mentioned that M. Schulhof of Paris is engaged upon a strict investigation of the elements of this comet, and has the intention of preparing extended ephemerides, in the same manner that he has done for several of the minor planets which had not been observed at several oppositions, but the sweeping lines for every fourth day throughout the year are given in Herr Mahn's ephemeris computed on the suggestion of Prof. Winnecke, which will be found in the *Vierteljahrsschrift der Astronomischen Gesellschaft*, 12 Jahrgang.

BIOLOGICAL NOTES

THE SHINING SLAVE-MAKER (POLYERGUS LUCIDUS).—The Rev. H. M'Cook is as fortunate as he is energetic in his studies of the American ants. At the December 1880, meeting of the Academy of Natural Sciences of Philadelphia he read a paper on the discovery at the foot of the Allegheny Mountains, near Altoona, of a nest of *Polyergus lucidus*, the American representative of the Legionary Ant of Huber (*P. rufescens*), an ant associated with that author's discovery of ant-nests, in which certain ants have associated with them, in a sort of slavery, ants of another species. The nest had four gates separated a few inches from each other; the chambers were placed one above the other, united by tubular galleries. In an inner ovoid chamber numbers of the ants, male and female, appeared; mingled with these in large numbers were workers in three forms—major, minor, and dwarf of *Formica Schauffussi*. A portion of the excavated nest was broken into, and on the next day but one was visited. None of the shining ants were at work, but the "slaves" were very busy cleaning out the galleries; a portion of the slaves were engaged in an extensive migration; a few were carrying their fellows, but for the most part the deportation was confined to the males and females of the shining ants. It was wonderful to see the large virgin-queens carried up the perpendicular face of the cutting for eighteen or twenty inches, and then for the distance of six feet over the ground and through the grass, and this in a few seconds over a minute. The shining ants are able to take a most wonderful grip. One of them had fallen under the displeasure of another, who held her firmly grasped by the middle thorax. Anxious to preserve the colony from unnecessary loss, Mr. M'Cook lifted the two out on the point of a quill toothpick, laid them on his hand, and thrust the fine point of the quill between the jaws of the agressor, and so teased her that she released her fellow. The rescued ant instantly clasped the palm of his hand, threw her abdomen under her, and then, with back curved like that of an angry cat, sawed and tugged away at the skin until an abrasion was made. The other ant still clung fast by her mandibles only to the toothpick's point, her body stretched out into space, her limbs stretched outwards, except one hind leg, which was a little bent upward, and thus without any perceptible support except that which her jaws gave her upon the quill-point, she hung outstretched for several minutes. About a month after its discovery the nest was again visited; it was abundantly peopled; the winged forms of the shining ant were however gone. Having succeeded in colonising these ants Mr. M'Cook was able to confirm in many particulars the statements of Huber, Forel, and others, but he never happened to see the slaves feeding their masters. He noticed that they seemed to like to move towards both warmth and light, but he does not seem to have settled the question whether they would not prefer the warmth without the light. They would appear to be very clean in their ways and persons. Various experiments seemed to establish the fact that these slave-makers always keep a guard ready at once for any attack.

ON THE RED COLOUR OF SALT COD.—During the hot and damp weather of summer in the United States the dried codfish sometimes exhibit a peculiar redness of colour. These red fish, as is well known, putrefy comparatively quickly, and this fact, taken in connection with the disagreeable, and in such fish unusual, colour, renders them unfit for market, so that in seasons when the redness prevails dealers in codfish suffer often very considerable losses. Prof. Farlow, M.D., was requested by the United States Fish Commission to investigate this subject, and his report appears in the Fish Report for 1880. In September, 1878, he went to Gloucester to examine the fish stores. The weather was at that time hot and damp, and the codfish then being prepared for the market were largely affected by the redness. This redness disappears with the return of cool weather. In most cases it does not appear until the fish have been landed from the vessels, though in a few cases the colour has appeared in the stock while still on board. A microscopical examination showed that the redness was owing to a very minute plant, *Clathrocystis roseo-persicina*, a species known to be closely related to *C. æruginosa*, so common in fresh-water ponds, and which has lately come into public notice in the States in consequence of the so called *pig pen* odour which it exhales when decaying. This red species is known both in America and Europe, and has been recently investigated by Cohn and others. It may sometimes be found tinging the surface of damp ground with a purplish tinge, and the anatomist is not unfamiliar with it as growing in his macerating tubs. It would appear not to flourish or increase very rapidly at a temperature below 65° Fahr. How it got to attack the dried fish was the next question. It was found that the plants could come from many sources, for it was found present in quantities in the wood-work of the wharves and packing-stores, but above all Prof. Farlow detected it in the salt with which the fish were cured. The salt from Cadiz had even a slight rose tinge. It will be a matter of interest, which perhaps some of our readers may help to solve, as to whether this plant is known in European fish-stations. In the great Norwegian cod-fisheries the temperature may not be high enough to favour its growth. As remedies Prof. Farlow suggests care in the selection of salt, and the constant cleaning of all wood-work or vessels that may come in contact with the fish. In addition to the red alga small quantities of cells destitute of colouring-matter and arranged in fours were not unfrequently found in the infected cod-fish. These suggested the genus Sarcina, but were not *S. ventriculi*. They rather, except in the absence of colouring-matter, resembled *Glœocapsa crepidinum*, Thuret, which species is common enough on the wood-work of the Gloucester wharves. While there is this resemblance Prof. Farlow prefers for the moment, and pending further investigation, to call it a Sarcina, and to describe it as a new species (*S. ? morrhuæ*).

MARINE ISOPODS OF NEW ENGLAND.—One of the most remarkable papers forming the extensive series of appendices to the Report of the United States Commissioners of Fish and Fisheries for 1878 is perhaps that by Oscar Harger on the marine Isopods of New England and adjacent waters. The limits chosen commence at Nova Scotia to the north and extend southwards to New Jersey. Forty-six species are recorded, and figures of these with the requisite details of anatomy are given on thirteen plates; several new species and one new genus (Syscenus) are described. It will be noted that the number of species is very considerably less than that known to frequent the British coasts, and of the former only eight are identical with British forms. This difference is very marked in the genus Sphæroma, of which genus there is but one species native to New England, while Bate and Westwood describe a dozen species belonging to this family as natives of Britain. *Limnoria lignosum*, one of the most destructive of the group, is apparently as common on the American coasts as on our own shores. It does not usually occur much below high-water mark, though Prof. Verrill has found it at a depth of ten fathoms in Casco Bay, and it was dredged by the U.S. Fish Commission at a depth of 7½ fathoms in Cape Cod Bay, Massachusetts. Of the family of the Cymothoidæ, of which we believe as yet no species has been found around the British Islands, three species belonging to three different genera are in Mr. Harger's list.—To this memoir there is appended a very complete list of authorities and an alphabetical index.

STATISTICS OF DISEASE IN ITALY.—In a recent paper to the Lombard Institute, Prof. Sangalli gives statistics of the diseases which terminated fatally in the Civic Hospital of Pavia during the period 1855 to 1881. The material was 6644 bodies which came up for autopsy, and the causes of death were, in decreasing order, genuine inflammation, 4504 deaths; tuberculosis, 808; pyæmia, 337; cancer, 366; hepatic cirrhosis, 252; extravasation of blood in the brain, 254; chronic ulcer (gastric and duodenal), 72, &c. (there being 2140 deaths apart from those by true inflammation). The 4504 deaths from inflammation presented 7962 separate inflammations. The deaths from tuberculosis are seen to be about 12 per cent. The ages most exposed to that disease lie between 20 and 30; next come those between 10 and 20, and between 30 and 40, about equal. There were twelve cases between 70 and 80, and one in an old man of 84. It does not appear that one sex suffers more than the other. Cancer occurs most between 50 and 60, and most largely in liver, lymphatic glands, and stomach. The patients were largely of the peasant class, and the author cannot support Niemeyer's view, that people living in marshy districts, liable to malaria, have a certain immunity from tuberculosis. Nor do the figures confirm the asserted tendency of ulcer in the stomach to favour the development of tuberculosis. Pyæmia appeared mostly in the lungs (149 cases out of 470), pleura, 99; liver, 73, &c. In some years there was a remarkable diminution of this disorder.

THE EYE AND INTENSITY OF COLOUR.—With an apparatus consisting of two Nicols with a gypsum plate between, and a spectroscope with a third Nicol attached to the eye-piece, Herr Dobrowolsky has examined the sensibility of the eye to spectral colours with different intensities of light (Pfluger's *Archiv*, v. 24, p. 189). From a large number of measurements it was found that, on an average, the red-colour sensation first occurred with a light-quantity equal to $\frac{1}{3283}$, while for blue the lowest amount of light was $\frac{1}{52535}$. Thus blue gives a sensation with an amount of light sixteen times less than that required for red. With rise in the degree of brightness, the increase of sensibility to red proceeds pretty regularly; but for blue the increase becomes gradually greater (with the weakest degrees of brightness this increase was = 0·22, with the strongest 0·82, with the mean 0·36). Comparing the two sensibilities together, from the maximum of light strength to the minimum, the sensibility to blue is always found to exceed that to red (maximum thirteen and a half times, minimum sixteen times, mean four times).

ISOETES LACUSTRIS.—In an interesting paper read before the Academy of Sciences of Paris (January 10, 1881), M. E. Mer calls attention to the peculiar conditions under which different forms of this fresh-water plant seem to originate in the Lake of Longemer. The basin of this lake was once occupied by a glacier, and now presents several different sorts of bottom. The soil to a depth of two to three metres is composed in part of a gravel formed of rock *débris* united by an iron cement, in part of ancient moraines, or where near the surface these will be mixed with the remains of plants and form a pretty tenacious mud. In all these situations Isoetes is to be found, but the plants differ most remarkably both as to their form, their structure, and their mode of reproduction as they are found in the different habitats. Taking the leaf-development as a guide, four varieties are easily discerned:—(1) *humilis*, growing sparsely in the gravel and sterile shallows, the leaves are not only few in number, but always of diminutive dimensions; sporange generally wanting or represented by a small cellular mass which rarely ever forms a propagule, and then these with puny leaves; (2) *stricta*, found on the borders of the lake or in the old alluvial, therefore in less sterile quarters than the preceding; leaves more numerous, stout, but still of small size; (3) *intermedia*, growing on ground formed of a mixture of mud and clay, either on the borders of the lake or at a depth of from one to two metres, leaves quite intermediate in character between the previous variety and the next; (4) *elatior*, growing on the clayey depths, with long leaves. The first form is always found isolated, and as to its asexual reproduction there is nothing more to be said; but the other three, according as they are subject to more or less heat, present each three varieties characterised by the mode of reproduction. 1. *Sporifera*, isolated individuals, mostly furnished with well-developed sporangia, stem large, roots numerous, leaves large. 2. *Gemmifera*, few fertile sporangia, but most of the leaves are furnished with propagula, and these well furnished with leaves, generally dextral, stem fairly developed. 3. *Sterilis*, individuals growing in compact masses, stems and roots slender, leaves not numerous, long and narrow, fertile sporangia very rare, and more often undeveloped masses of cells or abortive propagula. It would seem as if these facts had a practical interest to the collector, who may find in them a guide as to where to look for fertile specimens.

GEOGRAPHICAL NOTES

ON Friday, April 1, the French Geographical Society held a meeting in the large hall of the Sorbonne for the reception of Dr. Lenz on his return from Timbuctoo. M. Milne-Edwards was in the chair. Dr. Lenz, as our readers know, has been very successful, although his conclusions are adverse to the construction of a railway from the Niger to Algeria throughout the Sahara. On the following morning the Society received a telegram stating that Col. Flatters had been murdered by Touaregs at some distance from the Lebhkha Amagdor. In the evening the sad news was confirmed by an official message, stating that four starving Arabs from the mission had arrived at Ouargla, and that the Khobfa had left with four hundred mehari and camel horsemen to rescue the survivors, who were besieged south of Messaguer in the Touat region proper. Happily the news of the disaster to Col. Flatters' expedition has not yet been further confirmed, and authorities in Paris are inclined to believe that it has been much exaggerated, and that the story of the four natives has many elements of suspicion about it.

DR. LENZ, in his lecture at Paris, gave some interesting details on the present condition of Timbuctoo. Its houses are built of brick, and the population is now only 20,000. It has greatly decayed, and the inhabited part of the town is surrounded by great spaces covered with ruins. There are numerous schools and rich libraries. Dr. Lenz had a cordial reception, and every night during his twenty days' stay he was present at religious conferences which the learned men of the city held with his interpreter; the commentaries on the Koran formed the only subject of conversation. Timbuctoo is united with the Niger, six miles off, by a series of lakes, formerly canals. Dr. Lenz has also made some interesting observations on the Sahara, tending to confirm the conclusions of Rholfs and other recent scientific travellers as to the variety which is to be met with in the great desert. It is really a plateau about 300 metres in altitude, no part of it being below the level of the sea. Granite hills, sandy plains, shallow lakes, fertile oases, alternate over nearly the whole surface, while beasts of prey are rarely to be met with. Dr. Lenz will contribute a full account of his journey to the Berlin Africa Society, in whose journal many of his letters have already appeared.

IT is with sincere regret that we record the death of Lieut. Karl Weyprecht, at the age of forty-three, on March 29, of consumption. Lieut. Weyprecht will be known to our readers as the discoverer, with Lieut. Payr of Franz-Josef Land, in the Austro-Hungarian Expedition of 1872-4. His observations on the aurora borealis were of especial value, and he has published several papers on the subject. He was also the originator of the scheme for establishing a series of international observations around the Pole, which is likely to be realised next year.

THE Rev. G. Brown, the well-known representative of the church militant in the South Pacific, contributes to the new number of the Geographical Society's *Proceedings* a paper descriptive of a recent journey which he has made along the coasts of New Ireland and the adjacent islands, the latter including Sandwich Island, Portland Islands, and New Hanover. Dr. Benjamin Bradshaw, who has spent some years in collecting natural history specimens in the Upper Zambesi region, also contributes a brief paper on the Chobe River, together with a sketch-map of a portion of its course, adding materially to our knowledge of the geography of this region. Mr. Crocker's paper on Saráwak and Northern Borneo, lately read before the Society, is also given, and is illustrated with a good map. The geographical notes are full of interesting matter, one giving an account, by Mr. Sibiriakoff himself, of the voyage of the *Oscar Dickson* to the Yenisei Gulf in 1880. Another furnishes conclusive proof of the usefulness of the course of scientific instruction provided by the Council for intending travellers in foreign countries. From the last note we learn that Mr. C. R. Markham, the indefatigable secretary, is preparing for the forthcoming volume of the *Journal* a sketch of the Society's work in the past fifty years.

IN the current number of *Les Missions Catholiques*, Père Richard, a missionary in Algeria, commences an account of his journey, in company with Père Kermabon, among the Tuareg-Azguer tribes of the Sahara. The object of their journey was to study this almost unknown region, and to cultivate friendly relations with the chiefs and people generally with a view to the formation of a missionary station. The more interest attaches to Père Richard's narrative, as it deals with the very region which Col. Flatters has been now exploring with the object of settling the best practicable route for the projected Trans-Sahara railway. An entirely new map of this part of Africa, based on Père Richard's notes, accompanies the number.

A LATELY-ISSUED batch of *Reports* from H.M. Consuls (Part vi. of last year) contains useful geographical information respecting portions of South America, that relating to Chili and Peru being specially interesting at the present moment.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—On the 31st inst. the honorary degree of LL.D. was conferred on Prof. Helmholtz of Berlin at a special congregation.

Prof. Humphrey will take his usual May classes for the second M.B. and Natural Sciences Tripos next term, and the demonstrator will give demonstrations of the organs.

Prof. Babington will lecture on botany four times a week next term, beginning April 26. Mr. Hillhouse will give lectures on morphology and systematic botany, with practical work in the Botanical Gardens.

The Demonstrator of Comparative Anatomy will take an advanced class for instruction in the mammalia during the Easter term.

Prof. Stuart next term opens his new workshops and drawing office; in the latter instruction will be given in mechanical drawing and in machine designing, and also in graphical statics and its application to the theory of structures.

Mr. Garnett will commence an elementary course of lectures on electricity and magnetism on May 2 in the chemical laboratory of St. John's College.

The Senate has approved of Lord Rayleigh's appointment of two joint demonstrators of physics instead of one, and of the payment of a stipend of 100*l*. to each.

Mr. Balfour will lecture on the embryology of aves and mammalia next term, and have a practical class in that subject.

THE Court of Assistants of the Haberdashers' Company have have given to each of the schools under their management a cabinet of minerals, purchased from the executors of the late Prof. Tennant. The schools of the Company are at Monmouth, Newport, Hatcham, and Hoxton.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 3.—Constants of elasticity of fluor-spar, by H. Klang.—On the source of beats and beat-tones in harmonic intervals, by R. Koenig.—Description of a beat-tone apparatus for lecture experiments, by the same.—Contribution to the theory of resonance, by F. Kolacek.—Some applications of the law of dispersion to transparent, semi-transparent, and opaque media, by E. Ketteler.—Researches on the spectra of gaseous bodies, by F. Lippich.—On the electromotive force of galvanic combinations formed of zinc, sulphuric acid and platinum, or copper, silver, gold, or carbon, by C. Fromme.—On a new form of the Töpler mercury pump, and some experiments made with it, by E. Bessel-Hagen.—Researches on the height of the atmosphere and the constitution of gaseous heavenly bodies (continued), by A. Ritter.—On absorption of solar radiation by the carbonic acid of our atmosphere, by E. Lecher.—On the idea of galvanic polarisation, by W. Beetz.—On an artificially-formed body which takes polar directions and shows polar attractions, by W. Holtz.

Zeitschrift für wissenschaftliche Zoologie, vol. xxxv. part 2, February, 1881.—Dr. H. Adler, on the alternation of generations in the oak-gall insects, pp. 150-246, a very exhaustive treatise, with two admirably-coloured plates of the galls and one of the ovipositors, &c., of the gall-insects.—Hans Virchow, on the vessels in the eye and the appendages of the eyes in frogs, with two plates. Elias Metschnikoff, researches on the Orthonectidæ, with a plate.—Jos. Th. Cattie, contribution to a knowledge of the chorda supra-spinalis of the lepidoptera and of the central, peripheral, and sympathetic nerve systems in caterpillars, with a plate.—Dr. H. Bolau, on the pairing and propagation of a species of the genus Scyllium.—N. Kleinenberg, on the origin of the ova in Eudendrium (with a woodcut).

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 24.—"Observations on the Locomotive System of Echinodermata." (The Croonian Lecture.) By G. J. Romanes, M.A., F.R.S., and Prof. J. C. Ewart, M.D.

The principal results had reference to the tube-systems and nervous systems of the echinoderms. It was shown by injection that the ambulacral system and the so-called blood-vascular system are each closed systems, save at their common origin in the madreporic plate. Both systems communicate through this plate with the internal medium, but the one much more freely than the other, the ambulacral system being the least patent, so that it is only when a pressure of two feet is maintained for a number of hours that the injected fluid slowly permeates the stone-canal, or sand-tube, to ooze through the madreporic plate. Regarding the nervous system, it was found in Echinus that lateral branches arise from the five radial trunks to escape with the pedicels through the apertures of the pore plates. Each of these branches then courses down the pedicel, with which it escapes to the terminal sucker. From these lateral branches there also arises an intimate nerve-plexus, which covers the whole external surface of the shell, lying almost immediately beneath the surface epithelium, and extending from the shell to all the spines and pedicellariæ. In stained specimens the nerve-fibres and cells were traced to the capsular muscles at the bases of the spines, and delicate fibres were detected running up the spines and pedicellariæ, immediately below their epithelium. In the case of the pedicellariæ it appeared from several preparations that delicate fibres extended as far as the sensitive epithelial pod situated on the inner surface of each trident mandible, a short distance from the apex.

Such being the principal morphological results, the paper went on to detail a number of physiological experiments. First it was pointed out that the natural movements of echinodermata exhibit a high degree of co-ordination. Thus, for instance, all the echinoderms are able when inverted on a flat floor to right themselves. The common starfish does this by twisting the ends of two or more of its rays round, so as to bring the terminal suckers into action upon the floor of the tank, and then by a successive and similar action of the suckers further back in the series the whole ray is progressively twisted round, so that its ambulacral surface is applied flat against the floor. The rays which perform this action twist their spirals in the same direction, and by this concerted action drag the disk and the remaining rays over themselves as a fulcrum. Other species of starfish which have not their ambulacral suckers sufficiently developed to act in this way execute their righting movements by doubling under two or three of their adjacent rays, and turning a somersault over them, as in the previous case. Echinus rights itself when placed on its aboral pole, by the successive action of two or three adjacent rows of suckers—so gradually rising from aboral pole to equator, and then as gradually falling from equator to oral pole. Spatangus executes a similar manœuvre entirely by the successive pushing and propping action of its longer spines.

Experiments in stimulation showed that all the echinoderms observed sought to escape from injury in a direct line from the source of irritation. If two points of the surface are stimulated the direction of escape is the diagonal between them. When several points all round the animal are simultaneously stimulated the direction of advance becomes uncertain, with a marked tendency to rotation upon the vertical axis. If a short interval of time be allowed to elapse between the application of two successive stimuli the direction of advance will be in a straight line from the stimulus applied latest. If a circular band of injury be quickly made all the way round the equator of echinus, the animal crawls away from the broadest part of the band, *i.e.* from the *greatest amount* of injury.

The external nerve plexus supplies innervation to three sets of organs—the pedicels, the spines, and the pedicellariæ; for when any part of the external surface of echinus is touched, all the pedicels, spines, and pedicellariæ within reach of the point that is touched immediately approximate and close in upon the point, so holding fast to whatever body may be used as the instrument of stimulation. In executing this combined movement the pedicellariæ are the most active, the spines somewhat slower, and the pedicels very much slower. If the shape of the stimulating body admits of it, the forceps of the pedicellariæ seize the body and hold it till the spines and pedicels come up to assist.

And here we have proof of the function of the pedicellariæ. In climbing perpendicular or inclined surfaces of rock covered with waving seaweeds it must be no small advantage to an echinus to be provided on all sides with a multitude of forceps adapted, as described, to the instantaneous grasping and arresting of a passing frond; for in this way not only is an immediate hold obtained, but a moving piece of seaweed is held steady till the pedicels have time to establish a further and more permanent hold upon it with their sucking disks. That this is the chief function of the pedicellariæ is indicated by the facts that (1) if a piece of seaweed is drawn over the surface of an echinus this function may clearly be seen to be performed; (2) that the wonderfully tenacious grasp of the forceps is timed as to its duration with an apparent reference to the requirements of the pedicels, for after lasting about two minutes (which is about the time required for the suckers to bend over and fix themselves to the object held by the pedicellariæ, if such should be a suitable one) this wonderfully tenacious grasp is spontaneously released; and (3) that the most excitable part of the trident pedicellariæ is the inner surface of the mandibles, about a third of the way down their serrated edges, *i.e.* the part which a moving body cannot touch without being well within the grasp of the forceps.

When the forceps are closed they may generally be made immediately to expand by gently stroking the external surface of their bases.

With regard to stimulation of the spines, if severe irritation be applied to any part of the external or internal surface of an echinus, the spines all over the animal take on an active bristling movement. The tubercles at the bases of the spines are the most irritable points on the external surface.

With regard to stimulation of the pedicels, if an irritant be applied to any part of a row, all the pedicels in that row retract in succession from the seat of stimulation, but the influence does not extend to other rows. A contrary effect is produced by applying an irritant to any part of the external nerve-plexus, all the pedicels being then stimulated into increased activity. Of these antagonistic influences, the former, or inhibitory one, is the stronger, for if they are both in operation at the same time the pedicels are retracted.

Starfish (with the exception of brittle-stars) and echini crawl towards, and remain in, the light; but when their eye-spots are removed they no longer do so. When their eye-spots are left intact they can distinguish light of very feeble intensity.

Experiments in section showed that single rays detached from the organism crawl as fast and in as determinate a direction as do entire animals. They also crawl towards light, away from injuries, up perpendicular surfaces, and when inverted, right themselves. Dividing the ray-nerve in any part of its length has the effect of destroying all physiological continuity between the pedicels on either side of the division. Severing the nerve at the origin of each ray, or severing the nerve-ring between each ray, has the effect of totally destroying all co-ordination among the rays; therefore the animal can no longer crawl away from injuries, and when inverted it forms no definite plan for righting itself. Each ray acting for itself, without reference to the others, there is as a result a promiscuous distribution of spirals and doublings, which as often as not are acting in antagonism to one another. This division of the nerve usually induces, for some time after the operation, more or less tetanic-like rigidity of the rays. This operation however, although so completely destroying physiological continuity in the rows of pedicels and muscular system of the rays, does not destroy or perceptibly impair physiological continuity in the external nerve-plexus; for however much the nerve-ring and nerve-trunks may be injured, stimulation on the dorsal surface of the animals throws all the pedicels and muscular system of the rays into active movement. This fact proves that the pedicels and the muscles are all held in nervous connection with one another by the external plexus, without reference to the integrity of the main trunks.

If a cork-borer be rotated against the external surface of an echinus till the calcareous substance of the shell is reached, and therefore a continuous circular section of the overlying tissues effected, the spines and pedicellariæ within the circular area are physiologically separated from those without it, as regards their local reflex irritability. That is to say, if any part of this circular area is stimulated, all the spines and pedicellariæ within that area immediately respond to the stimulation in the ordinary way, while none of the spines or pedicellariæ surrounding the area are affected, and conversely. Therefore it is concluded that the function of the spines and pedicellariæ of localising and gathering round a seat of stimulation is exclusively dependent upon the external nervous plexus. If the line of injury is not a closed curve, so as not to produce a physiological island, the stimulating influence will radiate in straight lines from its source, but will not irradiate round the ends of the curve or line of injury.

Although the nervous connections on which the spines and pedicellariæ depend for their function of localising and closing round a seat of stimulation are thus shown to be completely destroyed by injury of the external plexus, other nervous connections, upon which another function of the spines depends, are not in the smallest degree impaired by such injury. This other function is that which brings about the general co-ordinated action of all the spines for the purposes of locomotion. That this function is not impaired by injury of the external plexus is proved by severely stimulating an area within a closed line of injury on the surface of the shell; all the spines over the whole surface of the animal then manifest their bristling movements, and by their co-ordinated action move the animal in a straight line of escape from the source of irritation.

We have, therefore, to distinguish between what may be called the local reflex function of the spines, which they show in common with the pedicellariæ, and which is exclusively dependent upon the external plexus, and what we may call the universal reflex function of the spines, which consists in their general co-ordinated action for the purposes of locomotion, and which is wholly independent of the external plexus. Evidently, therefore, this more universal function must depend upon some other set of nervous connections (which, however, the authors were not able to detect histologically), and experiment shows that these, if present, are distributed over all the *internal* surface of the shell. For if the internal surface be painted with acid, or scoured out with emery paper and brick-dust, the spines and pedicellariæ, after a short period of increased activity or bristling, become perfectly quiescent, lie flat, and lose both their spontaneity and irritability. After a few hours, however, the spontaneity and irritability of the spines return, though in a feeble degree, and also those of the pedicellariæ in a more marked degree. These effects take place over the whole external surface of the shell, if the whole of the internal surface be painted with acid or scoured with brick-dust; but if any part of the external surface be left unpainted or unscoured, the corresponding part of the external surface remains uninjured. From these experiments it is concluded:—(1) that the general co-ordination of the spines is wholly dependent on the integrity of the hypothetical internal plexus; (2) that the hypothetical internal plexus is everywhere in intimate connection with the external, apparently through the calcareous substance of the shell; and (3) that complete destruction of the former, while profoundly influencing through shock the functions of the latter, nevertheless does not wholly destroy them.

Echini may be divided into pieces, and the pedicels, spines, and pedicellariæ upon these pieces will continue to exhibit their functions of local reflex irritability, however small the pieces may be. If an entire double row of pedicels be divided out as a segment and then placed upon its aboral end, it may rear itself up on its oral end by the successive action of its pedicels, and then proceed to crawl about the floor of the tank. We have therefore to meet the question: Is the action of the ambulacral feet in executing these righting movements of a merely serial kind, *a*, *b*, and *c* first securing their hold on the tank floor, owing to the stimulus supplied by contact, and then by their traction tilting over the globe, till *d*, *e*, and *f* are able to touch the floor, and so on; *or* does the righting action depend upon nervous co-ordination? Experiments showed that both principles are combined, the action of the pedicels being serial, but also assisted by nervous co-ordination. This conclusion is sustained by the experiment of shaving off the spines and pedicels over one-half of one hemisphere, *i.e.* the half from the equator to the oral pole. When then inverted and forced to use their mutilated pedicel-rows, the echini reared themselves upon their equators, and then, having no more pedicels wherewith to continue the manœuvre, came to rest. This rest was permanent, the animal remaining, if accidents were excluded, upon its equator till it died. The question then here seems to resolve itself simply into this: Is the mechanism of the pedicels so constructed as to insure that their serial action shall always take place in the same direction? For if it can be shown that their serial action may take place indifferently in either direction it would follow that the persistency with which the partly shaved echini continue reared upon their equators, is the expression of some stimulus (such as a sense of gravity) continuously acting upon some central apparatus, and impelling the latter to a continuous, though fruitless, endeavour to co-ordinate the absent pedicels. If the pedicels are able to act serially in either direction, there is no more reason why a partly-shaved echinus should remain permanently reared upon its equator, than that it should remain permanently inverted upon its pole; and therefore the fact that in the latter position the pedicels set about an immediate rotation of the animal, while in the former, and quite as unnatural position, they hold the animal in persistent stasis—this fact tends to show that the righting movements of the pedicels are something more than serial. Thus the whole question as between the two hypotheses amounts to whether the pedicels are able to act serially from oral to aboral pole. Observation showed that they are so, for echini spontaneously rear themselves from their normal position on the oral pole, to the position of resting upon their equators. Further, as additional evidence that the righting movements are at least assisted by some centralising influence, is the fact that when the evolution is nearly completed by the pedicel-rows engaged in executing it, the lower pedicels in the other rows become strongly protruded and curved downwards, in anticipation of shortly coming into contact with the floor of the tank.

Removing the pentagonal nerve-ring has no effect at all upon the pedicellariæ or on the local reflex action of the spines; both these organs continue to close round an instrument of stimulation. But the general co-ordination of the spines is totally and permanently destroyed—their bristling movements no longer serving to convey the animal from a source of irritation, but only causing the animal aimlessly to gyrate. This shows that the pentagonal nerve-ring has in large measure the function of a nerve-centre. The same thing is shown by the effect of its removal upon the righting movements. These are gravely impaired, though not wholly destroyed—four in twelve specimens so mutilated continuing able to right themselves. These facts, together with the fact of separate segments of echinoderms behaving in all respects like entire animals, prove that the nervous system is in function, as in structure, everywhere both central and peripheral; although the impairing influence exerted on the co-ordination both of the spines and pedicels by removal of the pentagonal ring, proves that this ring has a more centralising function than any other part of the nervous system.

Chemical Society, March 30.—Anniversary Meeting.—The president, Prof. Roscoe, gave his annual address. He congratulated the Society on its flourishing condition. At no period in its history had the number of Fellows been so large, whilst the number of papers read during the past twelve months had increased both in number and in importance. The research fund founded by Dr. Longstaff had done much for the progress of science. The President touched upon the more important discoveries of the year. The supposed decomposition of chlorine and iodine by Victor Meyer has been found to be capable of another explanation. The solar and stellar evidence of the decomposition of metals accumulated by Mr. Lockyer has not yet found general acceptance by chemists. Capt. Abney and Col. Festing have discovered that the organic radicals methyl, ethyl, &c., give characteristic absorption spectra in the infra-red part of the spectrum. Baeyer has succeeded in preparing indigo artificially, and its manufacture on the commercial scale is rapidly progressing. The Society has lost by death ten Fellows, including Sir B. Brodie, Dr. Stenhouse, Prof. W. H. Miller, and Mr. Tennant.—The Longstaff medal was presented to Prof. Thorpe of the Yorkshire College, Leeds, as the Fellow who had done the most to promote chemical science by research.—The reports of the President and Treasurer were received and adopted, and the Officers and Council elected for the ensuing year. President, H. E. Roscoe. Vice-Presidents: F. A. Abel, Warren De La Rue, E. Frankland, J. H. Gladstone, A. W. Hofmann, W. Odling, Lyon Playfair, A. W. Williamson, A. Crum Brown, J. Dewar, J. H. Gilbert, A. V. Harcourt, J. E. Reynolds, J. Young. Secretaries: W. H. Perkin, H. E. Armstrong. Foreign Secretary, Hugo Müller. Treasurer, W. J. Russell. Council: F. D. Brown, M. Carteighe, H. McLeod, G. H. Makins, E. J. Mills, W. C. Roberts, C. Schorlemmer, J. M. Thomson, C. M. Tidy, W. Thorp, T. E. Thorpe, R. Warington.

Physical Society, March 26.—Prof. Fuller in the chair.—New member Mr. Lewis Wright, author and editor.—Dr. James Moser read a paper on electrostatic induction, especially relating to the branching of the induction in the differential inductometer and in the electrophorus. The author's experiments bore out the hypothesis of induction as enunciated by Faraday. Prof. Ayrton suggested the importance of adding guard-rings to the small plates of the five-plate inductometer or balance, since without these mathematical calculations could not be accurately applied, and the experimental determination of specific inductive capacity would be doubtful. Dr. Moser pointed out that though the theory was not absolutely correct it lay with the experimenter to get results very approximately correct.—Prof. Reinold, one of the secretaries of the Society, read a paper by himself and Prof. Rückert on the electrical resistance of liquid films with a revision of Newton's scale of colours. The experiments were in continuation of those published by the authors in 1877. Their object was to determine whether a film thinning under the action of gravity gave any evidence, by a change in its specific resistance, of an approach to a thickness equal to twice the radius of molecular attraction, and also to devise a method of finding the amount of water which might be absorbed by or evaporated from it. The thickness of the films was determined from their colour by means of two beams reflected from different mirrors on them.—Newton's scale of colours was revised by observations on Newton's rings, and partly by more than 2000 observations on the rings themselves. The thicknesses determined by direct observations on Newton's rings and those in the corrected table rarely differ by 1 per cent., while Newton's scale in parts differs from both by as much as 10 per cent. of the thickness. The films were formed from a solution of oleate of soda in glycerine, with a little nitrate of potash added to increase their electric conductivity. They were blown in a glass case from which the outer air could be excluded. Precautions were taken to keep the air in contact with the films inside the case at a proper humidity. These consisted in placing disks containing the solution at the bottom of the case and suspending within it sheets of blotting-paper, the lower edges of which dipped into the liquid. A hair hygrometer indicated changes in the humidity of the interior. The resistance of the films was measured by piercing them with gold wires, which were connected with the electrodes of a quadrant electrometer. The resistance of the film between the needles was calculated by comparing the deflection caused by the difference of potential of the two wires when a current was passing through the film with that produced by the difference of potential above and below a known resistance placed in the same circuit. The specific resistance of the liquid from which the films were formed was measured by a method identical in principle with the above. The liquid was contained in a glass tube with turned-up ends. Platinum wires were cemented into small holes drilled in the straight part of the tube, and their difference of potential compared with that of two points in the same circuit separated by a known resistance. This method has the great advantage of getting rid of any difficulties connected with polarisation. Test experiments on sulphuric acid proved the method to give results agreeing with those of Kohlrausch, who employed alternating currents and Wheatstone's bridge. The results of the experiments may be summed up as follows:—It is difficult to form a soap film under conditions precluding a slight evaporation or absorption of water, but the more nearly these conditions are attained the more closely does the specific resistance of the film agree with that of the liquid in mass. The films observed under the most favourable conditions obeyed Ohm's law with great accuracy, and much better than the others. The films indicate no approach to a thickness equal to the diameter of molecular attraction. A soap-film may even in an inclosed space readily loose 23 out of 57·7 volumes of water contained in every 100 volumes of the solution, when special precautions are not taken to maintain the surrounding space in a constant hygrometric condition. Prof. Ayrton suggested that in measuring the liquids and film the distance between the electrodes should be varied. Prof. Guthrie pointed out that the results of Prof. Reinold and Kohlrausch agreed with his own in showing that the conductivity of liquids obeyed Ohm's law.

Geological Society, March 23.—Robert Etheridge, F.R.S., president, in the chair.—Rev. Daniel Dutton and Capt. George Ernest A. Ross were elected Fellows of the Society.—The following communications were read:—The Upper Greensands and chloritic marl of the Isle of Wight, by C. Parkinson, F.G.S. In this paper the author described the Upper Greensand as exposed at St. Lawrence and along the Undercliff. At the base of the St. Lawrence Cliff there are hard bands of blue chert from which astaciform Crustacea have been obtained; and quite recently, in a large boulder of the same material lying on the beach, there were found the remains of a Chelonian, referred by Prof. Owen to the family Paludinosa, and named by him *Plastremys lata*. The presence of these freshwater organisms was thought to imply a connection with the Wealden continent. The chert-bed, 2 feet thick, was regarded by the author as marking the boundary between the Gault and the Greensand. Above it the author described 56 feet of compact red and yellow sands, of which the first 20 feet are unfossiliferous, the upper 32 feet show traces of organic remains; between them there is a fossiliferous zone 4 feet in thickness, containing *Ammonites inflatus*, *A. auritus*, and species of *Ponopæa*, *Cucullæa*, *Arca*, and *Trigonia*, and immediately below this a separate band containing an undetermined species of Ammonite. These sands are followed by 38 feet of alternate beds of hard chert and coarse greensands, having at the bottom 6 feet of inferior building-stone surmounted by 5 feet of freestone. The latter contains *Ammonites rostratus*, and the cherts various fossils, chiefly bivalves. *Clathraria Lyelli* also occurs at this level. Above the greensands come 6 feet of chloritic marl: the upper 3½ feet fossiliferous, with a base of hard phosphatic nodules containing crushed specimens of *Pecten asper*; the lower 2½ feet compact, with darker grains and few fossils. The author compared the sections of this series given by Capt. Ibbetson and Dr. Barrois; his own views closely correspond with those of the latter writer.—On the flow of an ice-sheet, and its connection with glacial phenomena, by Clement Reid, F.G.S. The author considers that the boulder-clays have been formed beneath an ice-sheet, and consequently there must have been formerly a huge mass of ice, which would have to flow 500 miles on a nearly level surface, and then to ascend a gentle slope for nearly another 100 miles. He does not think a great piling up of the ice at the North Pole can be assumed to account for this motion. This he explains by the gradual passage of the earth's heat through the mass of ice, raising the temperature of the whole instead of liquefying the surface-layer. As the heat passes upwards it raises the temperature of a particular layer, causes it to expand, and so to put a strain upon the layer above, and then to rupture it. The broken part spreads out, reunites by regelation, and then, receiving the heat from the layer below, again expands and ruptures the layer next above. Thus the movement is from the base upwards rather than from the surface downwards. The author estimates that the ice-sheet in Norfolk was only about 400 feet thick, because boulder-clay does not appear above that level, but only coarse boulder-gravel; in North Yorkshire it extends up to about 900 feet. The author considers that the shell-beds of Moel Tryfaen were not deposited under water, but thrust up-hill by this advancing ice-sheet.—Soil-cap motion, by R. W. Coppinger, communicated by the president. The author described numerous cases in Patagonia where the stumps, &c., of trees are to be seen in the marginal waters of the sea and of lakes. These, together with stones and rocks, sometimes simulating perched blocks, he considers to have been brought down by the motion of the soil-cap—a thick spongy mass resting upon rock often worn smooth by the action of ice, and so sliding down the more easily under the influence of vegetation. The appearances are not unlike those due to subsidence; but he points out that all the evidence is in favour of recent upheaval, instead of subsidence.

Victoria (Philosophical) Institute, April 4.—Prof. Balfour Stewart, F.R.S., read a paper on the visible universe, which he described in general terms, and then sought to trace its history back, giving a passing sketch of the views of the theologian on the one hand and the materialist on the other, through its many forms to its first logical origin. A discussion ensued, which was taken part in by several who had been specially invited, the question being treated from the scientific and the metaphysical point of view.

Paris

Academy of Sciences, March 28.—M. Wurtz in the chair.—On account of the death of M. Delesse, the Academy went early into Secret Committee.—The following papers were communicated:—On the heats of formation of diallyl, chloro-compounds, and aldehyde, by MM. Berthelot and Ogier.—Remarkable case of globular lightning; diffuse flashes near the surface of the ground, by M. Trécul. On August 25, 1880, during a thunderstorm, and in full daylight, he saw a very brilliant body, slightly elongated (say 38 to 40 ctm. long by 25 ctm. broad), and with conical ends, pass from one part of a dark cloud to another; and before disappearing, a small part of its substance fell, *as if having weight*, and gave a luminous vertical track with reddish globules at the sides. It divided in falling, and disappeared a little above the houses. The other phenomenon M. Trécul has often noticed in thunderstorms, viz., a band of feeble light, momentarily illuminating a street and reaching right across it, or only part of the width. The author adds some reflections on the phenomena he described on August 23, 1880.—On the representation of numbers by forms, by M. Poincaré.—On a class of linear differential equations, by M. Halphen.—On the reduction of positive quaternary quadratic forms, by M. Charve.—New researches on the winter egg of phylloxera; its discovery at Montpellier, by M. Mayet. To find the winter egg in Languedoc, he recommends searching on young American vines of the species *Riparia*, and only where galls are observed on the leaves; further, only raising the bark of two or three years (preferably the former).—Attempted application of the principle of Carnot to electro-chemical actions, by M. Chaperon.—On the construction of photophonic selenium-receivers, by M. Mercadier. These consist of two strips of brass (1 to 4 or 5m. long) separated by two strips of parchment paper, the whole wound in a close spiral, and held in position by two wooden pieces with screws. The arrangement is heated to the melting-point of selenium, and a pencil of selenium passed over the surface. These receivers are continuous, are easily made and repaired, have the same properties as the discontinuous ones, &c. It is possible to give them a very variable resistance, from 8000 to 200,000 ohms., without their ceasing to act well. A large nnmber arranged in series or in surface may be placed in the battery circuit, and many persons enabled to hear photophonic effects at once. In one of M. Mercadier's arrangements the sounds were heard at 2 or 3 m. distance.—On the causes of disturbance of telephonic transmission, by M. Gaiffe. He notices the disturbing effects of friction of wires with each other, and of vibrations caused by wind or otherwise.—On the preparation and the properties of protochloride of chromium, and of sulphate of protoxide of chromium, by M. Moissan.—On phosphoplatinic combinations, by M. Pomey.—Products of action of hydrochlorate of ammonia on glycerine, by M. Etard.—Irian grafts; pathogeny of cysts and epithelial tumours of the iris, by M. Masse. He has found (with rabbits) that small pieces of the conjunctiva or of skin introduced into the anterior chamber of the eye, through an incision made in the cornea, are pretty easily grafted on the iris. After some time the graft takes the form of a fine small pearl, very like the cysts or epithelial tumours which sometimes appear on the human iris after wounds of the cornea. The grafts with skin consist of a thick layer of pavement epithelium, with connective tissue beneath united to that of the iris In the centre of the grafts of conjunctiva a true cystic cavity is developed. Hairs with their follicles may also be grafted on the iris. Rothmund's theory of the cause of cysts and tumours of the iris (pieces of skin, &c., carried through a wound) is apparently verified by these researches.—On the nature and order of appearance of old eruptive rocks observed in the region of volcanoes with craters of Puy-de-Dôme, by M. Julien.

Vienna

Imperial Academy of Sciences, March 31.—V. Burg in the chair.—The following papers were read:—H. Wild, on the temperatures of the Russian Empire.—Dr. H. Goldschmidt, on the action of molecular silver on carbon chlorides.—Dr. F. Hocevar, on some experiments made with a Holtz's machine.—R. Andrasch, synthesis of methylated parabanic acid, of methyl thioparabanic acid, and of thiocholestrophane.—Dr. Emil Holub and A. v. Pezeln, ornithological results of Holub's voyages in South Africa.—Kachler and Spitzer, on Borneol- and camphor-carbonic acid.—Max Gröger, on sulphochromates.—Alb. Cobenzl, contribution to the dissociation of tungsten from antimony, arsenic, and iron, with an analysis of a so-called pseudo-meteor.

CONTENTS

PAGE
THE ARYAN VILLAGE. By EDWARD B. TYLOR, F.R.S. 525
NILE GLEANINGS 526
LETTERS TO THE EDITOR:—
Improved Arrangement of Scale for Reflecting Instruments.—F. JACOB (*With Diagram*) 527
A Note on Flame-Length.—LEWIS T. WRIGHT 527
Future Development of Electrical Appliances.—GEORGE RAYLEIGH VICARS 528
Prehistoric Europe.—R. H. TIDDEMAN 528
Induction Current from Leyden-jar Discharge.—W. LARDEN (*With Diagram*) 529
Classification of the Indo-Chinese and Oceanic Races.—A. H. KEANE 529
Crabs and Actinia.—Col. H. STUART WORTLEY 529
Migration of the Wagtail.—N. J. 529
Sound of the Aurora.—GEORGE F. BURDER 529
Earthquake Warnings.—H. M. C. 529
ON THE EARTHQUAKES AT AGRAM IN 1880-81. By Prof. SZABO . . 530
THE ST. PETERSBURG DYNAMITE MINE 531
FISH-CULTURE IN THE UNITED STATES 532
THE PARIS OBSERVATORY (*With Illustrations*) 533
ACHILLE DELESSE 535
PROFESSOR HELMHOLTZ'S FARADAY LECTURE 535
NOTES 540
OUR ASTRONOMICAL COLUMN:—
The Variable Stars U Cephei and U Geminorum 542
The Comet of 1812 542
BIOLOGICAL NOTES:—
The Shining Slave-Maker (*Polyergus lucidus*) 543
On the Red Colour of Salt Cod 543
Marine Isopods of New England 543
Statistics of Disease in Italy 543
The Eye and Intensity of Colour 543
Isoetes lacustris 544
GEOGRAPHICAL NOTES 544
UNIVERSITY AND EDUCATIONAL INTELLIGENCE 544
SCIENTIFIC SERIALS 545
SOCIETIES AND ACADEMIES 545